Appendices to the Report of Roger Howkins

Vertical Transportation Engineer | Lifts | Arup

Grenfell Tower Inquiry | September 2020

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Appendix 1

Table of key parts of the relevant standards relating to firefighting lifts, and corresponding sections of the B&Y specification

	BS 2655-1: 1970	BS 5588-5: 1991	BS EN 81-72: 2003	BS 5588-5: 2004	Butler & Young 2004 Specification
Definition	4: Firemen's lift	2.10: Firefighting Lift - A lift designated to have additional protection, with controls that enable it to be used under the direct control of the fire service in event of fire.	3.5: Firefighters Lift - A lift installed primarily intended for passengers use which has additional protection, controls and signals which enable it to be used under the direct control of the fire service.	3.12: Firefighting lift - lift with fire protection measures, including controls that enable it to be used under the direct control of the fire service in fighting a fire.	
Provision of FF shafts	4.1: Firemen's lifts may be required by the Fire Authority and their positioning is the subject of agreement between this Authority and the architect.	3.6: Buildings over 15m.		7.1.1: Buildings over 18m.	
General				7.2.4: Fire-fighting lift installations should conform to BS EN 81-72 and to BS EN 81-1 or BS EN 81-2 as appropriate for the particular type of lift.	
Environmental			5.1.2(a): Electrical/electronic landing control - function in temperatures of between 0 to 65 degrees C for a period equal to		2A.06 - The lift is required to function under the following conditions without prejudicing the overall performance -

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			that required for the structure.		Temperature between +5oC and +40oC
			5.1.2(b): All other electrical components not in the fire protected lobby - function in temperatures of between 0 to 40 degrees C.		
			5.1.2(c): Correct functioning of the lift control shall be ensured in smoke filled wells and/or machine rooms for the period equal to that required for the structure.		
Service			5.2.2: Shall serve every floor of the building.		1.1.1 - Serving - 21 floors, 21 openings

Lift car	4.2: The lift shall have an effective platform area not less than 1.45m2 or 15 ½ ft2 and be capable of carrying a load not less than 550kg or 1200 lb. 4.3: The lift shall have power operated doors giving a minimum clear opening width of 0.80m or 2 ft 9 in and arranged to remain open whilst the lift car is at a floor when under 'fire control' conditions.	11.2(a): Dimensions should comply with BS 5655.	5.2.3: Size of the FF lift shall preferably be selected from ISO 4190-1. At no time shall the size be less than 1 100 mm wide by 1 400 mm deep with a rated load of 630 kg. The minimum clear entrance width to the car shall be 800 mm.	7.2.7: The construction and design of fire-fighting lift cars, together with the installation of fire-fighting lifts, should conform to BS EN 81-72.	1.1.1 - Capacity - 12 person/900kg Car size - 1400mm wide x 1450mm deep x 2200 high clear approximately. Door - single panel side opening in patterned stainless steel 900mm wide x 2000mm high
		11.2(b): Frame and main structure should be made of materials of limited combustibility.			21.47 Lift Car: Enclosure… The car walls, ceiling and front return panels plus the car and landing doors and architraves shall be fabricated in 16 gauge, 316 grade patterned stainless steel…
Speed	4.4: The speed of the lift shall be such that it will run its full travel in not more than one minute.	11.2(c): Speed - it should run its full travel in not more than 1 minute.	5.2.4: The firefighters lift shall reach the furthest floor from the fire service access level within 60 s, see also 0.5 from after the closing of the lift doors.		1.1.1 - Speed - 2.0 mps. Travel - 62.75m.

Trap door		11.2(d): Emergency trap door complying with 8.12 of BS 5655-1: 1986 should be provided.	5.4.1: An emergency trap door shall be provided in the roof of the car measuring a minimum of 0,5 m 0,7 m. The emergency trap door shall conform to 8.12 of EN 81-1:1998 and EN 81-2:1998.	7.2.7: Fire-fighting lift cars should be provided with a means of external rescue of trapped fire-fighters in the lift car.	
Landing doors					
Signage		11.2(e): Should be clearly and conspicuously marked - firefighting lift: do not use for goods or refuse.		7.2.7: Should be clearly and conspicuously marked - firefighting lift: do not use for goods or refuse.	
Water protection - lift well		12.2(b): Electrical equipment within the FF lift well located within 1m of any wall separating the lift well from a lift lobby should be provided with enclosures - classified to IPX32.	5.3.1: Electrical equipment within the FF lift well and on the car, located within 1,0 m of any wall containing a landing door, shall be protected from dripping and splashing water or provided with enclosures - classified to IPX3.	7.2.8: To minimize the effect of water penetration, electrical equipment within the fire-fighting lift well and on the car should be protected against water in accordance with BS EN 81-72.	

		12.2(c): Electrical equipment necessary for the operation of the firefighting lift should not be installed within 1m of the bottom of the lift well.	5.3.2: Electrical equipment located less than 1m above the lift pit floor shall be protected to IP67.		
			5.3.5: Means shall be provided to prevent the water level in the pit from reaching equipment which could create a malfunction of the firefighters lift.		
Machine room		13(a): Should be sited within the firefighting shaft.	5.7.1: Any compartment containing the lift machine and its associated equipment shall be provided with at least the same degree of fire protection as is given to the lift well.		
		13(a)(1): Should be separated from the stair, lobby and lift well by fire resisting construction.			
		13(a)(2): Should be located above the firefighting lift well and accessible by way of the firefighting stair.			
		13(b): Should comply with BS 5655.			
		13(c): Should be protected from the entrance of water.			

Fire control switch and system - position and signage	4.5.1: Switch in a box marked 'fire control - adjacent to the lift opening at fire control level. Position of switch should make clear which lift it controls or a notice indicating which lift it controls.	14.2(a): Firefighting lift switch should be positioned near the lift landing door and clearly marked.	5.8.1: A firefighters lift switch shall be located in the lobby intended to be used as the firefighters service access level. The switch shall be located within 2 m horizontally from the firefighters lift, at a height between 1,8 m and 2,1 m above floor level. It shall be marked with a firefighters lift pictogram.	8.1: Fire-fighting lift control systems should conform to BS EN 81-72. A fire-fighting lift switch should be provided to enable the fire service to obtain immediate control of the fire-fighting lift(s) in a fire-fighting shaft. Provision should be made to control access to the fire-fighting switch. If there are two or more lifts installed together, there should be clear indication as to which lift is the fire-fighting lift.	2A.70 - Firemans Control
Fire control switch and system - function	4.5.3: Should ensure the safety devices remain operative, switch will bring the firemen's lift car to the fire control level without delay and with doors parked open. All landing call points and control switches shall be rendered inoperative, sole control vested in the car control station.	14.2: Should ensure: landing call buttons and car control station - rendered inoperative. all lifts return to FSAL. sole control should then be vested in the firefighting lift car control station.	Should ensure: 5.8.7: Phase 1 - landing controls - rendered inoperative all lifts return to FSAL 5.8.8: Phase 2 - sole control should then be vested in the firefighters car control panel	8.2: Should ensure: Phase 1 - landing controls - rendered inoperative all lifts return to FSAL Phase 2 - sole control should then be vested in the firefighters car control panel	Under firemans control, car and landing calls shall be cancelled and rendered inoperative. Lifts will travel to the ground floor, doors will open and remain open. Car pushes shall assume control. Registration of a car call and closure of the doors shall only be by sustained pressure on a lift car push. Lift doors shall only be opened at floor level by sustained pressure

					on the door open push and if released before the doors fully open the doors shall close.
Fire control switch and system - key	4.5.2: Only one fire switch shall be provided. The switch shall be of a type which does not require a key for operation e.g. a switch with two press buttons, or a tumbler switch marked "FIRE CONTROL", "ON" and "OFF". Where a two button switch is used the operated button shall remain depressed to indicate which button is in operation.		5.8.2: Operation of the firefighters lift switch shall be by means of the emergency unlocking triangle, as defined in annex B of EN 81-1:1998 and EN 81-2:1998. The operating positions of the switch shall be bi-stable and clearly marked `1' and '0'. In position '1' Firefighters service is initiated.		
Fire service communications system		15.1(a): Intercom - two way speech communication between the FF lift car and both FSAL and FF lift machine room. 15.1(c): Microphone and speaker, not a telephone.	5.12.1: Intercom - two way speech communication between the FF lift car and both FSAL and FF lift machine room.	8.4: A lift communication system conforming to BS EN 81-72 should be provided as part of the fire-fighting lift installation and should be separate from the fire service communications system.	2A.54 Lift Car: Hands Free Auto Dialling System - provides for a hands free auto dialling system which is capable of dialling a minimum of three separate locations. 2A.55 Car Intercom and CCTV Equipment provides for the existing intercom equipment to be dismantled, stored, re-installed and commissioned by

					RBKC contractor Eversafe.
Power supply - protection		16.1: Both the primary and secondary sources of power to the firefighting shaft need to be sufficiently protected against fire and water damage and also to be separated from each other.	5.1.6: The firefighters lift primary and secondary electrical power supply cables shall be fire protected and separated from each other and other power supplies.		
Secondary power supply - capacity		16.2(b): Should be able to maintain in operation the FF lift, normal lighting within the FF shaft, the communications system etc.	5.9.2: The secondary power supply shall be sufficient to run the firefighters lift at the rated load and to satisfy the time requirement referred to in 5.2.4.	14.1(1): Should be able to maintain in operation the FF lift, normal lighting within the FF shaft, the communications system etc.	
Secondary power supply - timing		16.2: Should operate within 30s of the failure of the primary electrical supply.		14.1: Should operate within 30s of the failure of the primary electrical supply.	

Secondary power supply - location		16.2(d)(1): Should be located in a protected shaft.		14.2(a): Should be located in a protected shaft.	
Secondary power supply - protection		16.2(d)(2): Should be protected against fire for a period not less than that required for the structural fire protection of the FF shaft.	5.9.1: The level of fire protection shall be at least equal to that given to the lift well (see annex C).	14.2(b): Should be protected against fire for a period not less than that required for the structural fire protection of the FF shaft.	
				8.3: The system design should be in accordance with BS EN 81-72. Changeover of electrical supplies should be in accordance with BS EN 81-72.	
Maintenance		17.2(b): Weekly operation of the FF lift switch.			
		17.2(d): 6 monthly inspection of FF lift.			
		17.2(e): Annual operational testing of FF lift controls.			

Appendix 2

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BRE Global Client Report

Grenfell Tower Fire Investigation – On Site Investigation Interim Report, work to 31st January 2018

Prepared for: Metropolitan Police Service

Date: 9th March 2018

Report Number: P109378-1012 Issue: 1

www.bre.co.uk

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Grenfell Tower Fire Investigation - On-Site Investigation Interim Report, work to 31st January 2018

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Executive Summary

This is an interim report, submitted at the request of the Metropolitan Police Service (MPS) to inform the Police-led investigation and other parties as to suggested lines of inquiry to pursue based upon work carried out to date.

This interim report is based on site investigation work at Grenfell Tower carried out between 14th June 2017 and 31st January 2018 by BRE Global.

Any new information or changes to current information and/or assumptions may necessitate review or modification of the findings and/or conclusions of this report.

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1 Introduction

1 This is an interim report, submitted at the request of the Metropolitan Police Service (MPS) to inform the Police-led investigation and other parties as to suggested lines of inquiry to pursue based upon work carried out to date.

2 This interim report is based on site investigation work at Grenfell Tower carried out between 14th June 2017 and 31st January 2018 by BRE Global.

3 Site investigation work is expected to continue into March 2018 and the findings detailed in this report may need to be updated in light of the findings of this further work.

4 On 14th June 2017, a fire broke out in Grenfell Tower, Grenfell Road, London, W11 1TG (the Tower). The fire spread extensively, resulting in 71 deaths, 74 confirmed hospitalisations due to injuries (admissions up until midday on 15th June 2017), and many more people being evacuated from their homes both in the Tower and the surrounding area. BRE Global Ltd (hereafter BRE) has been commissioned to provide support to the Metropolitan Police Service (MPS) in relation to the investigation of the fire.

5 MPS has given BRE the following overarching aims:

5.1 To establish the circumstances surrounding all or as many of the deaths resulting from the fire as possible.

5.2 To establish whether there have been any failings of duty of care owed to the victims of the fire (both fatalities and surviving residents).

5.3 To provide expert witness support in relation to any criminal prosecution, public inquiry or inquests arising from the above.

6 In order to address the above aims, it was agreed that BRE's programme of work is to address the following objectives:

6.1 How the fire spread from the item or items first ignited to involve the façade of Grenfell Tower.

6.2 How the external envelope of Grenfell Tower performed in relation to:

6.2.1 spread of fire and smoke and the deaths of the victims;

6.2.2 compliance with Building Regulations [1];

6.2.3 compliance with the Regulatory Reform (Fire Safety) Order 2005 [2]; and

6.2.4 any other fire safety related duty of care owed by duty holders to the victims of the fire.

6.3 How the general construction and fire precautions at Grenfell Tower performed in relation to:

6.3.1 spread of fire and smoke and the deaths of the victims;

6.3.2 compliance with Building Regulations;

6.3.3 compliance with the Regulatory Reform (Fire Safety) Order 2005; and

6.3.4 any other fire safety related duty of care owed by duty holders to the victims of the fire.

7 A programme of work has been developed by BRE and agreed with MPS. It is anticipated that the programme of work will need to evolve as findings from the programme of work are gained; however at present the programme of work includes the following tasks:

7.1 A detailed on-site examination gathering all relevant physical evidence regarding the building and its fire safety systems.

7.2 Standard fire tests and derived experiments to be carried out on relevant fire safety features such that their fire performance can be determined.

7.2.1 Small scale British Standard tests relevant to the regulatory compliance of components of the façade [3][4][5].

7.2.2 Small scale European standard tests relevant to the regulatory compliance of components of the façade [6][7][8][9][10].

7.2.3 Small scale British Standard tests for determination of fire properties of components from across the Tower [11].

7.2.4 Large scale British Standard tests and ad-hoc experiments on the façade system [12].

7.2.5 British Standard fire resistance tests on doors [13][14].

7.2.6 Experimental fridge freezer fires utilising the International Standard fire test room [15], to quantify the size of fire such a fridge freezer could produce in a compartment fire.

7.3 A reconstruction of the fire [16] in the flat of origin, in particular examining spread of the fire to the façade system. The reconstruction rig will be used for two tasks:

7.3.1 A reconstruction of the fire that occurred in the flat of fire origin, examining how the fire spread from items ignited to involve the façade of Grenfell Tower.

7.3.2 A repeat of the above, with the inclusion of a suitable sprinkler system, to examine how such a system might have impacted on fire development and spread.

7.4 A review of building documentation and evidence from the fire to determine design and actual (i.e. as built) construction of the block and level of performance afforded by the fire safety systems that were provided. This includes support to MPS to assist its officers with the process of reviewing all documentation disclosed by all relevant parties and parties under investigation.

7.5 A review of the locations where deceased were found with respect to the flats where these residents lived or were visiting to identify possible movement (if any) through the building immediately prior to death.

7.6 A review of witness statements, 999 call transcripts, and eyewitness photographs and videos to establish spread of fire and smoke and performance of building fire safety systems as witnessed (or recorded and/or obtained posthumously) by people in and around the Tower. This will include support to MPS to assist its officers with the process of taking witness statements and basic interpretation of photographic and video data of the fire.

7.7 Computer modelling of smoke movement and fire spread throughout common parts of the block to establish how the performance of the building and its fire safety systems may have impacted upon:

7.7.1 the ability and willingness of residents to use means of escape, and

7.7.2 the effectiveness of fire and rescue response by London Fire Brigade. (Note, however, BRE will not be commenting upon the effectiveness offire and rescue response by London Fire Brigade, nor on the performance of any of the emergency services.)

7.8 A review of all of the above work packages (upon their completion) to identify whether there is any need for them to be revisited in light of evidence obtained from previous work packages. There will also be ongoing interaction with the Forensic Examination Review Group (FERG) setup by MPS to provide independent oversight of the entire forensic process in relation to Grenfell Tower.

7.9 Review of all the above points to identify fire spread and fire safety issues relevant to the circumstances of each fatality.

7.10 Review of all the above points in relation to fire safety related duties of care owed by all duty holders in respect of:

7.10.1 initial construction of the block;

7.10.2 refurbishments between construction and 2014;

7.10.3 refurbishment of the block in 2014-2016;

7.10.4 ongoing management of fire safety by the responsible person under the Regulatory Reform (Fire Safety) Order 2005; and

7.10.5 ongoing management of tenants in relation to the Housing Acts [17][18]and the Smoke and Carbon Monoxide Alarm Regulations [19].

7.11 Expert witness support to any criminal prosecutions, inquests and the Public Inquiry as needed.

7.12 General technical support to the public inquiry when requested via the Memorandum of Understanding signed between MPS and the Public Inquiry [20].

8 This report is primarily concerned with findings in relation to the on-site investigation (item 7.1 above).

9 This report is not, in its current format, prepared in accordance with the requirements of Part 19 of the Criminal Procedure Rules [21]. However, work has been carried out in anticipation of such a need arising. To that end, it is confirmed that the contents of this report have been prepared impartially, with honesty and due care. This report makes clear where opinions are being expressed and where any assumptions have had to be made. Opinions are expressed only where BRE staff are competent to render such an opinion. Staff that have carried out work for this report but are not authors ofthis report are listed at Appendix A. CVs of the authors and peer reviewer are provided at Appendix B.

10 This report is based upon information gathered by BRE staff and other members of the MPS led team involved in investigating the fire that occurred on 14th June 2017. Any new information or changes to current information and/or assumptions may necessitate review or modification of the findings of this report.

2 Description of On-Site Investigation

11 BRE has been conducting an on-site investigation at Grenfell Tower since 14th June 2017, and has maintained a permanent presence at the investigation at the Tower from that date until the time of writing of this report. BRE has been working as part of the Grenfell Tower forensic team, led by MPS. Other organisations in the forensic team have been:

11.1 Origin and cause:

11.1.1 London Fire Brigade

11.1.2 Key Forensic Services

11.1.3 Bureau Veritas UK Ltd

11.2 RINA Consulting Ltd – Electrical survey

11.3 CORGI Services Ltd – Gas survey

11.4 WSP – Building Management System

12 The site of Grenfell Tower became potentially extremely hazardous as a result of the fire. Extensive work has been undertaken by numerous organisations to manage the safety of the Tower following the fire to enable a number of activities, including the BRE on-site examination, to occur in as safe a manner as possible. In addition to the forensic team above, BRE wishes to thank the Forensic Team and MPS and the following organisations for their parts in these efforts:

12.1 The Health and Safety Executive

12.2 Harrow Building Control

12.3 Wates Construction

12.4 Deconstruct (UK) Ltd

12.5 Mattison Scaffolding Ltd

12.6 Derisk (UK) Ltd

12.7 Michael Barclay Partnership LLP

12.8 Environtec Ltd

12.9 Plowman Craven Ltd

12.10 Kenyon International Emergency Services Inc

12.11 UK National Disaster Victim Identification Unit

13 The aims and objectives for the BRE on-site investigation are as follows:

13.1 To collect as much physical evidence as possible in relation to

13.1.1 Patterns of fire damage, fire spread and smoke spread at Grenfell Tower (externally and internally)

13.1.2 The fire protection systems at Grenfell Tower

13.1.3 The general construction of Grenfell Tower relevant to fire safety

13.2 To compare the physical evidence of the construction and fire protection of Grenfell Tower with the recommendations of the edition of Approved Document B which was in effect at the time of the last building work to be carried out at Grenfell Tower [22] (see Chapter 4.3 for rationale and impact assessment of previous versions of AD B having been in place). Note that departure from the recommendations of Approved Document B does not necessarily mean a breach or breaches of the Building Regulations; however it will provide lines of enquiry for other tasks and the overall investigation.

14 The methodology for the on-site investigation has developed over the course of the investigation. The overarching principles for the investigation have been developed in line with the Code of Practice for Investigators of Fires and Explosions for the Criminal Justice Systems in the UK [23]. However, there are two priorities which have taken precedence over the forensic examination:

14.1 The health and safety of all personnel working in and around the Tower.

14.2 The recovery of remains of victims of the fire.

15 Given the foregoing, the BRE on-site investigation has progressed as follows:

15.1 A preliminary investigation was carried out from the afternoon of 14th June 2017 until the night of 20th June 2017. This phase of the investigation was urgent, driven by the risk that the Tower might collapse, which would have resulted in the loss of much of the evidence. Entry to the Tower was undertaken whilst the structure was being closely monitored for movement and with measures in place for rapid evacuation of the Tower. Investigators sought to capture an overview of the fire safety features of the Tower in case this became the sole source of evidence available to the investigation.

15.2 Once emergency propping to the Tower was completed and additional safety precautions were put into place, priority shifted to the safe recovery of remains of victims of the fire. This recovery would necessitate large numbers of search officers, anthropologists and archaeologists accessing all of the fire damaged flats to sift debris. However, the preliminary investigation had revealed a need for a detailed examination of the front doors or remains of front doors to all of the flats in the building. The doors on upper floors had been completely destroyed, with only door ironmongery left in the debris on the floor. BRE therefore undertook a fingertip search of all of the front door thresholds, to attempt to find what ironmongery remained and where it had landed on the floor. This would assist identification of what type of door was present at each flat, its condition and whether it was likely to have been in the open or closed position at the time that it burnt through. This phase lasted fom 23rd June 2017 to 10th July 2017 and, once the examination of each flat was completed, released the Disaster Victim Identification (DVI) teams to commence their work to identify and recover all of the remains from the Tower.

15.3 From this point on, BRE's work phases overlapped each other but are described here in the order in which they were commenced in the Tower.

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15.4 Plans for full propping to the Tower and scaffolding of the Tower began to be formalised by organisations brought in by MPS to manage the Tower as a construction site (see list above). It was established at this stage that both propping and scaffolding would be most disruptive to flats, but much less so to the lobbies, lift and stair cores. Priority was therefore then given to the examination of flats. All flats were to be examined by BRE and the order in which flats were examined was dictated by the priority that needed to be given to propping in the various parts of the Tower, the objective being wherever possible to retrieve evidence prior to there being a risk of it being disturbed or destroyed by works needed. This work phase lasted from13th July 2017 to 21st December 2017.

15.5 The scaffolding of the Tower required fixing into a stable structure due to its height. Initial investigations by the contractor team had determined that the core containing the lobbies, lifts and stairs was the preferred structure for the fixing of the scaffolding, as this had suffered the least damage and was a continuous structure down into the basement of the Tower. This approach would necessitate fixing all the way through the fats from the outside of the building into the core. In addition to the need to examine flats detailed above, there was also a need to complete the examination of the smoke control system, as ventilation shafts are fixed to the outside of the shear walls forming the core, and would need to be destroyed to enable fixing. The approach was later modified so that fixing would be into the structural walls between flats, as these are understood by BRE to have been subsequently examined and found to be of sufficient strength to provide this function. Examination of the smoke control system was carried out by the BRE Heating, Ventilation and Air Conditioning (HVAC) team, under instruction from the BRE Fire Investigation team. This work phase lasted from 26th July 2017 to 10th August 2017.

15.6 Construction of scaffolding was needed for a number of reasons, including the need to safely access the surviving façade for its examination and removal as evidence, the need to cover the Tower as understood to be requested by the majority of community groups, and the eventual need for a safe means to demolish the Tower. The construction of the façade and the need to fix the scaffolding into the structure of the Tower meant that it would not be possible to build scaffolding without damaging or destroying evidence. A scaffold construction plan was therefore developed by the construction team in discussion with BRE and MPS regarding the forensic needs of the scaffolding. It was agreed that scaffolding would be built up to the floors for which façade removal was needed, the scaffolding handed over to MPS/BRE so that removal could be carried out, and then scaffolding would be built up to the next floor for handover and removal. Construction of the scaffolding began on 4th September 2017. BRE's work on the scaffold was due to be completed on 31st January 2018. However, lumps of concrete began falling off of the Tower on Monday 18th December 2017, resulting in works being halted for the safety of personnel. At the time of writing, an alternative scaffold plan is being designed and constructed by the construction team to catch any further debris that falls from the fire damaged parts of the external face above where works need to be completed. Completion of the removal of evidence from the façade is therefore currently anticipated to be in March 2018.

15.7 The final phase of the on-site investigation is to examine all aspects of the Tower which have not been affected by the aforementioned issues. These include the lobbies, stairwell, lift shafts, service risers, bin chutes and the dry riser. This final phase commenced in December 2017 and is due to be completed by March 2018.

3 T rends

16 The trend data set out in this chapter summ arises the key findings in relation to volume fire safety features of the tower, in particular:

16.1 Flat front doors

16.2 Dam age to flats

16.3 Presence of fire resisting entrance halls in flats

16.4 Sm oke and heat detection in flats

16.5 Fire stopping

16.6 Dam pers in smoke control system

17 All data in this chapter is liable to change as quality control of evidence and analysis across all flats is ongoing at the time of writing. In particular, ongoing analysis will seek to reduce the number of unknowns in the tables.

3.1 Flat front doors

18 Table 1 prov ides current data relating to flat front doors (further work is ongoing to attempt to reduce the number of unknowns currently in this table). As shown by Figure 1, 45 percent of flat front doors from Floor 4 to Floor 23 did not have a working door closer installed ("Door closer present but not working" plus "Door closer absent), 38 percent were unknown ("Door closer found but unconfirmed if working" plus "unknown if door closer installed") with 17 percent of flat front doors with working door closers.

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Table 1 – Summary flat front door findings

Floor	Flat	Door in-situ?	Door leaf type	Door frame type	Glazing in door?	Door closer present?	Door closer type	Working door closer?	Door open/closed
4	Flat 11	Yes	Composite	Composite	Yes	No	N/a	N/a	Closed
	Flat 12	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 13	Yes	Composite	Composite	No	Unknown	N/a	Unknown	Closed
	Flat 14	Yes	Composite	Composite	No	Yes	Overhead	Yes	Closed
	Flat 15	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 16	Yes	Composite	Composite	Yes	No	N/a	N/a	N/A
5	Flat 21	Yes	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 22	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 23	Yes	Composite	Composite	Yes	Yes	Concealed	Yes	Closed
	Flat 24	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 25	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 26	Yes	Composite	Composite	Unknown	Yes	Concealed	No	Open
6	Flat 31	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 32	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 33	Yes	Composite	Composite	Yes	Yes	Overhead	Yes	Closed
	Flat 34	Yes	Composite	Composite	No	Yes	Overhead	Yes	Closed
	Flat 35	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 36	Yes	Composite	Composite	No	Yes	Concealed	Unknown	Closed
7	Flat 41	Yes	Composite	Composite	No	No	N/a	N/a	Open
	Flat 42	Yes	Composite	Composite	Yes	Yes	Concealed	No	Closed
	Flat 43	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 44	No	Composite	Composite	Yes	Yes	Concealed	No	Open
	Flat 45	No	Composite	Composite	Yes	No	N/a	N/a	Open
	Flat 46	Yes	Composite	Composite	Yes	Yes	Concealed	Unknown	Unknown
8	Flat 51	Yes	Composite	Composite	Yes	Yes	Concealed	Yes	Closed
	Flat 52	Yes	Composite	Composite	Yes	Yes	Concealed	No	Closed
	Flat 53	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 54	Yes	Composite	Composite	Unknown	No	N/a	N/a	Closed
	Flat 55	No	Composite	Composite	No	Unknown	Unknown	Unknown	Closed
	Flat 56	Yes	Timber	Timber	No	Yes	Concealed	Unknown	Closed
9	Flat 61	No	Timber	Timber	No	Yes	Concealed	Yes	Closed
	Flat 62	Yes	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 63	Yes	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 64	No	Composite	Composite	No	Yes	Concealed	Unknown	Unknown
	Flat 65	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed
	Flat 66	No	Composite	Composite	No	No	N/a	N/a	Open

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Floor	Flat	Door in-situ?	Door leaf type	Door frame type	Glazing in door?	Door closer present?	Door closer type	Working door closer?	Door open/closed
10	Flat 71	Yes	Composite	Composite	Yes	No	N/a	N/a	Unknown
	Flat 72	Yes	Composite	Composite	Yes	No	N/a	N/a	Closed
	Flat 73	No	Composite	Composite	Unknown	No	N/a	N/a	Unknown
	Flat 74	No	Composite	Composite	Unknown	Yes	Concealed	No	Closed
	Flat 75	No	Composite	Composite	Unknown	No	N/a	N/a	Unknown
	Flat 76	No	Composite	Composite	Unknown	No	N/a	N/a	Unknown
11	Flat 81	No	Composite	Composite	Unknown	Yes	Concealed	Unknown	Closed
	Flat 82	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 83	Yes	Composite	Composite	Yes	Yes	Concealed	Unknown	Closed
	Flat 84	No	Composite	Composite	Unknown	Yes	Concealed	No	Unknown
	Flat 85	No	Composite	Composite	Unknown	Yes	Concealed	Unknown	Closed
	Flat 86	No	Timber	Timber	Unknown	Yes	Concealed	Unknown	Unknown
12	Flat 91	No	Timber	Timber	Unknown	Yes	Concealed	Yes	Closed
	Flat 92	No	Timber	Timber	Unknown	Yes	Concealed	Unknown	Unknown
	Flat 93	Yes	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 94	No	Composite	Composite	Yes	No	N/a	N/a	Unknown
	Flat 95	No	Composite	Composite	No	No	N/a	N/a	Unknown
	Flat 96	No	Composite	Composite	Unknown	Yes	Concealed	No	Closed
13	Flat 101	No	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 102	No	Composite	Composite	No	Yes	Concealed	No	Unknown
	Flat 103	No	Composite	Composite	Yes	No	N/a	N/a	Closed
	Flat 104	No	Composite	Composite	Yes	Yes	Concealed	Unknown	Closed
	Flat 105	No	Timber	Timber	No	Yes	Concealed	Unknown	Unknown
	Flat 106	No	Composite	Composite	No	No	N/a	N/a	Closed
14	Flat 111	No	Composite	Composite	Unknown	Yes	Concealed	No	Closed
	Flat 112	No	Timber	Timber	No	Yes	Overhead	No	Unknown
	Flat 113	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
	Flat 114	No	Composite	Composite	Unknown	Yes	Concealed	Yes	Closed
	Flat 115	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Closed
	Flat 116	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
15	Flat 121	No	Composite	Composite	Yes	Yes	Concealed	Yes	Closed
	Flat 122	No	Composite	Composite	Yes	No	N/a	N/a	Closed
	Flat 123	No	Composite	Composite	Yes	Yes	Concealed	No	Closed
	Flat 124	No	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 125	No	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 126	No	Composite	Timber	No	No	N/a	N/a	Closed

Floor	Flat	Door in-situ?	Door leaf type	Door frame type	Glazing in door?	Door closer present?	Door closer type	Working door closer?	Door open/closed
16	Flat 131	No	Composite	Composite	No	Unknown	Unknown	Unknown	Closed
	Flat 132	No	Composite	Composite	No	Unknown	Unknown	Unknown	Closed
	Flat 133	No	Composite	Composite	No	Unknown	Unknown	Unknown	Unknown
	Flat 134	No	Composite	Composite	No	Unknown	Unknown	Unknown	Closed
	Flat 135	No	Composite	Composite	Yes	Unknown	Unknown	Unknown	Closed
	Flat 136	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
17	Flat 141	No	Composite	Composite	Yes	Yes	Concealed	Unknown	Closed
	Flat 142	No	Timber	Timber	No	Yes	Concealed	Unknown	Closed
	Flat 143	No	Composite	Composite	Yes	Yes	Concealed	Unknown	Closed
	Flat 144	Yes	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 145	No	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 146	No	Composite	Composite	No	No	N/a	N/a	Closed
18	Flat 151	No	Composite	Composite	Yes	Yes	Overhead	Yes	Closed
	Flat 152	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
	Flat 153	No	Composite	Composite	No	Yes	Concealed	No	Unknown
	Flat 154	No	Timber	Timber	No	Yes	Concealed	Yes	Closed
	Flat 155	No	Composite	Composite	No	Yes	Concealed	Unknown	Unknown
	Flat 156	No	Timber	Timber	No	Yes	Concealed	Yes	Closed
19	Flat 161	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Closed
	Flat 162	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Closed
	Flat 163	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
	Flat 164	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
	Flat 165	No	Composite	Composite	Unknown	Unknown	Unknown	Unknown	Unknown
	Flat 166	No	Timber	Timber	Unknown	Unknown	Unknown	Unknown	Unknown
20	Flat 171	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed
	Flat 172	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed
	Flat 173	No	Composite	Composite	Unknown	Yes	Concealed	Unknown	Unknown
	Flat 174	No	Timber	Timber	No	Yes	Concealed	Unknown	Closed
	Flat 175	No	Composite	Composite	No	Yes	Concealed	Unknown	Unknown
	Flat 176	No	Composite	Composite	No	No	N/a	N/a	Closed
21	Flat 181	No	Composite	Composite	Unknown	Yes	Concealed	Yes	Closed
	Flat 182	No	Composite	Composite	Unknown	Yes	Concealed	Unknown	Unknown
	Flat 183	No	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 184	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed
	Flat 185	No	Timber	Timber	No	Yes	Concealed	Unknown	Unknown
	Flat 186	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed

Floor	Flat	Door in-situ?	Door leaf type	Door frame type	Glazing in door?	Door closer present?	Door closer type	Working door closer?	Door open/closed
22	Flat 191	No	Composite	Composite	No	Yes	Concealed	Unknown	Closed
	Flat 192	No	Composite	Composite	No	Yes	Concealed	No	Closed
	Flat 193	No	Composite	Composite	No	Yes	Concealed	No	Unknown
	Flat 194	No	Composite	Composite	No	No	N/a	N/a	Open
	Flat 195	No	Timber	Timber	No	Yes	Overhead	No	Unknown
	Flat 196	No	Composite	Composite	Yes	Yes	Concealed	Unknown	Closed
23	Flat 201	No	Composite	Composite	No	Yes	Concealed	Yes	Closed
	Flat 202	No	Timber	Timber	No	Yes	Overhead	No	Unknown
	Flat 203	No	Composite	Composite	No	No	N/a	N/a	Closed
	Flat 204	No	Composite	Composite	No	Yes	Concealed	No	Unknown
	Flat 205	No	Composite	Composite	No	No	N/a	N/a	Unknown
	Flat 206	No	Timber	Timber	No	Yes	Concealed	Yes	Closed

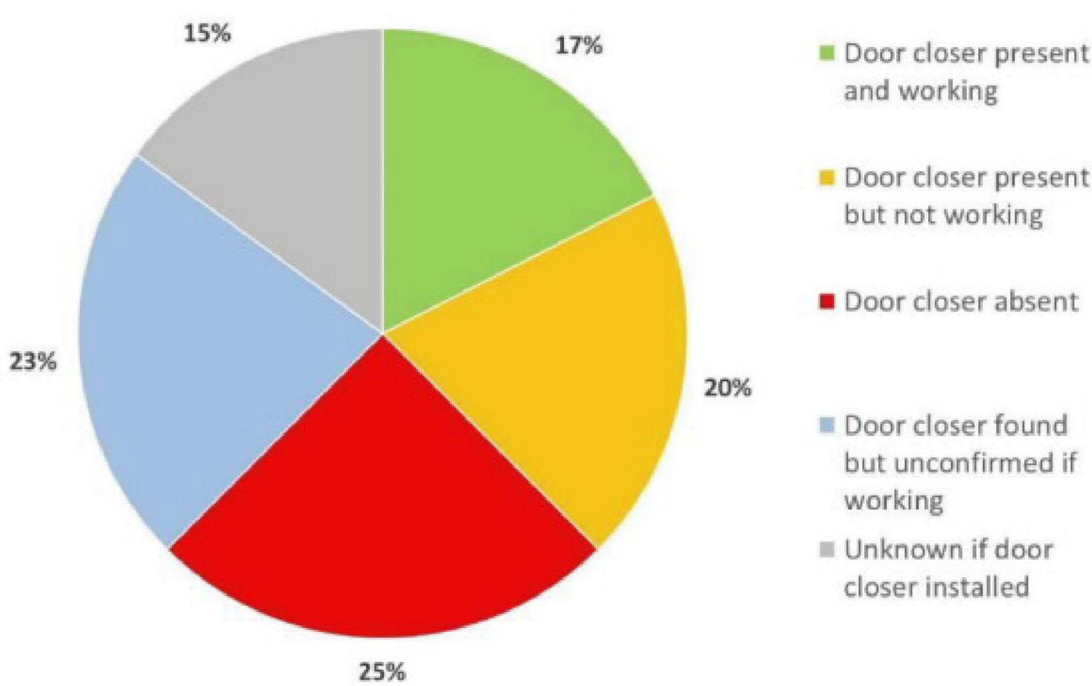

Figure 1 – Chart showing percentage of working versus non-working door closers from Floor 4 to Floor 23 (120 flats)

3.2 Flat internal surveys

19 Damage to flats generally increases with height up the Tower; a summary of the extent of damage to each flat is provided at Table 2 and Table 3.

20 The following levels were used to assess non-structural damage within flats:

20.1 0 – No damage

20.2 1 – Smoke and/or fire damage <1m^2

20.3 2 – Smoke and/or damage limited to 1 room

20.4 3 – Fire damage to multiple rooms

20.5 4 – Fire damage throughout flat with evidence of partitions remaining

20.6 5 – Flat consumed by fire

Table 2 – Trends across Tower showing extent of damage to flat fixtures, fittings and contents of flats

Floor	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
23	5	5	5	5	5	5
22	5	5	5	5	5	5
21	5	5	5	5	5	5
20	5	5	5	5	5	5
19	5	5	5	4	5	5
18	5	5	5	4	5	5
17	5	4	5	4	5	5
16	5	5	5	4	5	4
15	5	5	5	4	5	5
14	5	5	5	5	5	5
13	5	5	5	5	5	5
12	5	5	3	5	5	5
11	5	3	3	5	5	5
10	3	1	4	5	5	5
9	3	1	3	4	5	5
8	2	0	2	3	5	5
7	1	1	3	5	4	4
6	4	1	2	1	3	4
5	2	0	1	1	3	4
4	1	0	0	0	3	3

21 The following levels were used to assess the spalling within flats:

21.1 0 – no spalling (this does not indicate no fire/smoke damage)

21.2 1 – spalling but no exposure of reinforcing steel

21.3 2 – single layer of reinforcing steel exposed

21.4 3 – double layer of reinforcing steel exposed

21.5 4 – double layer of reinforcing steel exposed and/or reinforcing steel has snapped.

Table 3 – Trends across Tower showing extent of spalling of concrete and whether the floor slab was deflected across flats, from 23rd floor down to 4th floor. The table provides an average of spalling throughout the flat and the worst level of spalling. Deflection is noted where it could be observed by the naked eye

Floor	Type	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
23	Average	2	2	2	1	2	2
	Worst	2	3	2	2	2	3
	Deflection	-	-	-	Y	-	Y
22	Average	1	2	1	1	2	2
	Worst	2	4	4	2	3	3
	Deflection	Y	Y	Y	Y	Y	Y
21	Average	2	1	2	1	1	1
	Worst	3	3	3	2	3	3
	Deflection	Y	Y	Y	-	Y	Y
20	Average	1	1	2	1	1	1
	Worst	2	2	2	3	2	2
	Deflection	Y	-	Y	Y	-	-
19	Average	1	1	1	0	1	1
	Worst	2	2	3	2	2	2
	Deflection	Y	Y	-	-	Y	Y
18	Average	1	1	1	1	1	1
	Worst	2	2	2	2	2	3
	Deflection	Y	Y	Y	-	-	Y
17	Average	2	1	0	0	1	1
	Worst	2	2	2	2	2	2
	Deflection	-	-	-	-	-	Y
16	Average	1	1	1	0	0	1
	Worst	3	3	4	0	2	2
	Deflection	Y	Y	Y	Y	Y	Y
15	Average	1	1	1	1	0	1
	Worst	1	3	3	2	2	2
	Deflection	Y	-	Y	Y	Y	Y
14	Average	1	1	1	1	1	1
	Worst	1	3	2	2	4	2
	Deflection	Y	Y	Y	Y	Y	-

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Floor	Type	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
13	Average	3	1	1	1	2	1
	Worst	4	3	3	2	4	2
	Deflection	Y	Y	-	Y	Y	Y
12	Average	1	1	0	1	1	1
	Worst	2	2	0	2	2	3
	Deflection	-	-	-	-	-	-
11	Average	1	0	0	1	1	2
	Worst	3	0	0	2	3	3
	Deflection	-	-	-	-	-	-
10	Average	0	0	1	1	1	1
	Worst	0	0	4	3	3	3
	Deflection	-	-	-	-	-	-
9	Average	0	0	0	1	1	1
	Worst	0	0	0	3	2	3
	Deflection	-	-	-	-	-	-
8	Average	0	0	0	0	2	1
	Worst	0	0	0	3	3	4
	Deflection	-	-	-	-	-	-
7	Average	0	0	0	2	0	1
	Worst	0	0	0	3	2	4
	Deflection	-	-	-	-	-	-
6	Average	1	0	0	0	0	0
	Worst	3	0	0	0	0	2
	Deflection	-	-	-	-	-	-
5	Average	0	0	0	0	0	1
	Worst	0	0	0	0	0	3
	Deflection	-	-	-	-	-	-
4	Average	0	0	0	0	0	1
	Worst	0	0	0	0	0	2
	Deflection	-	-	-	-	-	-

22 Internal lobbies to the indiv idual flats have been examined to determine whether they comply with all of the recommendations for a fire protected entranceway at the time of the original construction of Grenfell. In Table 4 below, a "no" applies both to lobbies which do not comply with these recommendations and to lobbies where it is unclear whether they comply with these recommendations. Non-compliance arising solely from issues of actions or inactions on the part of residents (outside ofthe control of the landlord) and which might be categorised as maintenance, have not been considered as part of this current review (i.e. a lobby whose construction complies with the recommendations but for which the rising butt hinges no longer provide a self-closing function due to wear and/or lack of lubrication, is still considered compliant), though it may be considered later.

Table 4 – Trends across flats showing whether or not a compliant fire protected entrance hall has been found to be provided in each of the flats

Floor	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
23	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
22	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
21	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
20	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
19	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
18	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
17	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
16	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
15	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
14	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
13	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
12	Unknown	Unknown	Yes	Unknown	Unknown	Unknown
11	Unknown	No	Unknown	Unknown	Unknown	Unknown
10	Yes	No	Unknown	Unknown	Unknown	Unknown
9	No	Yes	Yes	Unknown	Unknown	Unknown
8	No	Yes	No	Yes	Unknown	Unknown
7	Yes	Yes	Yes	No	No	No
6	No	Yes	Yes	No	Yes	Yes
5	No	No	Yes	Yes	Yes	No
4	Yes	Yes	Yes	No	No	Yes

23 Prov ision of fire alarms within individual flats has been examined and is summarised at Table 5. Detection is deemed to be compliant where a smoke detector is provided in the flat lobby and a heat detector is provided in the kitchen and both have hardwired power supplies. Similar to internal lobbies, action by residents which hinder the operation of fire alarms have not been considered as part of this current review (i.e. a smoke detector which has been taped over is still considered compliant), though it may be considered later.

Table 5 – Trends across flats showing whether fire detection is considered compliant (smoke detector in entrance hall and heat detector in kitchen)

Floor	Detection	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
23	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
22	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
21	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Floor	Detection	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
20	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
19	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
18	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
17	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
16	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
15	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
14	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
13	Smoke	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
12	Smoke	Unknown	Unknown	Yes	Unknown	Unknown	Unknown
	Heat	Unknown	Unknown	Yes	Unknown	Unknown	Unknown
11	Smoke	Unknown	Yes	Unknown	Unknown	Unknown	Unknown
	Heat	Unknown	No	Unknown	Unknown	Unknown	Unknown
10	Smoke	Yes	Yes	Unknown	Unknown	Unknown	Unknown
	Heat	Yes	Yes	Unknown	Unknown	Unknown	Unknown
9	Smoke	Unknown	Yes	Yes	Unknown	Unknown	Unknown
	Heat	No	Yes	Unknown	Unknown	Unknown	Unknown
8	Smoke	Yes	Yes	Unknown	Yes	Unknown	Unknown
	Heat	Yes	Yes	Yes	Yes	Unknown	Unknown
7	Smoke	Yes	Yes	No	Unknown	Yes	Yes
	Heat	Yes	Yes	Unknown	Unknown	Yes	Yes
6	Smoke	Yes	Yes	Yes	Yes	Yes	Yes
	Heat	Yes	Yes	Yes	Yes	Yes	Yes
5	Smoke	Yes	Yes	Yes	Yes	Yes	Unknown
	Heat	Yes	Yes	Yes	Yes	Yes	Unknown
4	Smoke	Yes	Yes	Yes	Yes	Yes	Unknown
	Heat	Yes	Yes	Yes	Yes	Yes	Unknown

24 Provision of fire stopping around services entering individual flats has been examined and is summarised in Table 7. Fire stopping is deemed to be compliant where all examined fire stopping has been found to be compliant. Where there is any one example of inadequate fire stopping, then the overall fire stopping to that flat has been deemed to be non-compliant. Note that fire stopping which has not been accessible due to suspected presence of asbestos has been excluded; once inspected this may lead to flats currently considered compliant to become non-compliant.

Table 6 – Trends across flats showing whether all inspected fire stopping is considered compliant to each flat

Floor	Flat 1	Flat 2	Flat 3	Flat 4	Flat 5	Flat 6
23	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
22	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
21	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
20	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
19	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
18	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
17	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
16	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
15	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
14	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
13	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
12	Yes	Unknown	Yes	Unknown	Unknown	Yes
11	Yes	Yes	Yes	Yes	Yes	Yes
10	Yes	No	Unknown	Unknown	Yes	Unknown
9	Unknown	No	Unknown	Yes	Yes	Unknown
8	Unknown	No	No	No	Yes	Unknown
7	Yes	Yes	No	Unknown	Unknown	Unknown
6	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	No	Yes	Unknown

3.3 Smoke control dampers

25 A list of lobby smoke dampers is shown in Table 7, including its as-found (by BRE) open/closed position. It is notable that all dampers on Floor 11 were open, and on Floor 18 the south side dampers were open and the north side dampers closed.

Table 7 – Summary of BRE visual inspection of lobby smoke dampers

	Lower (supply) dampers as found status		Upper (extract) dampers as found status		BRE observations
Floor	Left hand side (LHS)	Right hand side (RHS)	LHS	RHS	
Ground	Closed (1 damper in riser ceiling)		Closed (1 damper in lobby wall)		Both dampers clean, no smoke residues
1	Closed (1 damper in lobby wall)		Closed (1 damper in lobby wall)		Both dampers clean, no smoke residues
2	Closed (1 damper in lobby ceiling)		Closed (1 damper in lobby ceiling)		Both dampers clean, no smoke residues
3	Closed (1 damper in lobby wall)		Closed (1 damper in lobby wall)		Both dampers clean, no smoke residues

	Lower (supply) dampers as found status		Upper (extract) dampers as found status		BRE observations
Floor	**Left hand side (LHS)**	**Right hand side (RHS)**	**LHS**	**RHS**	
4	Closed	Closed	Closed	Closed	Water damage to all dampers but smoke residues on supply dampers only. Smoke pattern on extract dampers showed contact points on edge of frames had lower smoke residues
5	Closed	Closed	Closed	Closed	Water damage and smoke residues on all dampers. Lower levels of smoke residue on damper blade tip contact points
6	Closed	Closed	Closed	Closed	Water damage on all dampers. No smoke residue on supply dampers and minimal residues on extract dampers. Lower levels of smoke residue on extract damper blade and frame edge contact points
7	***Slightly open***	Closed	Closed	Closed	Extract damper had even coverage of smoke residue except contact points on edges of frames and blade tips which were clean
8	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were clean
9	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were clean
10	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were clean
11	***Open***	***Open***	***Open***	***Open***	All visible damper surfaces had smoke residues
12	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were clean
13	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean.
14	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean

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	Lower (supply) dampers as found status		Upper (extract) dampers as found status		BRE observations
Floor	Left hand side (LHS)	Right hand side (RHS)	LHS	RHS	
15	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean
16	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean
17	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips had clean areas
18	***Open***	***Open***	Closed	Closed	All dampers had smoke residues but on extract dampers contact points on frame edge and blade tips were mostly clean
19	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean
20	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips had clean areas
21	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean
22	Closed	Closed	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean
23	Closed	***Middle damper blade slightly open***	Closed	Closed	All dampers had smoke residues but contact points on frame edge and blade tips were mostly clean (except slightly open damper blade)

Note to above table: Once the smoke extract system had been activated all dampers becom extracts.

4 Key Findings

4.1 Fire spread and damage across Tower

26 BRE understands from London Fire Brigade, Key Forensic and Bureau Veritas that the fire started in a fridge freezer in the kitchen of Flat 4-6 (Flat 16) on the fourth floor.

27 The fridge freezer is understood to have been situated within 1m of the kitchen window in Flat 4-6 and the large casement of the kitchen window (left of the fan light) is understood to have been in the tilt-open position. The position of the smaller casement (under the fan light) is not known at the time of writing this report. A fire involving the fridge freezer would, in BRE's opinion, generate flaming sufficient to impinge upon the construction of the kitchen window. The construction ofthe window, in BRE's opinion (and based on the evidence presented above), did not provide any substantial barrier to fire taking hold on the façade outside.

28 Given the foregoing, it is BRE's opinion that there are the following options which need to be considered for the path of fire spread to the façade:

28.1 Flames extending to and out of the open window, impinging on the aluminium external skin of the façade, melting the aluminium and igniting the polyethylene core underneath;

28.2 Flames extending to and out of the open window, then igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the Aluminium Composite Material (ACM);

28.3 Flames extending to and out of the open window, then entering the façade cavity via a gap in the ACM panels and igniting the rigid foam insulation facing into the cavity;

28.4 Flames igniting the extractor fan and/or the infill panel it is installed in, then flaming from these impinging on the aluminium external skin of the façade, melting the aluminium and igniting the polyethylene core underneath;

28.5 Flames igniting the extractor fan and/or the infill panel it is installed in, then flaming from these igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the ACM;

28.6 Flames igniting the extractor fan and/or the infill panel it is installed in, then flaming from these entering the façade cavity via a gap in the ACM panels and igniting the rigid insulation facing into the cavity;

28.7 Flames burning and/or deforming the construction around the window (uPVC, insulation and rubberised membrane), igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the ACM;

28.8 Flames burning and/or deforming the construction around the window (uPVC, insulation and rubberised membrane), igniting the rigid insulation facing into the cavity.

29 These hypotheses are not mutually exclusive and will be tested as part of the ongoing programme of work, with the aim of narrowing the number of possible hypotheses.

30 The physical evidence from the examination of the façade indicates (to BRE) a route for fire spread up the column adjacent to the kitchen of Flat 16. This route is provided by the combustible components in the construction and the lack of appropriate subdivision of this fuel to prevent fire involvement of one component involving the next. Spread of fire laterally across the façade of Grenfell Tower appears to have occurred via both columns and spandrel cassettes. As above, the combustible components of the façade provide a potential route for fire spread. Downward fire spread appears to have occurred, primarily as a result of burning droplets of polyethylene falling and igniting combustible materials below.

31 The various deficiencies identified in the construction of the façade could all have contributed to the spread of the fire described above. It is BRE's opinion that all of these would have contributed to some extent, though some will be more significant than others. The ongoing programme of work will seek to assess the relative significance of these.

32 As fire spread across the façade, it encountered windows of flats. It is BRE's opinion that the mechanisms of spread out of the window of Flat 16 to the façade would also allow spread back into flats from the façade. In particular, it is BRE's opinion that there are three principal options regarding the mechanism of fire spread back into flats:

32.1 The fire spreading across the façade led to flames breaking windows and/or extending in through open windows, igniting the contents of the flats;

32.2 The fire spreading across the façade led to flames breaking windows and/or extending in through open windows, igniting the internal linings of the fats;

32.3 The fire spreading across the façade breaching the construction around the windows, introducing flames inside of flats from the façade.

33 Once the fire was in any one flat, fire growth would initially occur within the room first involved, with smoke and fire going on to impact upon other rooms in the flat, depending on whether or not doors within the flat were open (unless fire had already spread to other rooms via the façade). Any single flat, once involved in fire, would be expected to be substantively destroyed as a flat is normally designed to be a single fire compartment. The severity of fire within any one flat would likely become limited by the ventilation provided by the broken windows of the flat and/or the flat front door if the door was open or burned away. The duration of fire within any one flat will be dependent upon the fire load within. This sequence of development and the factors involved would apply to all flats which ignited during the course of the incident.

34 As set out in Chapter 3.2, the severity and duration of the fire within each flat led to spalling and in some cases deflection of the concrete floor slabs within the flats. The patterns of spalling damage vary across flats with at least one flat per floor (from 4th to 23rd) having some level of spalling. The spalling survey undertaken by BRE investigators did not focus on measuring the depth of spalling but rather graded the level of spalling visually based upon the level of exposure of the reinforcing bars within the concrete. There was no obvious visible deflection of the floor slab below the 13th floor. Between the 4th floor and 16th floor there are 29 flats where the concrete has not spalled with the number of flats with spalling increasing up the Tower. Using data for the worst level of spalling in a flat (rather than average) the majority of damage is Level 2 or exposure of the first layer of reinforcing bars. There are nine flats where these reinforcing bars have snapped or the extent of the spalling exposed the end of a bar causing it to drop from the ceiling – this was considered the worst level of spalling. There is only very limited consistency in the pattern of spalling when considering the Tower as whole. However, this information may become more significant later in the investigation process once witness evidence and photographic evidence is collated with regards to the duration of fire in each flat.

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35 The common parts, in particular the lobbies and stairwell, have patterns of damage which vary considerably across the height of the building; there is not a consistent increase in damage progressing up the building. The protection of one area from another by fire resisting construction is only as good as the weakest point in the fire resisting construction. Whilst the concrete structure has (in BRE's opinion) performed extremely well in terms of its loadbearing capacity and the fire resistance integrity and insulation through the concrete itself, fire and smoke have entered lobbies and stairwells to extents which indicate weaknesses in the compartmentation between flats and the common parts. In particular, there is substantial smoke damage to the lobby on the fifth floor and seventh floor, and fire damage to the lobby on the 10th floor and 11th floor. These floors are significant as they are below the line at which there is total destruction of flats at the 13th floor and this damage may indicate significant impacts on viability of means of escape via the single stairwell.

36 There are two principal factors affecting the extent to which flat front doors have afforded protection between flats and lobbies:

36.1 Whether the doors, as supplied, provided the recommended period of fire resistance; 60 minutes;

36.2 Whether the doors closed as they should do under the action of self-closing devices, such that the doorset (i.e. the door and its frame) could provide some protection between flats and lobbies.

37 Across the upper floors; 9th floor and above, the majority of flat front doors are destroyed. Therefore at some point during the fire each of these doors has "failed", and fire and smoke has spread across the threshold where a barrier to fire spread ought to have been provided. However, given the length of time the fire was burning, it is not currently clear whether this "failure" means:

37.1 The door provided the level of protection expected, held back fire and smoke for a reasonable period of time and, assuming no other failures in compartmentation, protected the means of escape and firefighting access for a reasonable period of time. In this case its failure is solely an outcome of it being exposed to conditions of a severity and/or duration that exceeds that which the door should be able to withstand.

37.2 The door, although closed, did not provide the level of protection expected, allowing fire and smoke to spread more quickly to affect the means of escape and firefighting access than ought to have been the case. In this case its failure is an outcome of the doorset, or one of the components within the doorset, failing sooner than ought to have been case.

37.3 The door was left open and therefore provided no barrier to the spread of fire and smoke. In this case the only component of interest is the closer; whether it was present and working. The fire performance or otherwise of the other aspects of the door are of no use if the door remains open.

38 The doors which burnt through in the open position are:

38.1 Flat 7-4 (Flat 44);

38.2 Flat 7-5 (Flat 45);

38.3 Flat 9-6 (Flat 66); and

38.4 Flat 22-4 (Flat 194).

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39 Note that the doors to Flat 5-6 (Flat 26) and Flat 7-1 (Flat 41) are also considered by BRE to have been in the open position during the fire but these doors remain; the bottom half of the front door to Flat 5-6 remains and the front door to Flat 7-1 is intact (notwithstanding smoke damage).

40 The period of fire resistance provided by flat front doors will need to be determined via test. Once testing is complete, it will be possible to assess whether or not door failure is likely to have occurred at a time which might be considered reasonable against the guidance of Approved Document B and the Building Regulations. It may, subject to the amount of information that can be gathered about the severity of fires in the Tower over the course of the investigation, be possible to assess an approximate time at which doors failed as a result of fire attack.

41 Bin chute doors have performed well across all of the bin chutes up the Tower. Some of these doors have clearly been exposed to severe fire attack and there has been localised failure along the top edge of some of these doors, but the bin chute rooms behind have been largely undamaged throughout the incident.

42 Stairwell doors have been exposed to fire conditions in lobbies from the 10th to 23rd floors. However, the stairwell itself has only been exposed to fire temperatures (indicated via the burning of luminaires) at the 13th and 14th floors, and to significantly elevated temperatures (indicated via the melting of luminaire diffusers) at the 15th and 16th floors. The 17th to 23rd floors have undergone less severe conditions than at the aforementioned lower floors. The stairwell doors appear substantial and may provide 60 minutes fire resistance (to be confirmed via test). It is possible, although unlikely, that the severity and duration of fires at the 13th and 14th floors was significantly greater than those of floors above; this is considered unlikely because London Fire Brigade would normally, in BRE's experience, seek to bring fires under control on one floor before proceeding to the next; this will be confirmed via the witness evidence of firefighters. Assuming that all of the internal fires up the Tower were of a broadly consistent severity and/or duration (and considering the likelihood that extinguishment would have been achieved progressing up the Tower), then the pattern of damage in the stairwell indicates that some other factor needs to be considered. In BRE's opinion there are currently three principal possibilities that need to be considered to account for the localised areas of high damage in the stairwell:

42.1 That some of the stairwell doors were not self-closing, and remained open during the incident;

42.2 That someone or something (an object placed by someone) propped a stairwell door open for a period of time;

42.3 That the doors and/or the flows of smoke and hot gases around the stairwell were impacted by the smoke control system. In particular, given that extraction appears to have occurred at 11th floor level, it is possible that makeup air to the 11th floor was passing down through the stairwell from the permanently open vent at the head of the stair. Influx and passage of fresh air from the roof might have improved conditions in the stairwell. However, it is also possible that makeup air was drawn from the 13th and 14th floors into the stairwell, given their proximity to the 11th floor (pressure differentials would be strongest near the point of extraction) and may have drawn smoke, hot gases and fire from these floors into the stairwell. This possibility will be examined via the computer modelling to be carried out as part of the investigation, which will examine the interaction between the fires in the flats, the pathways generated by doors open, closed (gaps around door leaves) or feathering (door drawn intermittently open by the pressure differential of a smoke control system), the smoke control system and the viability of the means of escape throughout the incident.

4.2 Performance of Fire Safety Systems

4.2.1 Passive

43 The structure of the Tower has, in BRE's opinion, performed extremely well. Whilst the time at which the fire was deemed by London Fire Brigade to be under control is not yet known to BRE, it appears that the fire was burning at a level of severity which would significantly impact upon the fire resistance of the structure for between 9 and 12 hours. The gradings provided by the Post War Building Studies [24] indicate that the upper half of the structure could provide 6 hours fire resistance against a standard fire resistance furnace, and the lower half of the structure could provide more than this. Given the foregoing, it would (in BRE's opinion) be expected that the structure would have collapsed during the course of the incident. The physical evidence in relation to the structure confirms that there are parts of the structure which are very close to their point of failure.

44 Fire stopping has generally been found to be of a good standard. Some deficient fire stopping has been found but, based on BRE's experience, the proportion of inadequate fire stopping is not inconsistent with that of a typical building where fire stopping is monitored and, where deficiencies are identified, is remedied as part of an ongoing action plan.

45 Fire resisting doors have been found to vary across the Tower.

45.1 On the third floor and below, new doors appear to have been installed as part of the 2014-2016 refurbishment and these appear to be fire resisting doors. Only the font door to Flat 9 has been exposed to significant fire and smoke, and this door appears to have performed well in protecting the third floor lobby from the effects of fire.

45.2 On the fourth floor and above, the stairwell and refuse chute room doors appear to pre-date the 2014-2016 refurbishment. The refuse chute room doors have performed extremely well; all remain in place across the entire height of the building in spite of being exposed to severe fire attack from the lobbies. Some of the stairwell doors, particularly in the upper half of the building, have failed, however this tends to correspond with areas of high fire damage generally. Physical evidence indicates that some of the stairwell doors were open for a significant period when undergoing fire attack, but the reasons for and the timings of this need to be examined further (see above).

45.3 Flat front doors on the fourth floor and above have been found, by BRE, to be predominately composite construction incorporating plastic and metal components. Where these doors have been closed they have provided some level of protection against spread of smoke and fire into the protected lobby. However, their fire resistance rating is unknown as the doors are not marked with this information. In addition, a significant proportion of flat front doors either had no door closer or the door closer was not working which resulted in some doors remaining open when the residents evacuating have not closed doors behind them. Approved Document B recommends door closers are installed because it is accepted that in a fire situation people evacuating may forget to close doors behind them when leaving.

4.2.2 Active

46 Some of the smoke and heat detectors within flats have been variously heard beeping during the course of the investigation as a result of the disconnection of electricity supplies to the Tower. However, aside from this, their effectiveness during the course of the incident is not currently known; this will need to be established via witness testimony and 999 transcripts from the incident.

47 The smoke control system appears, based upon the physical evidence gathered, to have been operating. However, smoke control systems are normally only designed to cope with the smoke generated by a single fire in one fire compartment. The smoke control system in the Tower is likely to have been overwhelmed by the number of fires, particularly given that some doors were left open. It is, in BRE's opinion, unlikely that the smoke control system could have been reasonably expected to maintain clear air for evacuation in the means of escape in this incident. However, the smoke control system may have influenced smoke movement in and around the stairwell and as such may have impacted upon the time at which the stairwell became unavailable.

47.1 As would normally be the case, the smoke control system has been designed to extract from only one floor (the fire floor). This floor is determined by smoke detection in the lobbies. If an override switch is activated on another floor, the dampers on the original floor close so that there is always only one floor being extracted.

47.2 The pressure switch incorporated in this system appears to enable the function that fans slow down if the stairwell door is closed since this leads to a pressure differential greater than the value prescribed. However this assumes that all other doors onto the lobby of the fire floor are also closed. If one is open and is open to the outside (i.e. front door to a flat where windows are open), then the pressure differential will never be achieved and fans continue to operate at full speed. If this flat is also on fire then smoke (and possibly flames) will be drawn into the lobby by the system.

47.3 The makeup air for the smoke control system appears to be intended to come from the stairwell and the permanently open vent at the top of the stairwell. As described at Chapter 4.1, the pattern of damage in the stairwell indicates a possibility that the flow of air in the stairwell might have been influenced by the smoke control system. As previously set out, this will need further investigation via the computer modelling to be carried out.

48 The effectiveness of the dry rising main is not yet known and will need to be established via witness testimony from firefighters. It is of interest that the Tower was only provided with a dry rising main. BRE's understanding of the guidance in Approved Document B which recommends wet rising mains for buildings over 50m is that this is because fire engine pumps are not powerful enough to send water at the necessary pressure and flow above 50m. Given this, there are a number of possibilities to consider:

48.1 That pumps on London Fire Brigade appliances are sufficiently powerful to send water at sufficient pressure and flow up to 70m (the approximate height of the Tower – the highest outlet is on the roof);

48.2 That connecting multiple fire engine pumps in series might have generated enough power to send water at sufficient pressure and flow up to 70m However, given that vehicle access was only for one fire engine, the feasibility of this also needs to be considered;

48.3 That firefighting could not have taken place at the top of the Tower in any event because water flow and pressure would have been insufficient.

49 The absence of a sprinkler system in the Tower is of interest. Whilst no assessment of performance of a sprinkler system can be made as there was none, the potential benefits and limitations ofhaving a sprinkler system need to be considered.

49.1 Sprinklers control fires and significantly reduce the risk of fires spreading. However, in order to do so the sprinkler system must be capable of delivering water onto the items burning. In the specific circumstances of this incident, fire is understood to have taken hold inside a fridge

freezer adjacent to a window and cladding system Had a sprinkler system been installed, it is BRE's opinion that compliance with BS 9251 [25][26] in respect of sprinkler head positioning would have been achieved via the installation of a single sprinkler head in the middle of the kitchen ceiling. It is therefore possible that the metal chassis of the fridge freezer might have shielded the fire from the sprinkler spray. This possibility will be tested as part ofthe second reconstruction.

49.2 Sprinkler systems can only be designed to provide a given amount of water (i.e. pumps and pipework will have a maximum flow of water they can provide). Typically in a block of flats, sprinkler systems are only designed to have a maximum of four heads discharging water (BS 9251: 2005 specifies a minimum of four heads for a residential occupancy system), and pumps, tanks, pipes and other components are sized accordingly. Once fire had taken hold across the façade and ignited more than four flats, it is BRE's opinion that the sprinkler system is very unlikely to have made any appreciable difference to the spread ofthe fire.

49.3 Given the foregoing, it is BRE's opinion that a sprinkler systemdesigned and installed to current standards could only have significantly altered the outcome of the fire if it had prevented the fire from leaving Flat 16 and igniting the cladding.

50 The lift cars were both stopped on the 10th floor of the Tower. It is currently unknown whether the lifts were firefighting lifts or fireman lifts. Fireman lifts are not suitable for use during a fire since they have the functionality to return to the fire service access floor and thereby prevent their use by occupants. However, firefighting lifts can be used by firefighters during an incident and as such move between floors. It is currently unknown when the lifts stopped working and what their performance was prior to stopping. Witness statements and possibly information from the lift management system will inform this later in the investigation.

4.3 Approved Document B Comparison

51 Approved Document B (Fire safety) of the Building Regulations provides guidance on how to satisfy the requirements of Part B of Schedule 1 of the Building Regulations. The status ofApproved Documents is set out at Sections 6 and 7 of the Building Act 1984 [27], such that Approved Documents are generally considered to be "deemed to satisfy" guidance. This means that if someone doing building work has complied with the guidance in the relevant Approved Document, they are often deemed to have satisfied the requirements of the Building Regulations, although this would ultimately be a decision for Building Control or a court in the case of a dispute. They may choose not to follow the guidance in the relevant Approved Document, but are then responsible for demonstrating compliance with the Building Regulations by some other means. Given this status, Approved Document B has been used at this early stage of the programme of work and investigation to conduct a gap analysis. Where fire safety measures in Grenfell Tower are found to comply with the guidance of Approved Document B, these are unlikely to be of significant further interest with regards to an investigation to identify failure to comply with fire safety legislation. Conversely, where there exists a difference between the guidance and what is present at Grenfell Tower, the programme of work and wider investigation will need to seek to establish whether a valid alternative solution exists which demonstrates compliance with the Building Regulations, or whether there has been a breach of the Building Regulations.

52 The edition of Approved Document B which has been used by BRE in this report is the 2006 edition incorporating 2007, 2010 and 2013 amendments. This appears to BRE to have been the edition in effect at the time plans were drawn up for the refurbishment of 2014-2016, although it is noted that there are nine changes affecting the findings below between this edition and the original unamended 2006 edition [28]. None of these changes alter the technical findings and opinions ofBRE.

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52.1 Paragraph 1.5 is updated to reflect BS 5446 [29] Part 1 being superseded by BS EN 14604 [30].

52.2 A new Note 5 to Table 10 makes provision for internal linings in other circulation spaces (including common areas of blocks of flats) to be lined with products which achieve Class C (European Class) provided they are bonded to a Class A2 (European Class) substrate.

52.3 Appendix A, under Fire Resistance, makes reference to the 2007 edition of BS EN 13501 Part 4 [31], where previously it made reference to xxxx edition (a reference to the most recent edition).

52.4 Appendix A, under Reaction to Fire, makes reference to the 2007 edition of BS EN 13501 Part 1 [10], where previously it made reference to the 2002 edition [32].

52.5 Appendix A, under Internal Linings, makes reference to the use of standard substrates under BS EN 13238 [33], where previously it did not.

52.6 Appendix B makes reference to the 2008 edition of BS EN 1634 Part 1 [34], where previously it made reference to the 2000 edition [35].

52.7 Appendix B makes reference to the 2008 edition of BS EN 1634 Part 2 [36], where previously it made reference to the xxxx edition (a reference to the most recent edition).

52.8 Appendix B makes reference to the 2004 edition of BS EN 1634 Part 3 [37], where previously it made reference to the 2001 edition [38].

52.9 Appendix B makes reference to the fire resistance testing of lift landing doors under BS EN 81 Part 58 [39], where previously it did not.

53 Approved Document B Volume 2 deals with all types of building except dwellinghouses (which are covered by Volume 1). The parts of the guidance in Approved Document which are relevant to a building are based upon a number of key factors, in particular:

53.1 The purpose group of the premises

53.2 The height of the building

53.3 The height of the top storey of the building

53.4 The number of storeys above and below ground

53.5 The area and cubic capacity of the building

53.6 The shortest distance between the perimeter of the building and a relevant boundary

54 Grenfell Tower is predominantly a block of flats (Purpose Group 1(a)) but included a number of other uses, in particular a community room and nursery on the ground floor, a community meeting room on the first floor, and a boxing club on the second floor. All of these uses fall within the description of the Assembly and recreation Purpose Group (Purpose Group 5). Given that one of the uses of the Tower is a block of flats, each of the purpose groups in the building needs to be considered in its own right.

55 Grenfell Tower contains 24 storeys above ground, plus the plant room above. The upper surface of the plant room roof is approximately 70m above ground, whereas the top storey (23rd floor) is approximately 63m above ground. The Tower has sides of approximately 22m, with an overall area per floor of approximately 484m^2.

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56 Table 8 summ arises the relevant sections of Approved Document B outlining the guidance provided within and compares the physical evidence found at Grenfell Tower with the guidance in the relevant sections of the guidance. It further provides a list of implications for any future work and for the ongoing investigation.

57 Note that, in any ev ent, all features of the building, once fully investigated, will need to be considered in terms of their contribution to the overall package of fire safety which was afforded by the building. Therefore, even where a feature is indicated in Table 8 as needing no further investigation because it exceeds current recommendations, some further work may be necessary with regards to assessing the overall fire safety package of measures that existed in the Tower.

Table 8 – Comparison of physical evidence at Grenfell Tower with relevant guidance in Approved Document B [22]

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
<u>Section 1</u>			
Fire alarm and fire detection systems	Mains powered smoke and heat detectors in accordance with the recommendations of BS 5839 Part 6 to at least a Grade D Category LD3 standard: mains powered smoke detectors (additional heat detectors optional), each with an integral standby power supply, detectors to be provided in all circulation spaces that form part of the escape route from the flat.	Mains powered smoke and heat detectors interlinked within each and every flat. Communal automatic fire detection system in lift lobbies, linked to panel at ground floor entrance lobby, linked to smoke control system.	At present no further investigation regarding potential failure to comply recommended.
<u>Section 2</u>			
Means of escape from flats	All habitable rooms to have direct access to a protected entrance hall within flat.	Original construction of original flats and flats introduced by refurbishment appear to comply.	This feature of the Tower, insofar that it relates to original flats, is one which, in BRE's opinion, would be difficult and expensive to change as part of any refurbishment. At present no further investigation regarding

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
			potential failure to comply recommended.
	Single means of escape in common parts only acceptable if: • the flat is separated from the common stair by a protected lobby or common corridor, and • the protected lobby is protected by a smoke control system, and • the stairwell is ventilated.	Conforms with guidance.	On the basis that smoke control and stairwell ventilation were provided, this layout needs no further investigation. However the adequacy of smoke control and stairwell ventilation needs to be examined in any event.
	Stairs which are also firefighting stairs should be at least 1100mm wide.	Stairs in stairwell narrower – 1.02m (~1020mm). Staircase in atrium narrower still – 0.94m (~940mm)	This feature of the Tower, insofar that it relates to original flats, is one which, in BRE's opinion, would be difficult and expensive to change as part of any refurbishment. This feature of the building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
	Protected lobbies and stairs to be enclosed by fire resisting construction.	Based upon Fire Grading of Buildings, walls and floors exceed guidance.	This feature of the building will need to be considered in conjunction with other fire safety measures as

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
		Door fire performance currently unknown.	to whether the building as a whole provided sufficient protection. Doors to be subjected to standard fire resistance tests.
	The protected stair should discharge directly to the final exit or by way of a protected exit passageway to a final exit, having at least the same standard of fire resistance and lobby protection as the stairway.	The single stairwell discharges into an atrium, although the atrium appears to be separated from the remainder of the building via suitable fire resisting construction.	Housekeeping of the atrium would be particularly important; this may need to be considered as part of the review of fire risk assessments of the Tower.
	Gas service and installation pipes not to be installed in stairways unless in accordance with the requirements for installation and connection set out in Pipelines Safety Regulations 1996 [40] and the Gas Safety (Installation and Use) Regulations 1998 [41].	Gas installation being inspected by Corgi.	Implications pending findings from Corgi.
	Basements should be served by a separate stair.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	The stairs may serve both flats and other occupancies provided the flat is ancillary to the main use of the building and is provided with an independent alternative escape route, the stair is separated from any other occupancies on	This does not conform as the flats are the main use of the building.	This feature of the Tower, insofar that it relates to original flats, is one which, in BRE's opinion, would be difficult and expensive to change as part of any refurbishment.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
	lower stories by protected lobbies, any automatic fire detection and alarm system with which the main building is fitted also covers the flat.		This feature of the building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Section 5			
Fire resistance of enclosures, doors and glazed elements	Fire resistance should be: • 120 minutes f or loadbearing walls • 120 minutes around the protected shaft / firefighting shaft • FD60S f or all doors enclosing the protected shaft / firefighting shaft and stairwell doors.	Based upon Fire Grading of Buildings, walls and floors exceed guidance. Door fire performance currently unknown.	This will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection. Doors to be subjected to standard fire resistance tests.
Door fastenings	Door fastenings should not impede use in the direction of escape. Locks, whether physical or electronic, should be easily overridden by those making their escape.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Direction of door opening	Where practicable, doors should open in direction of escape.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Construction of stairs	Stairs should be constructed of limited combustibility materials.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
Headroom in escape routes	Clear headroom of not less than 2m.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Floor coverings	Should minimise slipperiness when wet.	The floor coverings in the lobbies appear to have been slip resistant. The stairwell floor comprises bare concrete. One member of the BRE team slipped on these stairs on 14th June 2017 when there was firefighting water flowing down the stairs, and the individual was wearing safety footwear at the time.	At present no further investigation regarding potential failure to comply recommended. May need to be considered if there are any indications that residents evacuating also encountered difficulty.
Final exits	Should be at least as wide as escape routes and facilitate dispersal of persons away from a building.	Final exit doors are 1m (~1000mm) wide (main entrance) and 0.85m (~850mm (east face entrance). This appears not to conform with guidance.	This will need to be reviewed in conjunction with the review of witness statements to establish whether there are any indications that residents evacuating encountered difficulty as a result of narrow escape routes.
Lighting of escape routes	Adequate artificial lighting in all common escape routes. Standards according to BS 5266 Part 1 [42]	No lighting measurements carried out as soot staining to luminaire components, walls and ceilings prevents accurate measurement of lighting levels. Appears to conform with guidance based on frequency of luminaires with battery backups.	At present no further investigation regarding potential failure to comply recommended.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
Exit signs	Except within a flat, signage in accordance with the Health and Safety (Safety signs and signals) Regulations 1996 [43] and BS 5499 Part 1 [44] (superseded by BS ISO 3864 Part 1 [45]).	Exit signs are provided on the ground to third floors but not on the fourth floor and floors above.	This will need to be considered in conjunction with the review of witness statements to establish whether there are any indications that residents evacuating encountered wayfinding difficulties.
Evacuation lifts	Where provided, these should comply with BS 5588 Part 8 [46] (superseded by BS 9999 [47]). Firefighting lifts (see Section 17) may be used for evacuation of disabled people as part of a management plan.	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not currently known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of lift doors and accompanying documents will confirm whether or not fire resisting. If not, then it may become necessary to test the lift landing doors.
Lift construction	Lift shaft should be enclosed within fire resisting construction so as to minimise smoke travel between lobbies on different floors.	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not currently known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of lift doors and accompanying document will confirm whether or not fire resisting. If not, then it may become necessary to test the lift landing doors.
Lift machine rooms	Lift machine rooms should be sited over the lift well.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Refuse chutes	Should be constructed in accordance with BS 5906 [48] and be separated from other	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
	parts of the building by fire resisting construction, and should not be located within protected stairways or protected lobbies.		
Section 6			
Wall and ceiling linings	Wall and ceiling linings of common escape routes should be Class 0.	Not yet known; samples taken.	Samples of paint and substrate from common escape routes have been taken and are due to be tested for their composition.
	Wall and ceiling linings within small rooms (no more than $4m^2$) should be Class 3.	Appears to comply, notwithstanding residents' own modifications and items below.	At present no further investigation regarding potential failure to comply recommended.
	Wall and ceiling linings of circulation spaces within dwellings should be Class 1.	MDF board has been introduced to box in the water supplies to flats, which is relevant to this.	It is recommended that the MDF board of this construction is tested.
	Parts of rooms (less than half the floor area and no more than $20m^2$) may be Class 3.	Both the uPVC around the windows and the PURL board on/near the external walls are relevant to this.	uPVC and PURL board to be tested.
Section 7			
Fire resistance	Current guidance does not permit unsprinklered buildings above 30m and as such does not provide a minimum period of fire resistance for loadbearing elements in such buildings. However, loadbearing elements in sprinklered buildings	Conforms or exceeds, although noting sprinklers are now a stipulation.	The balance of excessive fire resistance versus a lack of sprinklers in this building will need to be considered in conjunction with other fire safety measures as to whether the building

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
	above 30m should provide a minimum of 120 minutes fire resistance.		as a whole provided sufficient protection.
Section 8			
Provision of compartment walls and floors	Every wall separating a flat from any other part of the building and every floor should be a compartment wall/floor.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Sprinklers	Blocks of flats over 30m tall should be fitted with sprinklers inside flats (common areas need not be sprinklered).	Does not conform.	Further investigation of the decision making process at design stage of the refurbishment needed.
Construction of compartment walls and floors (generally – not including walls around firefighting shaft)	Should form a complete barrier to fire spread between the compartments they separate and provide 60 minutes fire resistance.	Based upon Fire Grading of Buildings, walls and floors exceed guidance.	This will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Doors	Doors in compartment walls should have the following fire resistance (European equivalent in brackets): • Separating flat f rom common space – FD30S (E30 S_a) • Enclosing a protected shaft forming a stairway situated wholly or partly above the adjoining ground in a building used for Flats etc. – FD30S (E30 S_a)	Fire resistance of doors not known.	A sample of doors to be subjected to standard fire resistance tests.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
	• Any door f orming part of the enclosure to a protected entrance hall or protected landing in a flat – FD20 (E20)		
Protected shafts	Current guidance does not permit unsprinklered buildings above 30m and as such does not provide a minimum period of fire resistance for protected shaft enclosures in such buildings. However, protected shafts in sprinklered buildings above 30m should provide a minimum of 120 minutes fire resistance.	Conforms or exceeds, although noting sprinklers are now a stipulation.	The balance of excessive fire resistance versus a lack of sprinklers in this building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Protected shafts conveying gas	Any pipe containing natural or LPG should be of screwed or welded steel construction, installed in accordance with the Pipelines Safety Regulations 1996 [40] and the Gas Safety (Installation and Use) Regulations 1998 [41].	Gas installation being inspected by Corgi.	Implications pending findings from Corgi.
Ventilation of protected shafts conveying gas	Ventilated direct to outside air by ventilation openings at high and low level in the shaft.	Gas installation being inspected by Corgi.	Implications pending findings from Corgi.
Section 9			
Provisions of cavity barriers	At the junction of all external cavity walls with compartment walls and floors.	Cavity barriers present but not adequate.	Further investigation to determine whether inadequacies arise from design, supply,

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
			workmanship or other issues. Cavity barrier inadequacies to be repeated in later large scale cladding experiments to assess significance.
	Around openings, including windows.	No cavity barriers found.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barrier inadequacies to be repeated in later large scale cladding experiments to assess significance.
	At intervals no greater than 20m where the lining is Class 1 or Class 0, or no greater than 10m for any other class.	Cavity barriers present but inadequate.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be repeated in later large scale cladding experiments to assess significance.
Construction and fixings for cavity barriers	Cavity barriers should provide at least 30 minutes fire resistance.	Inappropriate use of fixings.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
			repeated in later large scale cladding experiments to assess significance.
Section 10			
Fire stopping of pipes	Pipe stacks should be no more than 160mm diameter, branches 110mm, provided they are non-combustible, lead, aluminium, aluminium alloy, uPVC, or fibre cement construction. Other materials up to 40mm diameter.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Fire stopping of ventilation ducts	Air handling ducts can be protected in three ways: Method 1 – Protection using fire dampers Method 2 – Protection using fire-resisting enclosures Method 3 – Protection using fire-resisting ductwork	Bathroom extract not yet accessed due to potential presence of asbestos.	Implications pending inspection.
Fire stopping generally	May be made of cement mortar, gypsum-based plaster, cement or gypsum based vermiculite/perlite, glass fire, crushed rock, blast furnace slag or ceramic-based products and intumescent mastics.	Varying types of fire-stopping used. Not confirmed at the time of writing if mastics used were intumescent but all internal fire-stopping appeared to perform adequately.	Implications pending inspection.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
Section 12			
External surfaces above 18m	Class 0 or Class B-s3, d2 or better.	Awaiting standard test results.	Awaiting standard test results.
External surfaces below 18m	Index (I) or not more than 20 or Class C-s3, d2 or better, or timber.	Awaiting standard test results.	Awaiting standard test results.
Insulation materials/products	Any insulation, filler material (not including gaskets, sealants and similar) etc. used in the external wall construction should be limited combustibility.	Awaiting standard test results.	Awaiting standard test results.
Cavity barriers	Should be provided as per Section 9.	Cavity barriers present but inadequate.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be repeated in later large scale cladding experiments to assess significance.
Alternative approach	If not the above approach, the performance criteria in BR 135 [49] should be met using full scale test data from BS 8414 Part 1 or 2 [12][50].	BRE understand from MPS that at the time of writing no evidence of a BS 8414 test has been discovered.	Large scale cladding test to be carried out.
Section 13			
Space separation	Refer to BR 187 [51].	Appears to conform with guidance, although detailed analysis not yet carried out.	At present no further investigation regarding potential failure to comply recommended.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
		Building-to-building fire spread did not occur.	
Section 14			
Roof coverings	Roof to provide 30 minutes fire resistance from below for means of escape from plant room.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Roof covering CC or better, subject to distance to relevant boundary.	Appears to conform with guidance.	At present no further investigation regarding potential failure to comply recommended.
Section 15			
Fire mains	Wet fire main should be provided.	Dry rising fire main provided. Does not conform with guidance.	Analysis to be carried out to establish whether sufficient water flow and pressure can be achieved with one or more fire appliance pumps.
	Fire main outlets should be within stairwell (as flats open directly onto lobby).	Fire main outlets within lobbies. Does not conform with guidance.	Dry rising outlet in lobby not stairwell may have caused problems with firefighting tactics – to be checked against witness statements.
	Hydrants should be within 90m of fire main inlet	Distances conform with guidance but some hydrants were found not to conform with guidance concerning marking to assist firefighters to locate them.	Witness statements of firefighters to confirm whether any difficulties locating water supplies.
Section 16			
Vehicle access	Access for a pumping appliance to within 18m of inlet.	Possible for a single appliance to gain	Witness statements to be checked to ensure route was not blocked.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
		access within 18m of inlet.	To be considered in conjunction with dry rising main; whether one appliance powerful enough for water to 70m height.
	Roadways and hardstandings to be sufficiently wide, high and loadbearing for fire appliances used by the local fire and rescue service.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Section 17			
Provision of firefighting shafts	Provide firefighting shaft with firefighting lifts.	Lifts appear not to conform with standard for firefighting lift. May comply with firemans lift.	Further inspection of lift and findings from BMS retrieval needed.
	Firefighting shafts should serve all floors through which they pass.	Conforms with guidance noting that shaft need not serve basement.	At present no further investigation regarding potential failure to comply recommended.
	Every part of every storey should be no more than 60m from a fire main in a firefighting shaft.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Design and construction of firefighting shafts	Firefighting shaft equipped with fire mains with outlet connections and valves at every storey.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Firefighting lift shaft should conform with clauses 7 and 8 of BS 5588 Part 5 [52].	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not currently known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of lift doors and accompanying document will confirm

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing investigation
			whether or not fire resisting. If not, then it may become necessary to test the lift landing doors.
	Firefighting lift installation should conform with BS EN 81 Part 72 [53][54] and BS EN 81 Part 1 [55].	Inspection of systems ongoing, however a secondary power supply for the lifts has not been located indicating potential non-conformance.	Further inspection of lift and findings from BMS retrieval (WSP) and electrical survey (RINA) needed.
	Flats allowed to open directly onto lift lobby provided lift doors no more than 7.5m from firefighting stair.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Section 18			
Provision of smoke outlets	Smoke outlets should be provided.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Smoke outlets should be situated at high level.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Each compartment should have direct access to venting.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Natural smoke outlet provisions	Combined clear cross sectional area not less than 1/40th of the floor area.	Although only viewed and not specifically measured, appears to conform with guidance.	At present no further investigation regarding potential failure to comply recommended.
Construction of outlet ducts or shafts	Outlet ducts or shafts should be of non-combustible construction.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

5 Interim Conclusions

58 As set out in Chapter 2, the overarching aims for the BRE on-site investigation are as follows:

58.1 To collect as much physical evidence as possible in relation to

58.1.1 Patterns of fire damage, fire spread and smoke spread at Grenfell Tower (externally and internally)

58.1.2 The fire protection systems at Grenfell Tower

58.1.3 The general construction of Grenfell Tower relevant to fire safety

58.2 To compare the physical evidence of the construction and fire protection of Grenfell Tower with the recommendations of the edition of Approved Document B which was in effect at the time of the last building work to be carried out at Grenfell Tower [22].

59 Grenfell Tower, as originally built, appears to have been designed on the premise of providing very high levels of passive fire protection.

59.1 The structure and compartment walls/floors afforded a much higher degree of fire resistance than would currently be recommended by Approved Document B. Had the modern standard of fire resistance been provided, in BRE's opinion, given the severity of spalling to concrete including exposure of reinforcing steelwork, it is likely that the Tower would have collapsed, whether fully or partially.

59.2 The original façade of Grenfell Tower, comprising exposed concrete and, given its age, likely timber or metal frame windows, would not have provided a medium for fire spread up the external surface.

60 In BRE's opinion, provided compartmentation was completed via suitably fire resisting doors and fire stopping, there would have been little opportunity for a fire in a flat of Grenfell Tower to spread to any neighbouring flats. This principle of design is, in BRE's opinion, what would have allowed for a building of this height to be permitted a single staircase despite there being no suppression system.

61 Evidence collected and recorded during the on-site investigation has indicated that various routes for fire spread appear to have been introduced, whether via the addition of fuel or shortcomings in compartmentation:

61.1 The cladding over the façade appears to have introduced a medium for fire spread up the façade;

61.2 Subdivision of the fuel load presented by the cladding system via cavity barriers appears to have been inadequate;

61.3 The manner in which new windows were connected to the cladding system lacked any barriers to fire spread between flats and the cladding system;

61.4 The lack of door closers on fire doors have introduced weaknesses into the separation between flats and the common parts.

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62 The cladding system is of particular concern given the manner in which fire spread up and across it and involved flats as it did so. The multiple potential deficiencies concerning the cladding system reflect its significance with regards to actual fire spread during the fire. The cladding system had the following issues. Note the significance of these is far greater when they are considered in combination as opposed to when they occur in isolation.

62.1 Insulation was combustible. This appears to have provided a medium for fire spread up, across and within sections of the façade.

62.2 Cavity barriers were improperly oriented, were of insufficient size specification to close gaps in the event of fire, and/or gaps were larger than they ought to have been given the cavity barriers used.

62.3 Gaps between insulation and the surface of the building and gaps between insulation and cavity barriers, provided a route for fire spread.

62.4 The aluminium composite material used in the façade has a core which appears to be highly combustible. This material appears to have provided a medium for fire spread up and across the façade.

62.5 Windows appear to have been installed into the façade in a manner which provides a direct route for fire spread from flats into the cavity of the façade, and from the façade back into flats. There do not appear to have been any cavity barriers installed at locations where window openings communicate with the cavity in the façade.

63 Fire doors appear to have provided some degree of protection where these have been provided and closed. In particular, it is worthy of note that the doors onto the waste chute rooms appear to have performed particularly well. The absence of door closers on front doors to flats appears to have resulted in a significant number of doors being left open. Where this has occurred, the fire in each flat appears to have emitted large quantities of smoke (and later fire) directly into the immediate lobby, and these have gone on to affect the lifts and single stairwell.

64 The pattern of fire damage across Grenfell Tower is complex, but there is a general trend of damage increasing further up the Tower. The particular exception to this is in the stairwell, where damage appears to be concentrated around the 13th and 14th floors, with less damage across the upper parts of the stairwell.

65 The means of escape for Grenfell Tower appear at the time of construction to have been broadly compliant with guidance and codes of practice that were in place at the time. Whilst it is acknowledged that it would be difficult to make changes to the single stairwell as part of any refurbishment, assessment will need to be made of the impact of the associated building features, notably the atrium, the lifts and other occupancy types within the Tower, which were introduced/modified as part of the refurbishment.

66 Access and facilities for the fire and rescue service are in BRE's opinion variously deficient or in need of further investigation. A building of Grenfell Tower's height ought to have been fitted with a wet rising main as part of the refurbishment; instead the existing dry rising main was extended and modified. This is particularly significant in conjunction with the limited vehicle access at the Tower as, it is BRE's opinion that it is unlikely that a single fire appliance could provide sufficient pressure and flow of water for firefighting at the top of the Tower. The aforementioned points (paragraph 65) regarding means of escape necessarily affect access for firefighters within the Tower to carry out their various roles.

67 The gap analysis to Approv ed Document B (AD B) has highlighted where there are non-conformances or further investigation is required to confirm whether or not there is a non-conformance issue, see Table 9. The gap analysis will be used to inform the ongoing investigation with the aim of meeting the overarching objectives which have been set.

Table 9 – Summary of subjects from Table 8 for which further investigation is recommended

Non-conformance / potential non-conformance subject	Further investigation suggested
Means of escape	
Stairs narrower than recommended	Consider as part of holistic fire safety review
Stairwell discharges into atrium	Housekeeping within fire risk assessments
Stairs serving other occupancies	Consider as part of holistic fire safety review
Floors slippery when wet	Review witness statements
Final exits narrow	Review witness statements
Exit signs inadequate	Review witness statements
Internal linings	
Wall and ceiling linings in escape routes unknown	Sam ples taken and tests to be carried out
Wall and ceiling linings in flat circulation spaces	Testing recommended
Wall and ceiling linings in flats; uPVC and PURL board	Samples taken and tests to be carried out
Compartmentation	
Excessive fire resistance vs no sprinklers	Consider as part of holistic fire safety review
Doors fire resistance unknown	Fire resistance tests to be carried out
Gas services in protected shaft unknown	Pending report from CORGI
Ventilation of protected shafts conveying gas	Pending report from CORGI
Inadequate cavity barriers at compartment junctions	Further investigation to determine root cause plus inclusion in large scale tests and reconstruction
Inadequate cavity barriers around windows	Further investigation to determine root cause plus inclusion in large scale tests and reconstruction
Inadequate cavity barriers at relevant intervals	Further investigation to determine root cause plus inclusion in large scale tests and reconstruction
Cavity barriers inappropriately fixed	Further investigation to determine root cause plus inclusion in large scale tests and reconstruction

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Non-conformance / potential non-conformance subject	Further investigation suggested
Fire stopping of ventilation ducts unknown	Inspection pending asbestos survey
Fire stopping generally	Inspection to be completed pending asbestos survey
External fire spread	
External surfaces above 18m unknown fire performance	Small scale standard tests to be carried out
External surfaces below 18m unknown fire performance	Small scale standard tests to be carried out
Insulation materials and other major façade components unknown fire performance	Small scale standard tests to be carried out
Cavity barriers inadequate	Further investigation to determine root cause plus inclusion in large scale tests and reconstruction
Alternative cladding test approach unknown	Large scale compliance test to be carried out
Access and facilities for the fire service	
Dry rising main instead of wet rising main	Analysis of whether single fire engine can supply water to 23rd floor and roof to be carried out
Dry rising outlets in lobbies not stairwell	Review firefighter witness statements
Hydrants not clearly marked	Review firefighter witness statements
Vehicle access for one appliance only	To be considered in conjunction with dry rising main for ability to send water to 23rd floor or roof
Firefighting lift unknown	Continue survey of lifts and associated documentation. Awaiting reports from RINA and WSP
Firefighting lift landing doors unknown	Continue survey of lifts and associated documentation. Awaiting reports from RINA and WSP

6 References

[1] The Building Regulations 2010, SI 2010 No 2214.

[2] Regulatory Reform (Fire Safety) Order 2005, SI 2005 No 1541.

[3] BS 476 Part 7: 1997 Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products. British Standards Institution.

[4] BS 476 Part 6: 1989 + A1: 2009 Fire tests on building materials and structures. Method of test for fire propagation for products. British Standards Institution.

[5] BS 476 Part 11: 1982 Fire tests on building materials and structures. Method for assessing the heat emission from building materials. British Standards Institution.

[6] BS EN ISO 11925 Part 2: 2002 Reaction to fire tests. Ignitability of building products subjected to direct impingement of flame. Single-flame source test. British Standards Institution.

[7] BS EN ISO 1716: 2010 Reaction to fire tests for products. Determination of the gross heat of combustion (calorific value). British Standards Institution.

[8] BS EN ISO 1182: 2010 Reaction to fire tests for products. Non-combustibility test. British Standards Institution.

[9] BS EN ISO 13823: 2010 + A1: 2014 Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item. British Standards Institution.

[10] BS EN 13501 Part 1: 2007 + A1: 2009 Fire classification of construction products and building elements. Classification using test data from reaction to fire tests. British Standards Institution.

[11] BS ISO 5660 Part 1: 2015 Reaction-to-fire tests. Heat release, smoke production and mass loss rate. Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement). British Standards Institution.

[12] BS 8414 Part 1: 2015 Fire performance of external cladding systems. Test method for non-loadbearing external cladding systems applied to the masonry face of a building. British Standards Institution.

[13] BS 476 Part 20: 1987 Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles). British Standards Institution.

[14] BS 476 Part 22: 1987 Fire tests on building materials and structures. Method for determination of the fire resistance of non-loadbearing elements of construction. British Standards Institution.

[15] BS 476 Part 33: 1993, ISO 9705: 1993 Fire tests on building materials and structures. Full-scale room test for surface products. British Standards Institution.

[16] Shipp M. (Contributor). `Fire Investigation`; Chapter 4, `The use of laboratory reconstruction in fire investigations`. Edited by Niamh Nic Daeid, CRC Press Forensic Science Series, 2004.

[17] Housing Act 1957 (c. 56).

[18] Housing Act 2004 (c. 34).

[19] Smoke and Carbon Monoxide Alarm (England) Regulations 2015, SI 2015 No 1693.

[20] Grenfell Tower Inquiry/Metropolitan Police Service Memorandum of Understanding, dated 27th September 2017. Available from https://www.grenfelltowerinquiry.org.uk/wp-content/uploads/2017/08/Memorandum-of-understanding-with-the-Metropolitan-Police-Service.pdf

[21] The Criminal Procedure Rules 2015, SI 2015 No. 1490 (L. 18).

[22] HM Government, Building Regulations 2010, Approved Document B – Fire Safety, 2006 edition incorporating 2007, 2010 and 2013 amendments. Crown copyright, 2006.

[23] Code of Practice for Investigators of Fires and Explosions for the Criminal Justice Systems in the UK. January 2017. Available at: http://www.ife.org.uk/write/MediaUploads/Documents/Fire_Investigation_Code_of_Practice.pdf Last accessed 25th January 2018.

[24] Joint Committee of the Building Research Board of the Department of Scientific and Industrial Research and The Fire Offices' Committee. 1946. Post War Building Studies No. 20. The Fire Grading of Buildings Part I General Principles and Structural Precautions. HMSO.

[25] BS 9251: 2005 Sprinkler systems for residential and domestic occupancies – Code of practice. British Standards Institution.

[26] BS 9251: 2014 Fire sprinkler systems for residential and domestic occupancies – Code of practice. British Standards Institution.

[27] Building Act 1984, 1984 Chapter 55.

[28] HM Government, Building Regulations 2010, Approved Document B – Fire Safety, 2006 edition. Crown copyright, 2006.

[29] BS 5446 Part 1: 2000 Fire detection and fire alarm devices for dwellings. Specification for smoke alarms. British Standards Institution.

[30] BS EN 14604: 2005 Smoke alarm devices. British Standards Institution.

[31] BS EN 13501 Part 4: 2007 Fire classification of construction products and building elements. Classification using data from fire resistance tests on components of smoke control systems. British Standards Institution.

[32] BS EN 13501 Part 1: 2002 Fire classification of construction products and building elements. Classification using test data from reaction to fire tests. British Standards Institution.

[33] BS EN 13238: 2010 Reaction to fire tests for building products. Conditioning procedures and general rules for selection of substrates. British Standards Institution.

[34] BS EN 1634 Part 1: 2008 Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware. Fire resistance tests for doors, shutters and openable windows. British Standards Institution.

[35] BS EN 1634 Part 1: 2000 Fire resistance tests for door and shutter assemblies. Fire doors and shutters. British Standards Institution.

[36] BS EN 1634 Part 2: 2008 Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware. Fire resistance characterisation test for elements of building hardware. British Standards Institution.

[37] BS EN 1634 Part 3: 2004 Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware. Smoke control test for door and shutter assemblies. British Standards Institution.

[38] BS EN 1634 Part 3: 2001 Fire resistance tests for door and shutter assemblies. Smoke control doors and shutters. British Standards Institution.

[39] BS EN 81 Part 58: 2003 Safety rules for the construction and installation of lifts – Examination and tests. Landing doors fire resistance test. British Standards Institution.

[40] Pipelines Safety Regulations 1996, SI 1996 No. 825.

[41] Gas Safety (Installation and Use) Regulations 1998, SI 1998 No. 2451

[42] BS 5266 – 1: 2016 Emergency lighting. Code of practice for the emergency lighting of premises. British Standards Institution.

[43] Health & Safety (Safety signs and signals) Regulations 1996, SI 1996 No. 341

[44] BS 5499 – 1: 2002 Graphical symbols and signs. Safety signs, including fire safety signs. Specification for geometric shapes, colours and layout. British Standards Institution. Superseded by [45].

[45] BS ISO 3864 – 1: 2011 Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings. British Standards Institutions.

[46] BS 5588 – 8: 1999 Fire precautions in the design, construction and use of buildings. Code of practice for means of escape for disabled people. British Standards Institution. Superseded by [47].

[47] BS 9999: 2008 Code of practice for fire safety in the design, management and use of buildings. British Standards Institution.

[48] BS 5906: 2005 Waste management in buildings. Code of practice. British Standards Institution.

[49] Colwell, S and Baker, T. BR 135 (2013) Fire performance of external thermal insulation for walls of multistorey buildings. Third Edition. BRE 2013

[50] BS 8414 – 2: 2015 Fire performance of external cladding systems. Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel fame. British Standards Institution.

[51] Chitty, R. BR 187 (2014) External fire spread – Building separation and boundary distances. Second edition. IHS 2014

[52] BS 5588 – 5: 2004 Fire precautions in the design, construction and use of buildings. Access and facilities for fire-fighting. British Standards Institution. Superseded by [47].

[53] BS EN 81 – 72: 2015 Saf ety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts. Firefighters lifts. British Standards Institution.

[54] BS EN 81 – 72: 2003 Saf ety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts. Firefighters lifts. British Standards Institution.

[55] BS EN 81 – 1: 1998 + A3: 2009 Saf ety rules for the construction and installation of lifts. Electric lifts. British Standards Institution.

Appendix A Acknowledgements

The following individual's efforts are acknowledged as having provided input into this report by conducting on-site surveys and investigations and collating relevant information during the course of our investigation to date. Some individuals named below have since left BRE Global Ltd.

Name	Role
Sharon Hill	Fire Investigation Co-ordinator (Administrative assistance)
Sean Taylor	Fire Investigation Consultant (On-site investigation)
Meghan Sanders	Fire Investigation Consultant (On-site investigation)
Kieran Wood	Fire Investigation Consultant (On-site investigation)
Arron Perry	Senior Technician, Environment (Ventilation system)
Connor McIntosh*	(On-site inv estigation)
Kaloyan Markov*	(On-site investigation)

* No longer employed by BRE.

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Appendix B Curricula Vitae

NAME	**DAVID CROWDER**
CURRENT POSITION	Head of Fire investigation and Expert Witness Services, BRE Group
ACADEMIC QUALIFICATIONS	PhD, BSc (Hons)
PROFESSIONAL QUALIFICATIONS	CEng, MIFireE
SPECIALISATIONS	Fire investigation. Fire development and building performance against regulations and guidance. Experimental research and consultancy.

CAREER SUMMARY

Since joining BRE in 2006, David has been involved in a wide range of large scale experimental work, testing, consultancy and fire investigations, particularly with respect to new developments in the built environment. David has overall responsibility for the fire investigation team as well as expert witness services across all disciplines in the BRE Group of companies.

He has worked on a wide range of investigations and projects for the UK government, the EU and private concerns. Research projects include: fire spread in car parks, researching the effectiveness of residential sprinklers, evacuating mobility impaired people from hospitals, developing a fire protection strategy for HMS Victory, developing cost effective water misting systems for use in prison cells and a scoping study on the environmental impact of fires. He holds a PhD in the impact of fire chemistry (flammability and toxicity) in fatal fires, examined via the investigation and reconstruction of real fires, and a Bachelor of Science Degree with Honours in Forensic and Investigative Science specialised in Fire Engineering and Fire Investigation.

David specialises in investigating fire development, the performance of fire protection measures and systems during real fire incidents, and the regulatory aspects of performance in these areas. He is a Chartered Engineer registered with the Engineering Council by the Institution of Fire Engineers.

FIRE INVESTIGATION EXPERIENCE

The following has been selected with respect to experience as a fire investigator.

1. Dav id holds a PhD in the impact of fire chemistry (flammability and toxicity) in fatal fires, examined via the investigation and reconstruction of real fires, and a Bachelor of Science Degree with Honours in Forensic and Investigative Science specialised in Fire Engineering and Fire Investigation.
2. Dav id has been part of the fire investigation team at BRE since 2006 and has been Business Group Manager for Fire Investigation at BRE since 2011 and Head of Expert Witness Services

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across the BRE Group since 2014. This has included the on-site investigation of numerous major fires including the Cutty Sark fire in 2007, Atherstone-on-Stour in 2007, Royal Marsden Hospital in 2008, Lakanal in 2009, the Peckham and Camberwell timber frame fires in 2009 and 2010 respectively and Shirley Towers in 2010.

3. David attended the Atherstone-on-Stour multi fire-fighter fatality fire in 2007 and worked on teams for both prosecution and defence of cases brought against Warwickshire Fire and Rescue Service and its Officers. He was a member of the BRE team carrying out reconstructions for Warwickshire Police to investigate ignition scenarios and the plausibility of witness statements related to these. He then managed and led an extensive programme of reconstructions and computer modelling for Warwickshire Fire and Rescue Service to develop a timeline of fire development and spread responsible for the events witnessed during the incident. He was not called to give evidence at any of the Court hearings as his written evidence was agreed by both parties prior to the hearings.

4. David attended the Lakanal tower block fire in 2009, managing and undertaking an extensive programme of work for the Metropolitan Police Service, London Fire Brigade and the Department for Communities and Local Government. He led the BRE on-site investigation and managed an extensive programme of testing, reconstruction and computer modelling to establish the sequence of fire development and building performance during the incident. He prepared an extensive expert witness report reviewing all of the evidence collected by the multi-agency investigation, all of the legislation and guidance that applied to the fire safety of the building throughout its 50 year life, the works carried out on the building during that time and whether any parties may have responsibility for the condition of the building and consequent fire spread as a result of this. David presented three days of expert evidence during the inquest into the incident from January to March 2013. David was then retained by the London Fire and Emergency Planning Authority to provide expert witness support in relation to its prosecution of the London Borough of Southwark (LBS) under the Regulatory Reform (Fire Safety) Order 2005. LBS pleaded guilty to all the offences charged in February 2017.

5. David has provided expert witness services on a number of legal cases where there was extensive or unusual fire spread as well as numerous cases where there are disputes concerning the design and construction of premises which impact on fire safety. He has been involved in both prosecution and defence of cases under the Regulatory Reform (Fire Safety) Order 2005 as well as murder, manslaughter, arson with intent and reckless arson cases. He has also provided assistance in matters relating to both liability and quantum for damages in civil disputes as well as identifying opportunities for recovery. David's experience in civil proceedings includes giving evidence at the High Court and as part of Mediation and Arbitration proceedings.

6. David carried out computer modelling of the Penhallow Hotel fire of 2007 to investigate the way in which the layout and contents of the building contributed to the fire spread during the incident. This formed part of BRE's work supporting the Cornwall Fire and Rescue Service investigation into whether there were any failings under the Regulatory Reform (Fire Safety) Order 2005.

7. David has carried out many laboratory fire experiments and fire reconstructions on structures and components to test hypotheses or assess possible fire performance in support of investigations following major incidents, including the fires at the Hard Rock Cafe in 2005, the Royal Marsden Hospital in 2008, the multi-fatality house fire involving a freezer in Neasden in 2011 and a fire in a power station. He has also worked on research to investigate the feasibility of retrieving DNA from blood exposed to fire.

8. David has been involved in two fire investigations led by the UK's Marine Accident Investigation Branch; the Commodore Clipper fire of June 2010 and the Yeoman Bontrup fire of July 2011. His involvement in both investigations concerned the contribution of materials to the development and spread of the fires on the vessels.

9. David investigated track fires on the London Underground on behalf of Balfour Beatty. The investigation and supporting laboratory experiments led to the development of safer systems of work for Balfour Beatty and Track Alliance staff working on the London underground network.

10. David chairs the Institution of Fire Engineers Fire Investigation Special Interest Group.

11. David represents BRE on the UK Fire Investigation Strategic Steering Group of the Chief Fire Officers' Association.

12. David is one of the authors of the Code of Practice for Investigators of Fire and Explosions for the Criminal Justice Systems in the UK, which is jointly endorsed by the Chief Fire Officers' Association, the Institution of Fire Engineers and the UK Association of Fire Investigators.

13. David is a regular guest lecturer on the Fire and Explosions Investigation course at Leeds University, lecturing on the correct use of fire modelling in support of fire investigation.

OTHER RELEVANT EXPERIENCE

- Managed and led the programme of work for the Chief Fire Officers' Association drafting the new suite of National Operational Guidance on Fires in the Built Environment. This guidance will be used by the UK Fire and Rescue Service by CFOA to provide a common understanding and common language for firefighters to understand the behaviour of buildings and structures during fires.

- Member of the team carrying out research for the Department for Communities and Local Government on fire spread in car parks. Managed the programme of 11 large scale experiments that were carried out during the overall programme of research.

- Managed and led BRE involvement in the EU TRANSFEU project; a project to develop fire safety hazard analysis of railway rolling stock. Involved in the setting up and development activity on coupling the existing BS EN ISO 5859 smoke box to gas phase FTIR for detection and measurement of toxic gases; the method to be incorporated into EN 45545 Part 2.

- Managed and carried out programme of experimental research for the Fédération Internationale de l'Automobile (FIA) investigating fires in motor sport vehicles and feasibility of on-board and hand-held suppression systems used by marshals for dealing with these fires.

- Drafting of Government Guidance documents, including HTM 05-03 Part J (for the Department of Health) and parts of BB100 (for the Department for Children Schools and Families, now Department for Education).

- Member of the team carrying out research for the Ministry of Justice on fire safety in prison cells. Managed a full scale burnout of a prison cell to be used as benchmark data for the programme of research.

- Mem ber of the team carrying out fire risk assessment of HMS Victory for the Ministry of Defence. Responsible for design of test rig to replicate HMS Victory so that fire tests could be carried out to provide source data for design of suppression system for HMS Victory. Carried out investigation of Cutty Sark fire to gather supporting data for this process.
- Managed and carried out research f or Transport for London into potential vulnerability of Cycle Hire terminals to arson attack.
- Carried out com putational fluid dynamics modelling using JASMINE in support of ATKINS (now AECOM) design team for Dubai Metro Danube Station (previously named Jebel Ali Industrial station).
- Mem ber of the team carrying out scoping study for the Department for Communities and Local Government on sustainability and fire. Has extensive experience on the fire performance of buildings incorporating innovative construction products and techniques (also known as modern methods of construction) based on incident experience and experimental research.

PAPERS & PUBLICATIONS

1. Annable K, Greenwood S and Crowder D, “Residential sprinkler installation practice to m aximise functionality and to prevent possible fire penetration”, 2007.
2. Charters D and Crowder D. ‘Ev acuation of Mobility Impaired People from Hospitals’ BRE Trust Research Day, BRE, 19th November 2007.
3. Crowder D. ‘Recent Fire Engineering Research Findings and how Fire Inv estigation Fuels research’ Forensic Engineering Colloquium, University of Limerick, 10th March 2008.
4. Crowder D. ‘Fires in tim ber frame buildings – Manthorpe Avenue and BRE Fire Investigation’ IFE North West Chapter, Manchester, 12th March 2008.
5. Crowder D. ‘Lessons f rom Healthcare Fire Investigations’ BRE Fire Health Check conference, 8th July 2008.
6. Crowder D. ‘Fire inv estigations Involving Innovative Construction Products and Techniques’ Fire Investigation and Research Part 3, BRE, 12th February 2009.
7. Shipp M, Fraser-Mitchell J, Chitty R, Cullinan R, Crowder D, and Clark P. ‘Fire Spread in Car Parks; a summary of the CLG/BRE research programme and findings’ Fire Safety Engineering Magazine, 9th June 2009.
8. Crowder D. ‘Fire Inv estigation as a Mechanism for Improving the Built Environment’ University of Central Lancashire Fire Investigation MSc Course, 19th October 2009.
9. Crowder D. ‘Literature Rev iew and Fire Investigation findings – CLG Fire Spread in Car Parks’ CLG Fire Spread in Car Parks Conference, BRE, 27th October 2009.
10. Crowder D. ‘Fire investigation and research involving innovative construction products and techniques’ Hertfordshire branch of Institution of Fire Engineers Annual General Meeting, 27th April 2010.

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11. Crowder D and Cullinan R. 'Fire Spread in Car Parks: The Contribution of Materials on the Exterior of Modern Vehicles' Interflam 2010, 7th July 2010.
12. Crowder D and Gough I. 'Sprinklers in Car Parks' Fire Sprinkler 2010, 18th November 2010.
13. Crowder D. 'Fire investigation on behalf of Communities and Local Government: Learning lessons on how buildings and their occupants respond to fire' International Association of Arson Investigators Annual Training Conference, 25th January 2011.
14. Crowder D. 'Fire investigation as a feedback mechanism for the fire community' University of Edinburgh and Lloyds Register Educational Trust Technical Leadership seminar in Fire Safety Engineering, 2nd June 2011.
15. Crowder D. 'DCLG Research Project: Fire Spread in Car Parks' Fire Safety in Residential Care Premises and Fires in Multi-Storey Car Parks IFE East SussexGroup CPD Training Day, 21st July 2011.
16. Crowder D. 'Fire Safety Update' Building Research Housing Group Seminar 76: Safety Matters, 17th November 2011.
17. Crowder D. 'The Lakanal Fire, London – Findings from the Inquest' Various, April 2013 to June 2014.
18. Crowder D. 'Potential Perils of modern methods of Construction' Association of Insurance Surveyors CPD seminar, 25th June 2012.
19. Crowder D. 'Fire and Safety' Building Research Housing Group Seminar 77: Does Safety Matter, 13th September 2012.
20. Crowder D. 'Renewable Energy Risks and Modern Methods ofConstruction Losses' Zurich Risk Engineering Forum, 10th October 2012.
21. Crowder D. 'Monitoring the fire risks of sustainable technologies' Fireforum Congress 2012 "Fire and Sustainability" Brussels, 18th October 2012.
22. Crowder D and Charters D. 'Evacuating Vulnerable and Dependant People from Buildings in an Emergency' FB52. IHS BRE Press 2013.
23. Crowder D. 'The Fire Risks of Renewable Energy Generation' Allianz Regional Risk Control training day, 12th March 2013.
24. Crowder D. 'Fire Protection in Social Housing – The Lessons to be Learnt' Firex2013, 14th May 2013.
25. Crowder D. 'Lessons from Real Fires in Timber Construction' Wood2Build, 6th June 2013.
26. Shipp, M, Crowder, D, Holland, C et al. (2013) Fire safety and solar electric/photovoltaic systems. International Fire Professional, October 2013; 6, pp. 12-17.
27. Crowder D and Westlake J. 'Prevention of Arson in Schools' Education Estates Conference, 26th November 2013.
28. Crowder D. 'Do You Understand the Structure of Your Building?' All Party Parliamentary Fire Safety and Rescue Group, 4th December 2013

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29. Foster A and Crowder D. 'Proximate Cause and Subrogation' Chartered Institute of Loss Adjustors Future Focus Conference, 2nd May 2014.

30. Crowder D. 'Fire safety in student accommodation – Lessons from related real incidents' University Safety and Health Association Fire Seminar, 4th June 2014.

31. Crowder D. 'Fire safety issues in social housing – real fire experience' Firex 2014, 17th June 2014.

32. Shipp, M, Holland, C, Crowder, D and Lennon, T. (2015) 'Gone to blazes; Tackling fire spread in roof voids'. RIBA Journal. Available online February 2015.

33. Crowder, D. 'Lessons from Major Fire Disasters' Fire Toxicity 2016, 21st March 2016.

34. Holland, C, Crowder, D and Shipp, M. (2016) External fire spread: New research Part 1. Building Engineer April 2016.

35. Holland, C, Crowder, D, Shipp, M and Cole, N. (2016) External fire spread Part 2: New experiments on façade systems. Building Engineer May 2016.

36. Holland, C, Crowder, D and Shipp, M. (2016) Fire safety issues with balconies. Building Engineer July 2016.

37. Holland, C, Crowder, D and Shipp, M. (2017) Life safety and Regulation 7. Building Engineer January 2017.

NAME	CIARA HOLLAND
CURRENT POSITION	Senior Fire Investigation Consultant
ACADEMIC QUALIFICATIONS	MSc Forensic Science BSc (Hons) Forensic Chemistry
PROFESSIONAL QUALIFICATIONS	AIFireE, MCSFS
SPECIALISATIONS	Fire investigation, Fire development and building performance against building regulations and guidance, Experimental research and consultancy

CAREER SUMMARY

Ciara is a Senior Fire Investigation Consultant within the BRE Fire Investigation team. She specialises in the investigation of fire safety deficiencies and how these deficiencies contribute to disproportionate damage. As part of this work, Ciara regularly assesses how fire safety deficiencies relate to legislative, contractual and professional duties of those responsible for the provision of fire safety designs and fire protection systems.

Since joining BRE in 2012, Ciara has worked on a variety of research projects for UK Government and private concerns. Projects include: assessing the effect of fire on various electrical cable supports, the effect of fire on consumer units, reviewing performance of compartmentation in roof voids in past fires, large scale reconstructions and experiments following fires involving hotels and development of guidance on fires in the built environment for the National Operational Guidance programme for the UK Fire and Rescue Service.

Prior to BRE, Ciara lectured on Forensic Science, with a focus on Forensic Toxicology and Quality Assurance, at the University of Strathclyde as a Teaching Associate. She was responsible for the delivery of the fire science input on the Scottish National Fire Investigators Courses 2011/2012. Further responsibility within these courses involved assisting with the setup and data recording at ~18 live burns. She was further employed as a Research Associate at Strathclyde University to investigate an analytical method of analysis for brominated flame retardants.

Ciara holds an undergraduate degree in Forensic Chemistry and an MSc in Forensic Science. Ciara is a Member of the Chartered Society of Forensic Sciences, an Associate Member of the Institution of Fire Engineers, a member of the International Association of Arson Investigators (IAAI) and the UK Association of Fire Investigators (UK Chapter of IAAI). Ciara represents BRE Global on the UK's National Arson Prevention Forum and is a visiting lecturer on Fire Science and Fire Investigation at the University of Strathclyde.

EXPERIENCE

The following has been selected with respect to experience as a fire investigator.

- Ciara attended the scene at Oldham Street, Manchester in July 2013 following a firefighter fatality to investigate the fire on behalf of DCLG. Subsequently, Ciara provided an expert report to the

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Coroner of the inquest held in May 2016 specifcally addressing issues related to the fire loading in the premises at the time of the fire.

- Ciara is Deputy Project Manager for the Investigation of Real Fires project which BRE undertakes on behalf of DCLG. As part of this project Ciara has investigated issues with building performance at a number of fire scenes or following a fire at a premises including: Oldham Street, Manchester, July 2013 (firefighter fatality), Nottingham University, September 2014 (timber frame under-construction), Camden Market, May 2014 (market stalls) and Langley Mill, Derby, June 2015 (multi-fatal fire).
- Ciara has managed and led a number of large-scale experimental research projects looking at various aspects of fire safety performance of buildings including:
    - A programme of work which looked at the effect of fire on electrical cable supports and fixings following the deaths of a number of firefighters; the findings of this research were used to inform the latest amendment to BS 7671 – the wiring regulations.
    - A series of fire experiments investigating the performance of domestic consumer units in fires; the findings of this research were also used to inform an amendment to the wiring regulations (BS 7671).
    - A series of large-scale experiments assessing the performance of different external building façades including non-fire rated double glazing when exposed to a fire from below.
    - A series of experiments investigating fire spread along soffits in buildings to determine whether it provides a route for by-passing compartmentation.
    - Large-scale fire experiments to assess the fire development characteristics of photovoltaic lithium-ion battery storage units during a fire.
- Ciara has also carried out many laboratory fire experiments and fire reconstructions on structures and components to test hypotheses or assess possible fire performance in support of investigations following incidents. These experiments range from bench-scale analysis of toxic species evolved from burning electrical equipment in trains to large-scale reconstructions or partial reconstructions of incidents. Most notably a large-scale reconstruction and subsequent experimental programme to investigate fire safety solutions in relation to a series of fires at timber-frame hotels.
- Ciara has provided expert opinion on a number of legal cases. She has been involved in the defence of criminal cases including murder and arson with intent and reckless arson cases.
- Ciara has also provided assistance in a number of civil disputes where there was extensive or unusual fire spread as well as cases where there are disputes concerning the design and construction of premises which impact on fire safety. This includes matters concerning liabilities for damage post-fire and disputes over passive fire protection defects in various building types. Ciara has provided expert advice at mediation.
- Ciara was a key member of the team on a programme of work for the Chief Fire Officers' Association drafting the new suite of National Operational Guidance on Fires in the Built Environment. This guidance will be used by the UK Fire and Rescue Service by CFOA to provide a common understanding and common language for firefighters to understand the behaviour of buildings and structures during fires.
- Ciara is a member of the team conducting research into fire incidents involving photovoltaic/solar panel systems on behalf of the Department for Business, Energy and Industrial Strategy.

Findings from the research will be used to monitor and improve the safe-use of these systems and inform guidance provided to Fire & Rescue Services when fighting fires involving these systems.

- Ciara is also proficient in the application and use of various analytical techniques including GC-MS, GC-FID, HPLC, FT-IR and UV for forensic investigations.

PUBLICATIONS

1. Holland, C, et al. (2012) Elemental analysis of paper using Laser Induced Breakdown Spectroscopy. Poster presentation at European Academy of Forensic Science Triennial Conference, August 2012.

2. Shipp, M, Crowder, D, Holland, C et al. (2013) Fire safety and solar electric/photovoltaic systems. International Fire Professional, October 2013; 6, pp. 12-17.

3. NicDaeid, N, Savage, K, Ramsay, D, Holland, C et al. (2014) Development of gas chromatography-mass spectrometry (GC-MS) and other rapid screening methods for the analysis of 16 'legal high' cathinone derivatives. Science & Justice, January 2014; 54 (1) pp. 22-31.

4. Holland, C. Understanding additional risks through the introduction of photovoltaics. Presentation at FIREX International 2014, Expertise & Guidance Theatre, ExCel London, June 2014.

5. Holland, C. Fire Investigation: An Intelligence Led Approach. Presentation at CFOA Conference: A View from the Top Floor at FIREX International 2014 ExCel London, June 2014.

6. Holland, C and Bulbrook, D. National Operational Guidance – Fires in the Built Environment. Presentation at the Institution of Fire Engineers AGM, Stratford-upon-Avon, June 2014.

7. Holland, C. Fires in educational premises – Is there a problem? Presentation at the Institution of Fire Engineers South East Branch Seminar on Fire Safety in Educational Premises and Compartmentation, Siemens HQ, Frimley, September 2014.

8. Holland, C. A series of experiments to assess the effect of fire on a selection of electrical cable supports. Presentation at the Institution of Fire Engineers RE14 conference, Fire Service College, Moreton-on-Marsh, November 2014.

9. Holland C. 3rd party certification and fire protection fakes. Presentation at the UK Association of Fire Investigators Annual Training Conference, University of London Union, January 2015.

10. Shipp, M, Holland, C, Crowder, D and Lennon, T. (2015) Gone to blazes; Tackling fire spread in roof voids. RIBA Journal. Available online February 2015.

11. Holland, C. (2015) Fire safety of cable installations in buildings. Building Engineer September 2015.

12. Holland, C. (2015) Process mapping deliberate fire investigation and prosecution - BRE perspective on provision of expert witness services. Arson Prevention Forum Conference, Emergency Services Show, September 2015.

13. Holland, C. (2016) Life safety and the UK Building Codes. Fire Toxicity 2016 Conference, University of Central Lancashire, Preston, March 2016.

14. Holland, C, Crowder, D and Shipp, M. (2016) External fire spread: New research Part 1. Building Engineer April 2016.

15. Holland, C, Crowder, D, Shipp, M and Cole, N. (2016) External fire spread (Part 2): New experiments on façade systems. Building Engineer May 2016.

16. Holland, C, Crowder, D and Shipp, M. (2016) Fire safety issues with balconies. Building Engineer July 2016.

17. Holland, C, Crowder, D and Shipp, M. (2016) Life safety and Regulation 7. Building Engineer January 2017.

18. Holland, C. Fire experiments with emerging technology. Presentation at the IFE SouthWales Branch seminar, South Wales Fire & Rescue Service HQ, Llantrisant, April 2017.

19. Holland, C. Fire incidents in care homes and sheltered accommodation post-Rose Park Inquiry. Presentation at Fire Safety in Healthcare Services Conference 2017, Dublin, April 2017.

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NAME	DAVID BUTLER
CURRENT POSITION	Associate Director, HVAC Engineering and Building Diagnostics
ACADEMIC QUALIFICATIONS	MSc, BTech
PROFESSIONAL QUALIFICATIONS	Fellow of Institute of Refrigeration
SPECIALISATIONS	Physical mock-up testing, building diagnostics, site investigations and consultancy related to building services including heating, ventilation and air conditioning.

CAREER SUMMARY

Over 30 years' experience of designing and undertaking of physical mock-up tests, laboratory testing and site investigations and consultancy on the performance of building conditioning systems. This has included conventional HVAC systems and low energy and passive systems and heat pumps. Experience over the last 10 years of building investigations relating to building physics including overheating, condensation and the operation and performance of HVAC systems in houses, commercial and other buildings. Undertaken policy related work under DEFRA's MTP and for the Carbon Trust related to air conditioning.

EXPERT WITNESS RELATED

2016 – Investigation into dampness at Aberystwyth University for Balfour Beatty Investments.

2016 – Review of air conditioning at Linwood Community Leisure Centre for Renfrewshire Council.

2013-2016 – Expert opinion on overheating at Flat 164, 25 Barge Walk.

2014 - 2016 – Site investigation of dampness in thatched roof at Farthingale for Cunningham Lindsey.

2015 – Report on heat pump at Commongate Cottage Re: Mark Noble v s Finn Geotherm (referred by IDRS, International Dispute Resolution Centre).

2015 – Investigation into failure of computer centre cooling system failure at Surrey University for Clyde & Co.

2015 – Expert opinion on high humidity at Cedar Cottage, Blackheath for Eversheds LLP on behalf of Morden College.

2015 – Review of thermostatic mixing valve (TMV) failures at Elizabeth House, Thurrock for Devonshires Solicitors on behalf of Hanover Housing Association.

2014 – Reassessment of soffit insulation and condensation in flats for Paradigm Housing Group.

2014 – Review of M&E Specification, Employers Requirements and contract documents of a large residential housing scheme for Rydon Construction.

2014 – Site investigation and review of underfloor heating system for Cunningham Lindsey.

2014 – Investigation into heating systems at Longtown for Riverside Housing Association.

2014 – Advice on ductwork insulation at Orford Park Leisure Hub for Warrington Borough Council.

2013 – Advice on overheating of hospital ward pantries for Lewisham Healthcare NHS Trust.

2013 – Review and expert opinion report for Accent Nene regarding defective air source heat pump installations in 101 dwellings.

2011 to 2012 – Detailed site investigations and monitoring of air to water heat pumps at a new housing development to determine cause of occupant complaints for the developer.

2010 – Detailed investigation into an electrically heated flat for Accent Nene.

2006 to 2007 – Expert Opinion on chilled beam performance at Bristol Harbourside for Kier Build. Briefing Kier Build and their solicitors and Barrister on technical aspects relating to chilled beams (and provision of technical testing services).

OTHER RELEVANT EXPERIENCE

Full-scale physical mock-up testing of internal environments, including air movement, ventilation, heating/cooling performance and thermal comfort.

Laboratory testing of HVAC components including heat pumps.

Building diagnostics, consultancy and expert opinion on overheating, air quality, building health, control and energy efficiency related to building conditioning systems (mechanical and passive ventilation and cooling and heat pumps).

Client advice and design guidance on passive and low energy cooling and air conditioning systems.

Monitoring of building services systems and equipment in the field to assess system performance and building environmental parameters and to investigate overheating and condensation.

Development and review of testing methodologies to assess the thermal performance of buildings using the co-heating test method.

Technical Expert and Consultant to the Carbon Trust for various refrigeration related technologies including chillers, and new technology studies.

PAPERS AND PUBLICATIONS

Over 80 published papers and technical articles including:

Abela A, DJG Butler. BRE Information Paper on Heat Metering. December 2016

Butler DJG and A Dengel. Review of co-heating test methodologies. NHBC Foundation 2013.

Butler DJG. Seminar presentation on Targeting packaged ac efficiency, RAC 2009, BirminghamNEC, 2009.

Butler DJG. Refrigeration for air conditioning buildings. Refrigeration: Optimising refrigeration systems for building services engineers, CIBSE, London 2008.

Butler DJG, MJ Swainson. The role of physical mock-up testing to predict air conditioning performance. CIBSE National Conference, 30 September 2004, London.

Butler DJG (contract author) CIBSE Guide B4. Refrigeration and heat rejection. The Chartered Institution of Building Services Engineers, September 2003.

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NAME	MARTIN SHIPP
CURRENT POSITION	Technical Development Director; Fire Safety, BRE Fire Safety Group
ACADEMIC QUALIFICATIONS	BSc (Hons) Physics
PROFESSIONAL QUALIFICATIONS	CEng FIFireE CPhys MInstP
SPECIALISATIONS	Research management, Fire investigation, Fire safety engineering, Fire safety management, Fire safety risk assessment , Expert witness, fire consultancy

CAREER SUMMARY

Martin Shipp currently has responsibility for fire safety engineering, fire investigation, fire safety management and projects related to all aspects of transport fire safety. He has over forty years' experience at BRE involving applied research, testing, risk assessment, fire investigation, project management, drafting of guidance documents and fire safety engineering consultancy.

Martin is a Chartered fire safety engineer, and has expertise in experimental research, consultancy, laboratory testing and fire safety management. He specialises in risk assessment and hazard analysis, building examination, on-site fire investigation and failure examination, design reviews, large-scale experimental research, vehicle and tunnel fire safety, and is an experienced expert witness. He has carried out investigations for many major UK fires in recent years.

FIRE INVESTIGATION EXPERIENCE

The following has been selected with respect to experience as a fire investigator.

1. Martin is a Chartered (fire) Engineer with the UK Engineering Council, and a Fellow of the Institution of Fire Engineers. He is a Chartered Physicist and a Member of the Institute of Physics. He is a member of the Board (Trustee) of the Institution of Fire Engineers and IFE International President 2017/2018.

2. Martin joined the BRE fire div ision (then, the Fire Research Station; FRS) in 1974, and has carried out fire safety research (primarily experimental and primarily for government clients) since then.

3. In 1988 Martin was called upon to assist the Departm ent of Energy in its inquiry into the Piper Alpha disaster, and then to contribute to the Cullen enquiry by leading the BRE team that carried out an on-site investigation of the ERQ module from Piper Alpha, that had been recovered from the sea bed.

4. From 1988 to 2011 Martin has been head of the BRE teamcarrying out investigations of real fires, primarily for central government (building regulations). This has included the investigation

of numerous major fires including Windsor Castle 1992, and assisting Bedfordshire Police with the investigation into the Yarl's Wood Detention Centre fire in 2002[1].

5. Martin attended the Rosepark Care Home fire in 2004 and managed an extensive programme of laboratory research for the Scottish Executive and Procurator Fiscal in connection with the incident. He gave evidence to the Fatal Accident Inquiry for 3½ days in 2010.

6. Martin has carried out many laboratory fire experiments and fire reconstructions on structures and components to test hypotheses or assess possible fire performance following major incidents. See, for example, his Chapter "The use of laboratory reconstruction in fire investigations" which is Chapter 4 in the book "Fire Investigation" edited by Niamh Nic Daeid[2].

7. As a fire safety scientist, Martin has provided expert advice, and appeared in Court, on a number of criminal and civil legal cases, including the multi-fatality Falklands Hospital arson case (at the Old Bailey) 1984, the Yarl's Wood detention centre fire (at Harrow Crown Court) 2002, the multi-fatality Aviemore "Four Seasons" hotel fire (at Inverness Sheriff's Court) 1995, and a multi-fatality domestic fire in Dumfries (at Dumfries Sheriff's Court).

8. Martin has provided expert fire engineering advice to solicitors and barristers on a number of civil cases where there was extensive or unusual fire spread. This has included fires involving a large supermarket, a block of flats, a London hotel, and a large white goods warehouse. (None of these cases have come to Court.)

9. Martin was a member of the management committee of the Forum of Arson Investigators (now subsumed by the UK-AFI). He has been a guest member of the European Network of Forensic Science Institutes (ENFSI) Fire and Explosion Investigation Working Group. Martin has represented BRE on the UK's National Arson Control Forum.

10. From 1987 Martin was the BRE lead consultant to the UK/French Channel Tunnel Safety Authority (CTSA), advising on all aspects of fire safety (tunnel and rolling stock). Following the fire in the Tunnel in November 1996 he was appointed by the Safety Authority Inquiry Team to take the lead in the on-site investigation of the fire. His report on fire development was incorporated into the CTSA report into the incident[3,4].

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[1] The Ombudsman's report. Yarl's Wood 2002: Inquiry into a disturbance and fire. http://www.ppo.gov.uk/special-investigations/yarls-wood-02.html

[2] "Fire Investigation" edited by Niamh Nic Daeid. CRC Press Forensic Science Series, 2004. ISBN 9780415248914.

[3] "*Inquiry into the fire* on the *Heavy Goods Vehicle Shuttle 7539* on 18 November 1996". The Stationery Office, 1997, ISBN 9780115519314.

[4] Shipp M. (Contributor). `The Handbook of Tunnel Fire Safety`; Chapter 2, `Tunnel fire investigation I: The Channel Tunnel fire, 18 November 1996`. Edited by Alan Beard and Richard Carvel, Thomas Telford, 2005.

11. Martin was a member of the BRE team that assisted with the investigation into the Paddington (Ladbroke Grove) railway fire on behalf of Railtrack in 1999. Findings were incorporated in the Inquiry Report[5].

12. Martin provided assistance to Cornwall Fire and Rescue Service as part of the Penhallow Hotel fire investigation in 2007, and gave evidence (including computer modelling carried out by specialist colleagues) at the Coroner's Court for that incident.

13. Martin provided assistance to North Yorkshire Police as part of the investigation into the fatal fire which occurred in September 2009 in Buckrose Court, Norton, Malton, North Yorkshire, and gave evidence in Leeds Crown Court during the trial.

14. Martin provided assistance to Warwickshire Police as part of the Atherstone-on-Stour fire investigation in 2007, and has carried out laboratory reconstructions for that inquiry.

15. Martin was a member of the Metropolitan Police Service/ London Fire Brigade team investigating the fire at Lakanal House, Camberwell, July 2009.

16. During 2004/05 Martin led the BRE team drafting a number of the new guidance documents on fire safety risk assessment to support the Regulatory Reform (Fire Safety) Order (FSO) (for ODPM – now Department for Communities and Local Government (DCLG)).

17. Martin has carried out, or managed the carrying out of, fire safety risk assessments for a number of clients, including carrying out the fire safety risk assessment of HMS Victory for the Ministry of Defence (MOD) Navy at Portsmouth.

OTHER RELEVANT EXPERIENCE

Managed and executed research, consultancy, risk assessment and drafting of guidance documents in the following areas:

- Fire safety in Tunnels and consultancy to Channel Tunnel Safety Authority. Development of key performance indicators for Fire Safety Engineering.
- Drafting of BS5599 Part 12 Managing fire safety (and management of parts of BS9999) for British Standards Institute (BSI).
- Drafting of CIBSE (Chartered Institution of Building Services Engineers) Guide E (Fire safety engineering) Chapter 14 Fire safety management.
- Drafting of Government Guidance documents, including parts of AD B (for DCLG), eight FSO Guides (for DCLG) and BB100 (for the Department for Children Schools and Families, now Department for Education).
- In 1992 Martin was asked by the European Space Agency (ESA) to review the fire safety provisions for the European module of the International Space Station, and this included being

[5] "The Ladbroke Grove Rail Inquiry ", Parts 1 and 2. The Rt Hon Lord Cullen. Health and Safety Commission, 2001. ISBN 0717620565.

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project manager for a joint FRS/ESA experimental study of fires in space by carrying out fire experiments in micro-gravity during parabolic flights.

- Prof essional posts include: member of the BS committee FSH/14 to develop BS 9999:2008, drafting the section on the Management of Fire Safety (became BS 5588 Part 12). He was a member of drafting committee for CIBCE Guide E (Fire Engineering) (management section), member of the management committee of the Forum of Arson Investigators and guest member of the ENFSI Fire and Explosion Investigation Working Group. Member of the UK Association of Fire Investigators (the UK Chapter of the International Association of Arson Investigators (IAAI). Member of the CFOA Fire Investigation Strategic Steering Group. Member of the editorial board of Fire Safety Engineering magazine. BRE representative to the National Arson Control Forum. Elected member of the Board (Trustee) of the Institution ofFire Engineers and International President 2017/2018. Martin is on the executive board of the Fire Sector Federation and workstream chair for Fire Investigation.
- Mem ber of the BRE team reviewing the fire strategy for Gatwick Airport on behalfof BAA (now Gatwick Airport Ltd). Led the BRE team in carrying out the fire safety risk assessment for HMS Victory on behalf of MOD. Acted as independent reviewer of the risk assessments from Penhallow hotel on behalf of Cornwall Fire and Rescue Service. Led the BRE team who carried out a laboratory reconstruction to assist in resolving a FSO dispute on behalfof Essex Fire and Rescue Service, and computer modelling to assist in resolving a FSO dispute on behalf of Edinburgh City Council.

PAPERS & PUBLICATIONS

Martin has published and lectured extensively and is sole or joint author in over 200 publications and national or international conference papers. A selection ofhis most recent relevant outputs follows:

1. W illiams C. and Shipp M. `Fire safety management`, CIBSE Guide E: Fire engineering guide launch, London, Friday 6th February 2004.
2. Shipp M. (Contributor). `Fire Inv estigation`; Chapter 4, `The use of laboratory reconstruction in fire investigations`. Edited by Niamh Nic Daeid, CRC Press Forensic Science Series, 2004.
3. Shipp M. (Contributor). `The Handbook of Tunnel Fire Safety`; Chapter 2, `Tunnel fire investigation I: The Channel Tunnel fire, 18th November 1996`. Edited by Alan Beard and Richard Carvel, Thomas Telford, 2005.
4. Shipp M and Harrison R. `Gov ernment advice`. Fire Prevention/Fire Engineers Journal Fire Industry Confederation Supplement “Fire Safety Order; your responsibilities explained”, April 2006.
5. Shipp M. `Is fire saf ety management too difficult?`. Paper given at Building Better Schools - designing to maximise safety and minimise risk, BRE, Watford, 14th November 2006.
6. Shipp M. `School fires`. Paper giv en at “The Shape of Things to Come: Fire safety in our schools”, the All-Party Parliamentary Fire Safety and Rescue Group meeting, House of Commons, Monday 4th December 2006.

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7. Shipp M. `Fire saf ety design solutions`. Paper given at "The Regulatory Reform (Fire Safety) Order 2005: Risk assessment and design implications", CIBSE Engineering Centre, Tuesday 30th January 2007

8. Martin B and Shipp M. `Recent changes to Approv ed Document B`. Fire Safety Professional, Issue 23, Spring 2007.

9. Fraser-Mitchell J, Shipp M, and others. `Building Bulletin 100: Design f or fire safety in schools` (BB 100). Department for children, schools and families. RIBA Bookshops. 2007. http://www.teachernet.gov.uk/_doc/12199/BuildingBulletin100_onlineversion.pdf

10. Shipp M. `Fire Safety Regulatory Reform Order`. Presentation to AXA Insurance visit to BRE, 27th November 2007.

11. Shipp M. `The Guides`. Presentation at the IFE South Western Branch Seminar: "Fire Safety Order – suitable and sufficient?", Sandy Park, Exeter. 15th May 2008.

12. Shipp M. `Fire investigation as a Component of Community Risk Reduction`, IFE AGM and Conference 2008 "Innovation in Community Risk Reduction", Blackpool, 2nd and 3rd July 2008.

13. Shipp M. ` Managing fire safety and managing occupied buildings`. Presentation at the BSI launch "Fire Safety in Buildings BS 9999:2008", 15 Hatfields, London, Thursday 13th November 2008.

14. Shipp M. `An introduction to the FSO and the day` and ` What else? where next?`. Presentations at the BRE Conference "The Fire Safety Order – Practical Problems for Practitioners", 8th April 2009, BRE, Watford.

15. Shipp M and Smith V. ` What to do when there is no guide`. Presentation at the BRE Conference "The Fire Safety Order – Practical Problems for Practitioners", BRE, Watford, 8th April 2009.

16. Shipp M. (Contributor). `Fire Safety Management`. CIBSE Guide E: Fire Engineering, 3rd Edition. The Chartered Institution of Building Services Engineers. 2010.

17. Shipp M. `Fire Safety Management`. Presentation at the CIBSE Guide E: Fire Engineering Conference, CIBSE Engineering Centre, Balham. 17th May 2010.

18. Shipp M. `The Fire Safety Order - Challenges for the Risk Assessor`. Presentation at International Firex 2011, NEC Birmingham, Tuesday 17th May 2011.

19. Shipp M. `The role of sprinklers for fire safety in care homes: lessons learned from Rosepark`. Paper given at "Sprinklers save lives, property, money, jobs, communities, the environment, the evidence is compelling isn't it?", the All-Party Parliamentary Fire Safety and Rescue Group meeting, House of Commons and House of Lords, Westminster, Monday 6th February 2012.

20. Shipp M. ` Fire Development and Building Research Establishment` and ` Fire Safety Enforcement (and Building Research Establishment)`. Presentation at "The Penhallow Hotel Fire": Cornwall Fire & Rescue Service National Seminar, 28th March 2012.

21. Holland C, Shipp M and Crowder D. `A series of experiments to assess the effect of fire on a selection of electrical cable supports and fixings`. Wiring Matters - Autumn Issue 2015.

22. Shipp M. `Understanding the built environment and modern methods of construction`. Presentation at the Congress on the Future of Firefighter Safety, Caledonian Club, London, 9th October 2015.

23. Holland C, Crowder D and Shipp M. `External fire spread: New research Part 1`. Building Engineer. April 2016.

24. Holland C, Crowder D, Shipp M and Cole N. `External fire spread (Part 2): New experiments on façade systems`. Building Engineer. May 2016.

25. Holland C, Crowder D and Shipp M. `Fire safety issues with balconies`. Building Engineer. June 2016.

26. Shipp M. ` New fire safety knowledge from experimental research and investigations – a personal experience`. Presentation at the IFE 2016 International Conference “Fire Engineering Contributions to World Cities”, the Guildhall, London. 27th and 28th July 2016.

27. Holland C, Crowder D and Shipp M. `Fire probes uncover cost of poor workmanship`. CIOB Construction Manager. 25th May 2017.

28. Shipp M. `Improving fire safety by research`. Presentation at the IFE 2017 International Conference “Learning lessons, sharing knowledge, saving lives, reducing losses”. Greater Manchester Fire and Rescue Service Training Centre, Manchester. 11th -12th July 2017.

29. Shipp M. `Learning from Incidents, an International Perspective`. Presentation at the IFE Mid-Western Branch event “Fire-fighter Safety in Buildings Part 10 – ‘New’ Perspectives”. Severn Park Training Centre, Avonmouth. 21st August 2017.

Report Ends

Appendix 3

MET00019973

WSP

Metropolitan Police

Operation Northleigh

Site Investigation Report

Project No. 70042523

Date: August 2018

Metropolitan Police

OPERATION NORTHLEIGH

Site Investigation Report

CONFIDENTIAL

Metropolitan Police

OPERATION NORTHLEIGH

Site Investigation Report

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70042523

DATE: AUGUST 2018

WSP
WSP House
70 Chancery Lane
London
WC2A 1AF
Phone: [redacted]
Fax: [redacted]
WSP.com

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	8th August 2018			
Date	Arthur Green			
Prepared by	andrew.hurley@wsp.com Digitally signed by andrew.hurley@wsp.com DN: cn=andrew.hurley@wsp.com, email=andrew.hurley@wsp.com Reason: I am the author of this document Date: 2018.08.10 18:43:04 +01'00'			
Signature	Andrew Hurley			
Checked by	andrew.hurley@wsp.com Digitally signed by andrew.hurley@wsp.com DN: cn=andrew.hurley@wsp.com, email=andrew.hurley@wsp.com Reason: I have reviewed this document Date: 2018.08.10 18:43:33 +01'00'			
Signature	Steven Truss			
Authorised by	Truss, Steven Digitally signed by Truss, Steven DN: cn=Truss, Steven, ou=London (Chancery Lane), email=Steven.Truss@wsp.com Reason: I am approving this document Date: 2018.08.10 18:50:44 +01'00'			
Signature	70042523-300			
Project number				
Report number	T:\Specialists\Vertical Transport\10_Projects\5_Live Projects			
File reference	8th August 2018			

CONTENTS

1 INTRODUCTION

Following the serious fire at Grenfell Tower on 14th June 2017, as part of their investigation, the Metropolitan Police appointed WSP to review the Vertical Transportation System (Lifts) in order to determine how they behaved in response to the fire.

Due to the technical nature of the type of equipment, WSP employed the expertise of Eric Richards, an independent test engineer to assist with the technical and specialist parts of the investigation. Specifically, this was to download and review data that was recovered from the existing lift controllers.

WSP also employed the services of Elan Lifts to undertake the removal of the lift controllers from the machine room for ongoing investigation and interrogation.

WSP also contacted suppliers, as and when necessary, to obtain technical information e.g. operation manuals, although the purpose of our enquiry, i.e. the investigation at Grenfell Tower was not disclosed

Our site investigation into the behaviour of the lifts in the event of a fire was conducted in four separate visits. The first site visit was an initial visual inspection to witness the condition of the lift equipment after the fire and to assess what the scope of works entailed to produce this confidential report. The second visit was the removal of the lift control panels with further visits to the Metropolitan Police storage facility in Deer Park Road, Wimbledon were undertaken to carry out the interrogation of the lift control panels. We were escorted by the Metropolitan Police on all occasions and observed all protocols requested of us.

Our report in parts makes references to British and European Standards. If so then we will refer to the latest issued documents available at the time of the incident.

1.1 PERSONNEL AND ROLES INVOLVED

WSP (Vertical Transportation)

Steven Truss	:	VT Director
Andrew Hurley	:	Associate Director
Arthur Green	:	Associate
Eric Richards	:	Independent Test Engineer

Metropolitan Police

Martin Tucker	:	MPS, Investigating Officer
James McQuen	:	MPS, Investigating Officer
Metropolitan Police	:	Forensic Photographers
London Fire Brigade	:	Watch Manager

Elan Lifts

Tony Fillery	:	Director, Elan Lifts
Aaron Fillery	:	Engineer, Elan Lifts
Jed N'dong	:	Engineer, Elan Lifts

2 EXCLUSIONS

Due to the condition of both the building and in particular; the lifts on site, the following were not included:

1. Mains power was not applied to the lift controller's whilst on site (power was not available).
2. No operational tests were conducted.
3. No dynamic tests were conducted
4. The lift was not moved using the hand winding system
5. Power failure tests were not conducted.
6. The Lift Test and Data Report was not provided nor referenced.

3 DOCUMENTS RECEIVED

WSP requested and were provided with the following documents:

1. Thames Valley Controls (TVC), Job Details.
2. Butler & Young Standard features January 2005.
3. Calculated values for VVVF\Vector Drives.
4. Ver. 2 Stentorgate Speech Unit Request Form.
5. Ver. 2 Stentorgate Handwind Unit Request Form.
6. Fax to Cressall Resistors from TVC re supply of Dynamic Breaking Resistors.
7. Email to TVC from Cressall Resistors re Dynamic Breaking Resistors.
8. TVC Spare Parts List.
9. TVC Certification of Test for contact number V"VEC 66/29 'B'.
10. VEC & VFD Control Panel check list.
11. M6809 Vec/vfr Mk3 Configuration Sheet.
12. M6809 Mk3 Special Programme Request.
13. Motor Data / Parameter Sheet.
14. TVC Contract History.
15. TVC acceptance request.
16. TVC Acknowledgement of receipt of Order.
17. Apex Lift & Escalator Engineers Ltd, Order.
18. TVC Controller wiring diagrams.

4 APPLICABLE STANDARDS

The following Standards were used as reference for this report:

British & National Standards	
BS 5655: Part 1: 1997	Safety rules for the construction and installation of electric lifts
BS 5655-11: 2005	Code of practice for the undertaking of modifications to existing electric lifts
European (CEN) Standards	
BS EN 81-20:2014	Safety rules for the construction and installation of lifts. Lifts for the transport of persons and goods.
BS EN 81-28: 2003	Safety rules for the construction and installation of lifts. Remote alarm on passenger and goods passenger lifts.
BS EN 81-70: 2003	Safety rules for the construction and installation of lifts. Accessibility to lifts for persons including persons with disability.
BS EN 81-71:	Vandal resistant lifts
BS EN 81-73: 2016	Behaviour of lifts in the event of fire
BS EN 81-80: 2003	Safety rules for the construction and installation of existing lifts. Rules for the improvement of safety of existing passenger and goods passenger lift.
BS EN 12015: 2014	Electromagnetic compatibility. Product family standard for lifts, escalators and moving walks. Emission
BS EN 12016: 2013	Electromagnetic compatibility. Product family standard for lifts, escalators and moving walks. Immunity
BS EN 13015:2001+A1:2008	Maintenance for lifts and escalators. Rules for maintenance instructions

This list is non-exhaustive.

At all times the current edition of the above standards are applicable.

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5 EQUIPMENT DETAILS

The following details were obtained from documents provided by the Metropolitan Police. As both lifts were not operational it was not possible to include any dynamic data.

	Left Hand Lift	Right Hand Lift
Customer ID:	H090	H091
Manufacturer:	Modernised by Apex Lift & Escalator Engineers	
Installation Date:	Modernised 2005	
Rated Load:	900kg	
Rated Speed:	2m/s	
Travel:	65m	
No. of Stops:	24	
No. of Openings:	24	
Front Openings:	24	
Alternate Openings	None	
Machine Make:	Sassi	
Machine Position:	Machine Above	
Machine Type:	Geared with flange mounted motor	
Drive Type:	Variable Voltage Variable Frequency (VVVF)	
Door Type:	Single panel side opening	
Door Opening:	800 x 2000	
Controller Manufacturer:	Thames Valley Controls	
Controller Type	M6809	

Lift Service Provider	Not Disclosed
Autodialler	Windcrest AD1000EN-4R

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6 SITE VISIT 1

Date : 15th March 2018

Time : 10.00

Venue : Grenfell Tower, Grenfell Road, W11 1TQ

Present: Andrew Hurley, Associate Director Vertical Transportation, WSP
Eric Richards, Independent Lift Test Engineer
James McQuen, MPS Investigating Officer, Metropolitan Police
Dave Cross, MPS Investigating Officer, Metropolitan Police

6.1 PURPOSE OF VISIT

The purpose of this visit was to undertake a visual inspection of the site with regard to the lifts in order to determine the general condition of the lift lobby's, lift cars and the control equipment within the lift motor room above the lift shafts at roof level.

- On visual inspection we were unable to determine the integrity (strength) and safe condition of the landing doors at each entrance.
- It was therefore recommended that each landing door was boarded up to restrict access and safe guard personnel working in the tower. The protection applied did not tamper with the existing landing doors / entrance.
- Visual inspection of the fireman's control switches at both the ground and walkway levels.
- Visually they had not been damaged by either the fire or water. It was recommended that both switches were removed from site and further examined off site.
- Check condition of lift motor and controller equipment.
- The general condition of the lift controllers was satisfactory and had not been damaged by the fire or water. In order to interrogate the lift control systems they needed to be removed from site and be powered up to determine what information could still be downloaded from the lift microprocessor control.
- To visually check the electrical power supplies to the lifts.
- The incoming supply main switches show signs of the effect of smoke contamination.
- We were unable to determine if there was a dual power supply as no change over switch was visible within the lift machine room demise.
- To visually check fire alarm interfaces.
- A fire alarm interface was present in the lift motor room.
- To visually check the lift machine (Gearbox, brake and motor)
- Signs of both smoke and intense heat around this area including the lift ropes.

It was recommended that the lift cars and counter weights were both suitably lowered into the lift pits to ensure the lift equipment was safe from future movement.

7 SITE VISIT 2

Date :	18th April 2018
Time :	10.00
Venue :	Grenfell Tower, Grenfell Road, W11 1TQ
Present:	Arthur Green, Associate Vertical Transportation, WSP
	Eric Richards, Independent Lift Test Engineer
	Melissa Bussette, Forensics Science Officer, Metropolitan Police
	Aaron Fillery, Engineer,. Elan Lifts
	Jed N'dong, Engineer, Elan Lifts
	Watch Manager from London Fire Brigade

7.1 PURPOSE OF VISIT

The purpose of this visit was to complete the following works:

- To arrange for the removal of the existing lift controllers (2 no) by engineers from Elan Lifts
- To check the fire alarm interface in the machine room
- To check the fireman's switches were connected to the controllers
- To check the operation and status of the fireman's switch located on the ground floor
- To check the operation and status of the fireman's switch located on the walkway level
- To check the power supplies
- To check if the safety gears were engaged on the lift car
- To check the condition of the top of the lift cars

7.2 MACHINE ROOM

GENERAL

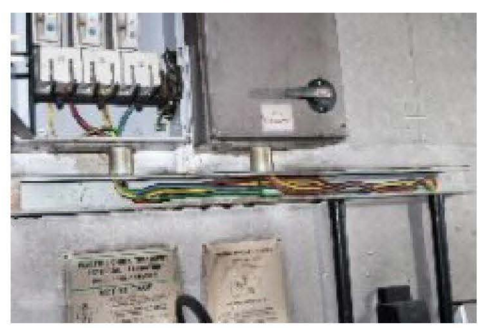
- There was no lighting in the machine room upon arrival. Temporary lighting was provided.
- The access hatch between the controllers was open. The access hatch doors were damaged in the fire. A scaffold tower was erected underneath the access hatch and used as a temporary platform.
- Temporary scaffold and boarding will be required to remove the controllers from the machine room to the roof.
- Temporary scaffold will be required to remove the controllers from the roof to the external hoist.
- The machine room access door was removed to facilitate the removal of the controllers from the machine room.
- Landing entrance protection was removed at levels G, 9, 10, 11 and the top floor.

The battery terminals were corroded on both controllers. If these batteries are used to retain the event and fault logs then they would now be dead and vital information regarding the lift operation may be lost.

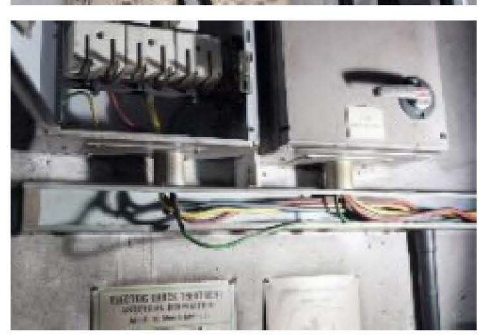
POWER SUPPLIES:

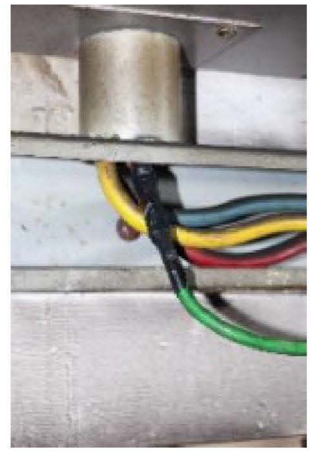
- The lift main isolators were located adjacent to the machine room access door.

- The trunking lids were removed (during this visit) from underneath the mains isolators in order to check the condition of the mains cables.



- The incoming earth wire to the left hand isolator, Lift H091, was wrapped with insulation tape which was hidden inside the conduit. The earth wire was possibly too short and had been extended.





- An attempt was made to determine the route of the incoming mains wire at the top floor riser but extensive fire damage prevented a positive identification.

- We removed the trunking lid on the 9th floor riser to confirm there were 2 x red, 2 x blue, 2 x yellow, 2 x green/yellow and 1 x black cables. This was the case.

FIRE ALARM INTERFACE

- Within the machine room an electrical unit to provide the electrical connectivity interface for the lifts to the building alarm system.
- The purpose of this unit was to recall the lifts to a designated floor when a fire was detected.
- We removed the protective cover to confirm wiring was intact.

- We confirmed fire alarm interface was connected to one of the controllers. We also confirmed that an interconnecting wire was connected to the second controller in order to provide a suitable signal.
- We confirmed there was a connection for the fireman's switch on the controller wiring diagrams.
- We confirmed there was a connection for the fireman's switch to both controllers (yellow & grey wiring).
- We were unable to confirm a connection of a second fireman's switch.

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MACHINE

- Guarding to hand winding wheels was removed.

- Both brake couplings were corroded with evidence of flaking on top of the brake coupling on the left hand lift. Therefore the brake may not be in a suitable condition to stop the lift car if operated whilst on site.

- The traction sheaves show signs of heat damage as there were very little signs of any yellow paint.

- The traction sheaves and grooves were corroded.

DIVERTER SHEAVES

- The diverter sheaves were corroded and indicated signs of heat damage.

MACHINE STEELWORK

- The original blue paint was not present on steelwork located over the openings to the hoistway.
- The steelwork was blackened and corroded above the openings to the hoistway.

SUSPENSION ROPES

- The main suspension ropes were corroded.
- The hemp inner core of the rope (if provided on this construction of rope) may have been affected by the heat. This would affect the integrity of the rope.
- These ropes may not be safe if the lift cars need to be moved.
- OVERSPEED GOVERNORS
- The guarding to both governors was removed.
- The left hand governor, H090, was not engaged.
- The mechanism of the left hand governor appeared to be seized.
- The right hand governor, H091, was not engaged
- The mechanism on the right hand governor appeared to be free.

7.3 TOP OF LIFT CAR

H090

- We gained access to the top of the lift car by opening the landing doors at floor 11.
- The top of car inspection control switch was in the NORMAL position.
- The top of car emergency stop was in the RUN position.
- The lift was in the unlocking zone.
- The lift was approximately 75mm to 100mm above the finished floor level.
- There was no isolation rubbers between the rope anchor and the car hitch plate. There was no evidence of any being fitted.

H091

- We gained access to the top of the lift car by opening the landing doors at floor 11.
- The top of car inspection control switch was in the NORMAL position.
- The top of car emergency stop was in the STOP position.
- The lift was in the unlocking zone.
- The lift was approximately 75mm to 100mm above the finished floor level
- The isolation rubbers between the rope anchor and the car hitch plate were fitted.

7.4 UNDERNEATH LIFT CAR

H091

- We gained visual access to the underside of the lift car by opening the landing doors at floor 9.
- VG Bi Directional safety gears were fitted.
- The safety gear was not engaged.
- The safety operated switch was in its NORMAL position
- There were gaps measuring approx. 1.5mm – 2mm between both car and counterweight guide joints.

7.5 FIREMAN'S SWITCHES

LEVEL 2 (WALKWAY)

- A drop type key is used to both operate the fireman's switch and to open the landing doors of the lift in an emergency.
- The notches on the release key align with similar notches inside the box in order to operate the switch. This is to prevent access by unauthorised persons.

wsp

- It was not possible to operate the fireman's switch using the release key.

- We removed the faceplate to discover that there were no wires connected to the fireman's switch.

- The conduit from the shaft to the rear of the box contained one red wire. This was possibly a draw wire for future connection.
- With the faceplate removed we checked the operation with the release key. It was very difficult to align the key to the slots in the brackets to operate the micro switch.
- The micro switch was not bi-stable i.e. it was spring loaded and returned to its normal operating position.

GROUND FLOOR

- A green flag could be seen through the hole in the faceplate.

- The fireman's switch was difficult to operate.
- The faceplate was removed to determine the reason for failing to operate the switch.

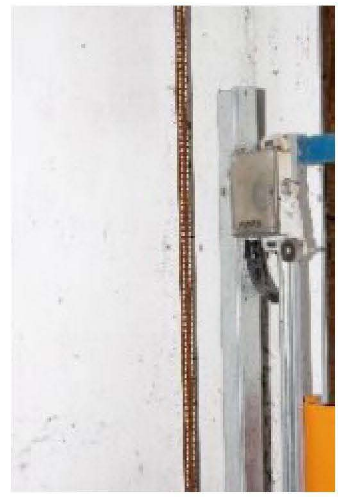
- We discovered that the mechanism was seized and damaged/deformed.
- The contacts were open circuit when checked with a multi-meter.
- The wiring was coloured yellow and grey.

7.6 H091 LIFT PIT

- There was approx. 75mm of water in the pit.
- The Pit Emergency Stop switch was in the STOP position.

7.7 POSITION REFERENCE SYSTEM

- It should be ascertained if the position reference system is operated via infra-red as this could have a detrimental effect on the operation of the lift.



ADDITIONAL INFORMATION

- Arthur Green and Eric Richards visited two other tower blocks in the local area to ascertain if the fireman's switches were functional. On both buildings the fireman's switches had been changed from the drop release key to a triangular euro key operated type.
-
- We briefly checked the operation of the fireman's switch. The lifts returned to the Ground Floor. However, we discovered that the operation of the lifts was not to current standards.

8 SITE VISIT 3

Date : 16th May 2018

Time : 10.00

Venue : Deer Park Road, South Wimbledon

Present: Arthur Green, Associate Vertical Transportation, WSP
Eric Richards, Independent Lift Test Engineer
James McQuen, MPS Investigating Officer, Metropolitan Police
Forensic Police Photographer

8.1 PURPOSE OF VISIT

- To check the present (post fire) condition of the controllers.
- To check the status of all fuses, circuit breakers, overloads etc. on both lifts.
- To apply mains power to the controllers.
- To interrogate the controllers and record any stored events and faults.
- To check the present condition of the Windcrest Autodiallers.

8.2 CONTROLLER POWER SUPPLIES

GENERAL

- The lift controllers were positioned close to the roller shutter doors at the side of the building.
- Non-essential components e.g. Variable frequency drive units, dynamic breaking resistors, batteries were not reconnected to the controller to assist the fault interrogation exercise.

POWER SUPPLIES

- Power was not immediately available although there was a 415vac supply used to power the roller shutter doors.
- We instructed the electrician to provide a commando type plug and approx. 25 metres of cable in order to connect 2 phases to the main power supply transformer on the controller.
- Preliminary photographs were taken of the present condition of both controllers.
- The dynamic breaking resistors were not reconnected to the controller as these are only used to absorb the regenerative energy when the lift is in motion.
- The variable frequency drives were not reconnected.
- The main battery backups were not reconnected to the controller.
- The front and back cover doors were not refitted to the controllers.
- The controllers had the remains of the field / shaft wiring attached as a result of them being removed from the lift machine room.

8.3 CONTROLLER FUSES

H090

NAME	PURPOSE	SPECIFIED RATING (A)	ACTUAL RATING (A)	STATUS
PSU1		5	5	INTACT
PSU2		5	5	INTACT
BMOL		Specific		INTACT
Motor Overload		Specific	64	INTACT
CB1				ON
BSF		6.3	6.3	INTACT
DF1		3	3.15	INTACT
CCF		3	4	BLOWN
LPF	Landing Push Feed	1	1	BLOWN
CPF	Car Push Feed	0.5	0.5	INTACT
CFF		0.25	0.25	BLOWN
MKII 6809 POWER SUPPLY FUSES				
75v		1	1	INTACT
19v		3	3.15	INTACT
9v		3	3.15	INTACT
100v		0.5	0.25	INTACT
LPF	Landing Push Feed		1	INTACT
CPF	Car Push Feed	0.5	0.5	INTACT
24v		2	2	INTACT
10v		2	2	INTACT
STENTORGATEFUSES				
A			6.3	INTACT
B			6.3	INTACT

H091

NAME	PURPOSE	SPECIFIED RATING (A)	ACTUAL RATING (A)	STATUS
PSU1		5	5	INTACT
PSU2		5	5	INTACT
BMOL		Specific		INTACT
Motor Overload		Specific	64	INTACT
CB1				TRIPPED
BSF		6.3	6.3	INTACT
DF1		3	3.15	INTACT
CCF		3	6.3	BLOWN
LPF	Landing Push Feed	1	1	BLOWN
CPF	Car Push Feed	0.5	0.5	INTACT
CFF		0.25	0.25	INTACT
MKII 6809 POWER SUPPLY FUSES				
75v		1	1	INTACT
19v		3	3.15	INTACT
9v		3	3.15	INTACT
100v		0.5	0.25	INTACT
LPF	Landing Push Feed		1	INTACT
CPF	Car Push Feed	0.5	0.5	INTACT

24v		2	2	INTACT
10v		2	2	INTACT
STENTORGATEFUSES				
A			6.3	INTACT
B			6.3	INTACT

MACHINE ROOM THERMOSTAT (Located inside the controller to monitor the ambient temperature of the machine room)

- H090: Intact
- H091: Broken

M6809 MICROPROCESSOR CONFIGURATION

H090			**H091**	
DIP SW	**SETTING**		**DIP SW**	**SETTING**
SW1.1	OFF	FL1 BINARY	SW1.1	OFF
SW1.2	OFF	FL2 BINARY	SW1.2	OFF
SW1.3	OFF	FL4 BINARY	SW1.3	OFF
SW1.4	ON	FL8 BINARY	SW1.4	ON
SW1.5	ON	FL16 BINARY	SW1.5	ON
SW1.6	OFF	LISI/LOSI	SW1.6	OFF
SW1.7	ON	ON=DC/WPB OFF=PC	SW1.7	ON
SW1.8	OFF	NOT USED	SW1.8	OFF
SW2.1	ON	HOMING ENABLE	SW2.1	ON
SW2.2	ON	LIFT SELF TEST ENABLE	SW2.2	ON
SW2.3	ON	ANTI-NUISANCE ENABLE	SW2.3	ON
SW2.4	ON	DOOR NUDGING	SW2.4	ON
DDS	UP		DDS	UP
PTT	UP		PTT	UP

8.4 FIELD WIRING

FIELD / SHAFT WIRING

- All redundant field wiring was removed in order not to blow any fuses when the power was applied to the controller
- Two phases of a 415vac supply were connected to the 0v and 400v terminals of the MKII 6908 Power Supply

RHO00000004_0112

8.5 STORED EVENTS AND FAULTS

Each controller is capable of storing the latest 200 events/faults. Any new events/faults will shift out the oldest faults. The time on the processor is not the same as the present time.

With the mains power applied the stored events and faults were as follows:

H090

The following faults were recorded when the controller was powered up. Please note the position reference commences at 1 e.g. 1 = Ground, 2 = 1st floor, 11 = 10th floor etc.

LOG	CODE	DESCRIPTION	POS	TIME	DATE	CARD	PHOTO Ref.
200	51	LIGHT DUTY	1	11:48	16/05/2018	A	DSC_0090
199	64	THERMISTORTRIP	1	11:48	16/05/2018	A	DSC_0091
198	64	LOST LAR	1	11:48	16/05/2018	A	DSC_0092
197	46	SEEK NXT FLR SE5	1	11:48	16/05/2018	A	DSC_0093
196	00	POWER ON RESET	1	11:48	16/05/2018	A	DSC_0094

The following faults were recorded on the date of the incident:

LOG	CODE	DESCRIPTION	POS	TIME	DATE	CARD	PHOTO Ref.
195	51	LIGHT DUTY	11	03:07	14/06/2017	A	DSC_0095
194	01	LOST LAR	11	01:16	14/06/2017	A	DSC_0096
193	04	DOOR OPEN PR. TIME-OUT	11	01:16	14/06/2017	A	DSC_0097
192	04	DOOR OPEN PR. TIME-OUT	11	01:16	14/06/2017	A	DSC_0098
191	04	DOOR OPEN PR. TIM- OUT	11	01:15	14/06/2017	A	DSC_0099
190	27	LOST LDG PUSH FEED	11	01:15	14/06/2017	A	DSC_0100
189	04	DOOR OPEN PR. TIME-OUT	11	01:15	14/06/2017	A	DSC_0101
188	20	FRONT SE OVERTIME	11	01:15	14/06/2017	A	DSC_0102
187	9	D/CLOSE PR. TIME-OUT	11	01:14	14/06/2017	A	DSC_0103
186	12	CALLS TF'D OR CNCL'D	11	01:14	14/06/2017	A	DSC_0104
185	04	DOOR OPEN PR. TIM- OUT	11	01:14	14/06/2017	A	DSC_0105
184	37	STUCK DOWN CALL	11	00:48	14/06/2017	A	DSC_0106
183	37	STUCK DOWN CALL	11	00:38	14/06/2017	A	DSC_0107
182	20	FRONT SE OVERTIME	7	00:29	14/06/2017	A	DSC_0108
181	37	STUCK DOWN CALL	11	00:15	14/06/2017	A	DSC_0109

Please refer to Appendix A for a description of all fault codes.

The following are recorded historic events/faults:

LOG	CODE	DESCRIPTION	POS	TIME	DATE	CARD	PHOTO Ref.
180	36	STUCK CAR CALL	4	23:58	13/06/2017	A	DSC_0110
179	9	D/CLOSE PR. TIME-OUT	3	23:44	13/06/2017	A	DSC_0111
178	15	DOOR NUDGING	3	23:44	13/06/2017	A	DSC_0112
177	20	FRONT SE OVERTIME	3	23:42	13/06/2017	A	DSC_0113
176	15	DOOR NUDGING	1	23:42	13/06/2017	A	DSC_0114
175	20	FRONT SE OVERTIME	1	23:41	13/06/2017	A	DSC_0115
174	15	DOOR NUDGING	1	19:29	13/06/2017	A	DSC_0116
173	20	FRONT SE OVERTIME	1	15:41	13/06/2017	A	DSC_0117
172	15	DOOR NUDGING	6	15:34	13/06/2017	A	DSC_0118
171	20	FRONT SE OVERTIME	6	15:33	13/06/2017	A	DSC_0119
170	12	CALLS TF'D OR CNCL'D	23	07:31	13/06/2017	A	DSC_0120
169	12	CALLS TF'D OR CNCL'D	19	07:23	13/06/2017	A	DSC_0121
168	20	FRONT SE OVERTIME	1	06:05	13/06/2017	A	DSC_0122
167	20	FRONT SE OVERTIME	22	18:24	12/06/2017	A	DSC_0123
166	20	FRONT SE OVERTIME	22	18:23	12/06/2017	A	DSC_0124
165	12	CALLS TF'D OR CNCL'D	6	17:06	12/06/2017	A	DSC_0125
164	15	DOOR NUDGING	6	17:06	12/06/2017	A	DSC_0126
163	20	FRONT SE OVERTIME	6	17:06	12/06/2017	A	DSC_0127
162	12	CALLS TF'D OR CNCL'D	15	05:16	12/06/2017	A	DSC_0128
161	12	CALLS TF'D OR CNCL'D	1	14:11	12/06/2017	A	DSC_0129
160	15	DOOR NUDGING	1	14:11	12/06/2017	A	DSC_0130
159	12	CALLS TF'D OR CNCL'D	23	07:30	12/06/2017	B	DSC_0002
158	15	DOOR NUDGING	1	07:26	12/06/2017	B	DSC_0003
157	20	FRONT SE OVERTIME	1	07:26	12/06/2017	B	DSC_0004
156	20	FRONT SE OVERTIME	1	07:02	12/06/2017	B	DSC_0005
155	20	FRONT SE OVERTIME	20	19:02	11/06/2017	B	DSC_0006
154	15	DOOR NUDGING	15	18:30	11/06/2017	B	DSC_0007
153	20	FRONT SE	1	16:01	11/06/2017	B	DSC_0008

		OVERTIME					
152	12	CALLS TF'D OR CNCL'D	1	14:28	11/06/2017	B	DSC_0009
151	20	FRONT SE OVERTIME	21	12:13	11/06/2017	B	DSC_0010
150	20	FRONT SE OVERTIME	21	12:13	11/06/2017	B	DSC_0011
149	20	FRONT SE OVERTIME	23	10:19	11/06/2017	B	DSC_0012
148	15	DOOR NUDGING	5	22:45	10/06/2017	B	DSC_0013
147	20	FRONT SE OVERTIME	5	10:48	10/06/2017	B	DSC_0014
146	12	CALLS TF'D OR CNCL'D	6	11:02	10/06/2017	B	DSC_0015
145	15	DOOR NUDGING	6	19:46	10/06/2017	B	DSC_0016
144	20	FRONT SE OVERTIME	6	19:46	10/06/2017	B	DSC_0017
143	12	CALLS TF'D OR CNCL'D	19	19:43	10/06/2017	B	DSC_0018
142	12	CALLS TF'D OR CNCL'D	19	19:42	10/06/2017	B	DSC_0019
141	15	DOOR NUDGING	19	19:42	10/06/2017	B	DSC_0020
140	20	FRONT SE OVERTIME	19	19:42	10/06/2017	B	DSC_0021
139	20	FRONT SE OVERTIME	1	19:28	10/06/2017	B	DSC_0022
138	12	CALLS TF'D OR CNCL'D	23	19:17	10/06/2017	B	DSC_0023
137	15	DOOR NUDGING	23	19:17	10/06/2017	B	DSC_0024
136	20	FRONT SE OVERTIME	23	19:16	10/06/2017	B	DSC_0025
135	12	CALLS TF'D OR CNCL'D	3	14:51	10/06/2017	B	DSC_0026
134	15	DOOR NUDGING	19	13:19	10/06/2017	B	DSC_0027
133	20	FRONT SE OVERTIME	19	13:19	10/06/2017	B	DSC_0028
132	15	DOOR NUDGING	10	08:56	10/06/2017	B	DSC_0030
131	20	FRONT SE OVERTIME	10	08:56	10/06/2017	B	DSC_0031
130	12	CALLS TF'D OR CNCL'D	4	07:13	10/06/2017	B	DSC_0032
129	20	FRONT SE OVERTIME	21	19:41	09/06/2017	B	DSC_0033
128	12	CALLS TF'D OR CNCL'D	15	19:20	09/06/2017	B	DSC_0034
127	20	FRONT SE OVERTIME	19	19:20	09/06/2017	B	DSC_0035
126	12	CALLS TF'D OR CNCL'D	19	19:19	09/06/2017	B	DSC_0036
125	12	CALLS TF'D OR CNCL'D	19	19:18	09/06/2017	B	DSC_0037

124	15	DOOR NUDGING	19	19:18	09/06/2017	B	DSC_0038
123	20	FRONT SE OVERTIME	19	19:18	09/06/2017	B	DSC_0039
122	12	CALLS TF'D OR CNCL'D	24	17:33	09/06/2017	B	DSC_0040
121	15	DOOR NUDGING	24	17:33	09/06/2017	B	DSC_0041
120	20	FRONT SE OVERTIME	24	17:33	09/06/2017	B	DSC_0042
119	12	CALLS TF'D OR CNCL'D	24	09:35	09/06/2017	B	DSC_0043
118	20	FRONT SE OVERTIME	24	08:58	09/06/2017	B	DSC_0044
117	12	CALLS TF'D OR CNCL'D	24	07:05	09/06/2017	B	DSC_0045
116	15	DOOR NUDGING	24	07:05	09/06/2017	B	DSC_0046
115	20	FRONT SE OVERTIME	1	06:56	09/06/2017	B	DSC_0047
114	15	DOOR NUDGING	5	06:42	09/06/2017	B	DSC_0048
113	20	FRONT SE OVERTIME	1	06:42	09/06/2017	B	DSC_0049
112	20	FRONT SE OVERTIME	17	21:21	08/06/2017	B	DSC_0050
111	15	DOOR NUDGING	10	19:45	08/06/2017	B	DSC_0051
110	20	FRONT SE OVERTIME	17	19:45	08/06/2017	B	DSC_0052
109	20	FRONT SE OVERTIME	13	17:49	08/06/2017	B	DSC_0053
108	15	DOOR NUDGING	1	17:34	08/06/2017	B	DSC_0054
107	20	FRONT SE OVERTIME	1	17:34	08/06/2017	B	DSC_0055
106	20	FRONT SE OVERTIME	1	16:33	08/06/2017	B	DSC_0056
105	15	DOOR NUDGING	4	16:30	08/06/2017	B	DSC_0057
104	20	FRONT SE OVERTIME	1	16:28	08/06/2017	B	DSC_0058
103	15	DOOR NUDGING	4	16:27	08/06/2017	B	DSC_0059
102	12	CALLS TF'D OR CNCL'D	1	16:24	08/06/2017	B	DSC_0060
101	15	DOOR NUDGING	1	16:23	08/06/2017	B	DSC_0061
100	20	FRONT SE OVERTIME	4	16:21	08/06/2017	B	DSC_0062
99	20	FRONT SE OVERTIME	1	16:20	08/06/2017	B	DSC_0063
98	15	DOOR NUDGING	4	15:58	08/06/2017	B	DSC_0064
97	20	FRONT SE OVERTIME	6	14:45	08/06/2017	B	DSC_0065
96	20	FRONT SE OVERTIME	1	12:37	08/06/2017	B	DSC_0066

95	37	STUCK DOWN CALL	17	12:34	08/06/2017	B	DSC_0067
94	20	FRONT SE OVERTIME	24	12:33	08/06/2017	B	DSC_0068
93	12	CALLS TF'D OR CNCL'D	24	12:33	08/06/2017	B	DSC_0069
92	12	CALLS TF'D OR CNCL'D	1	12:28	08/06/2017	B	DSC_0070
91	20	FRONT SE OVERTIME	1	12:24	08/06/2017	B	DSC_0071
90	12	CALLS TF'D OR CNCL'D	4	11:57	08/06/2017	B	DSC_0072
89	15	DOOR NUDGING	4	13:26	08/06/2017	B	DSC_0073
88	20	FRONT SE OVERTIME	1	06:42	08/06/2017	B	DSC_0074
87	12	CALLS TF'D OR CNCL'D	8	14:17	07/06/2017	B	DSC_0075
86	15	DOOR NUDGING	8	14:17	07/06/2017	B	DSC_0076
85	20	FRONT SE OVERTIME	8	14:17	07/06/2017	B	DSC_0077
84	20	FRONT SE OVERTIME	1	14:16	07/06/2017	B	DSC_0078
83	03	NOT IN DOOR ZONE	1	10:04	07/06/2017	B	DSC_0079
82	03	NOT IN DOOR ZONE	1	10:04	07/06/2017	B	DSC_0080
81	05	GL LOST	1	10:04	07/06/2017	B	DSC_0081
80	42	TEST CONTROL	2	09:55	07/06/2017	B	DSC_0082
79	18	SELF-TEST ERROR	2	09:55	07/06/2017	B	DSC_0083
78	01	LOST LAR	2	09:55	07/06/2017	B	DSC_0084
77	42	TEST CONTROL	2	09:43	07/06/2017	B	DSC_0085
76	18	SELF-TEST ERROR	2	09:42	07/06/2017	B	DSC_0086
75	01	LOST LAR	2	09:42	07/06/2017	B	DSC_0088
74	38	STUCK UP CALL	1	07:32	07/06/2017	B	DSC_0089
73	37	STUCK DOWN CALL	4	07:31	07/06/2017	B	DSC_0090
72	37	STUCK DOWN CALL	18	07:30	07/06/2017	B	DSC_0091
71	36	STUCK CAR CALL	3	17:05	06/06/2017	B	DSC_0092
70	14	MULTIPLE START FAILS	2	17:00	06/06/2017	B	DSC_0093
69	08	PRE-LOCK FAIL	2	17:00	06/06/2017	B	DSC_0094
68	08	PRE-LOCK FAIL	2	16:59	06/06/2017	B	DSC_0095
67	08	PRE-LOCK FAIL	2	16:59	06/06/2017	B	DSC_0096
66	14	MULTIPLE START FAILS	2	16:56	06/06/2017	B	DSC_0097
65	08	PRE-LOCK FAIL	2	16:56	06/06/2017	B	DSC_0098

64	08	PRE-LOCK FAIL	2	16:56	06/06/2017	B	DSC_0099
63	08	PRE-LOCK FAIL	2	16:55	06/06/2017	B	DSC_0100
62	12	CALLS TF'D OR CNCL'D	2	16.52	06/06/2017	B	DSC_0101
61	14	MULTIPLE START FAILS	2	16:51	06/06/2017	B	DSC_0102
60	08	PRE-LOCK FAIL	2	16:51	06/06/2017	B	DSC_0103
59	12	CALLS TF'D OR CNCL'D	2	16:51	06/06/2017	B	DSC_0104
58	08	PRE-LOCK FAIL	2	16:51	06/06/2017	B	DSC_0105
57	08	PRE-LOCK FAIL	2	16:51	06/06/2017	B	DSC_0106
56	37	STUCK DOWN CALL	21	16:09	06/06/2017	B	DSC_0107
55	37	STUCK DOWN CALL	19	16:09	06/06/2017	B	DSC_0108
54	36	STUCK CAR CALL	23	15:46	06/06/2017	B	DSC_0109
53	36	STUCK CAR CALL	22	15:46	06/06/2017	B	DSC_0110
52	36	STUCK CAR CALL	21	15:46	06/06/2017	B	DSC_0111
51	36	STUCK CAR CALL	19	15:46	06/06/2017	B	DSC_0112
50	36	STUCK CAR CALL	18	15:46	06/06/2017	B	DSC_0113
49	36	STUCK CAR CALL	17	15:46	06/06/2017	B	DSC_0114
48	36	STUCK CAR CALL	20	15:46	06/06/2017	B	DSC_0115
47	36	STUCK CAR CALL	15	15:46	06/06/2017	B	DSC_0116
46	36	STUCK CAR CALL	16	15:46	06/06/2017	B	DSC_0117
45	36	STUCK CAR CALL	24	15:46	06/06/2017	B	DSC_0118
44	12	CALLS TF'D OR CNCL'D	2	16:51	06/06/2017	B	DSC_0119
43	15	DOOR NUDGING	7	15:43	06/06/2017	B	DSC_0120
42	12	CALLS TF'D OR CNCL'D	1	15:28	06/06/2017	B	DSC_0121
41	15	DOOR NUDGING	23	13:26	06/06/2017	B	DSC_0122
40	08	PRE-LOCK FAIL	2	07:41	06/06/2017	B	DSC_0123
39	08	PRE-LOCK FAIL	2	07:41	06/06/2017	B	DSC_0124
38	14	MULTIPLE START FAILS	2	07:38	06/06/2017	B	DSC_0125
37	08	PRE-LOCK FAIL	2	07:38	06/06/2017	B	DSC_0126
36	08	PRE-LOCK FAIL	2	07:38	06/06/2017	B	DSC_0127
35	08	PRE-LOCK FAIL	2	07:37	06/06/2017	B	DSC_0128
34	14	MULTIPLE START FAILS	2	07:37	06/06/2017	B	DSC_0129

wsp

33	08	PRE-LOCK FAIL	2	07:37	06/06/2017	B	DSC_0130
32	08	PRE-LOCK FAIL	2	07:37	06/06/2017	B	DSC_0131
31	08	PRE-LOCK FAIL	2	07:36	06/06/2017	B	DSC_0132
30	08	PRE-LOCK FAIL	2	21:40	05/06/2017	B	DSC_0133
29	08	PRE-LOCK FAIL	1	16:52	05/06/2017	B	DSC_0134
28	12	CALLS TF'D OR CNCL'D	16	15:11	05/06/2017	B	DSC_0135
27	15	DOOR NUDGING	16	15:11	05/06/2017	B	DSC_0136
26	20	FRONT SE OVERTIME	16	15:11	05/06/2017	B	DSC_0137
25	20	FRONT SE OVERTIME	6	15:07	05/06/2017	C	DSC_0002
24	12	CALLS TF'D OR CNCL'D	1	14:27	05/06/2017	C	DSC_0003
23	15	DOOR NUDGING	1	14:27	05/06/2017	C	DSC_0004
22	20	FRONT SE OVERTIME	1	14:27	05/06/2017	C	DSC_0005
21	12	CALLS TF'D OR CNCL'D	12	12:42	05/06/2017	C	DSC_0006
20	15	DOOR NUDGING	12	12:42	05/06/2017	C	DSC_0007
19	20	FRONT SE OVERTIME	12	14:27	05/06/2017	C	DSC_0008
18	18	SELF-TEST ERROR	2	10:55	05/06/2017	C	DSC_0009
17	01	LOST LAR	2	10:55	05/06/2017	C	DSC_0010
16	37	STUCK DOWN CALL	24	07:37	05/06/2017	C	DSC_0011
15	38	STUCK UP CALL	15	07:34	05/06/2017	C	DSC_0012
14	37	STUCK DOWN CALL	15	07:37	05/06/2017	C	DSC_0013
13	37	STUCK DOWN CALL	16	07:37	05/06/2017	C	DSC_0014
12	38	STUCK UP CALL	1	12:24	05/06/2017	C	DSC_0015
11	37	STUCK DOWN CALL	4	12:23	05/06/2017	C	DSC_0016
10	37	STUCK DOWN CALL	23	12:22	05/06/2017	C	DSC_0017
9	38	STUCK UP CALL	1	11:31	05/06/2017	C	DSC_0018
8	37	STUCK DOWN CALL	22	11:29	05/06/2017	C	DSC_0019
7	37	STUCK DOWN CALL	16	11:29	05/06/2017	C	DSC_0020
6	38	STUCK UP CALL	16	11:27	05/06/2017	C	DSC_0021
5	36	STUCK CAR CALL	3	02:35	04/06/2017	C	DSC_0022
4	12	CALLS TF'D OR CNCL'D	12	02:22	04/06/2017	C	DSC_0023
3	08	PRE-LOCK FAIL	2	02:22	04/06/2017	C	DSC_0024

2	08	PRE-LOCK FAIL	2	02:21	04/06/2017	C	DSC_0025
1	20	FRONT SE OVERTIME	6	01:08	04/06/2017	C	DSC_0026

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The following faults were recorded when the controller was powered up:

LOG	CODE	DESCRIPTION	POS	TIME	DATE	CARD	PHOTO Ref.
200	51	LIGHT DUTY	1	14:41	16/05/2018	C	DSC_0034
199	64	THERMISTORTRIP	1	14:41	16/05/2018	C	DSC_0035
198	01	LOST LAR	1	14:41	16/05/2018	C	DSC_0036
197	04	SEEK NXT FLR SE5	1	14:41	16/05/2018	C	DSC_0037
196	00	POWER ON RESET	1	14:41	16/05/2018	C	DSC_0038

All of the remaining faults were recorded on the date of the incident:

LOG	CODE	DESCRIPTION	POS	TIME	DATE	CARD	PHOTO Ref.
195	01	LOST LAR	11	02:33	14/06/2017	C	DSC_0039
194	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0040
193	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0041
192	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0042
191	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0043
190	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0044
189	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0045
188	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0046
187	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0047
186	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0048
185	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0049
184	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0050
183	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0051
182	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0052
181	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0053
180	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0054
179	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0055
178	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0056

177	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0057
176	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0058
175	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0059
174	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0060
173	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0061
172	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0062
171	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0063
170	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0064
169	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0065
168	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0066
167	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0067
166	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0068
165	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0069
164	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0070
163	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0071
162	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0072
161	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0073
160	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0074
159	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0075
158	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0076
157	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0077
156	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0078
155	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0079
154	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0080
153	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0081
152	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0082
151	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0083
150	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0084
149	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0085
148	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0086
147	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0087
146	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0088

145	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0089
144	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0090
143	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0091
142	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0092
141	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0093
140	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0094
139	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0095
138	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0096
137	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0097
136	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0098
135	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0099
134	48	SE COMMS FAILURE	11	02:33	14/06/2017	C	DSC_0100
133	50	SE COMMS OK SE5	11	02:33	14/06/2017	C	DSC_0101
132	48	SE COMMS FAILURE	11	02:32	14/06/2017	C	DSC_0102
131	50	SE COMMS OK SE5	11	02:32	14/06/2017	C	DSC_0103
130	48	SE COMMS FAILURE	11	02:32	14/06/2017	C	DSC_0104
129	50	SE COMMS OK SE5	11	02:32	14/06/2017	C	DSC_0105
128	48	SE COMMS FAILURE	11	02:32	14/06/2017	C	DSC_0106
127							
126	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0002
125	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0003
124	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0004
123	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0005
122	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0006
121	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0007
120	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0008
119	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0009
118	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0010
117	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0011
116	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0012
115	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0013
114	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0014

113	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0015
112	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0016
111	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0017
110	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0018
109	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0019
108	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0020
107	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0021
106	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0022
105	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0023
104	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0024
103	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0025
102	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0026
101	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0027
100	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0028
99	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0029
98	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0030
97	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0031
96	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0032
95	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0033
94	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0034
93	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0035
92	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0036
91	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0037
90	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0038
89	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0039
88	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0040
87	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0041
86	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0042
85	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0043
84	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0044
83	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0045
82	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0046

81	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0047
80	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0048
79	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0049
78	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0050
77	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0051
76	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0053
75	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0054
74	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0055
73	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0056
72	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0057
71	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0058
70	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0059
69	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0060
68	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0061
67	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0062
66	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0063
65	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0064
64	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0065
63	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0066
62	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0067
61	50	SE COMMS OK SE5	11	02:32	14/06/2017	D	DSC_0068
60	48	SE COMMS FAILURE	11	02:32	14/06/2017	D	DSC_0069
59	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0070
58	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0071
57	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0072
56	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0073
55	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0074
54	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0075
53	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0076
52	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0077
51	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0078
50	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0079

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49	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0080
48	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0081
47	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0082
46	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0083
45	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0084
44	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0085
43	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0086
42	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0087
41	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0088
40	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0089
39	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0090
38	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0091
37	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0092
36	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0093
35	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0094
34	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0095
33		SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0096
32	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0097
31	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0098
30	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0099
29	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0100
28	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0101
27	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0102
26	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0103
25	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0104
24	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0105
23	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0106
22	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0107
21	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0108
20	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0109
19	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0110
18	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0111

17	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0112
16	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0113
15	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0114
14	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0115
13	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0116
12	48	SE COMMS FAILURE	11	02:31	14/06/2017	D	DSC_0117
11	50	SE COMMS OK SE5	11	02:31	14/06/2017	D	DSC_0118
10	48	SE COMMS FAILURE	11	02:31	14/06/2017	E	DSC_0001
9	50	SE COMMS OK SE5	11	02:31	14/06/2017	E	DSC_0002
8	48	SE COMMS FAILURE	11	02:31	14/06/2017	E	DSC_0003
7	50	SE COMMS OK SE5	11	02:31	14/06/2017	E	DSC_0004
6	48	SE COMMS FAILURE	11	02:31	14/06/2017	E	DSC_0005
5	50	SE COMMS OK SE5	11	02:31	14/06/2017	E	DSC_0006
4	48	SE COMMS FAILURE	11	02:31	14/06/2017	E	DSC_0007
3	50	SE COMMS OK SE5	11	02:31	14/06/2017	E	DSC_0008
2	48	SE COMMS FAILURE	11	02:31	14/06/2017	E	DSC_0009
1	50	SE COMMS OK SE5	11	02:31	14/06/2017	E	DSC_0010

8.6 WINDCREST AUTODIALLERS

GENERAL

The label on the front of the Autodialler control box provided the following details:

- Windcrest AD1000EN-4R System
- Press button to operate intercom facility
- For Technical Assistance TEL [redacted]
- Back up Battery to be Tested/Changed May 2008 31/05/05
- Access was gained to the internal components of the Autodiallers
- The back-up batteries appear to be original as the cable ties securing them had not been cut and replaced.
- There were no additional labels on the battery indicating the replacement date.
- The fuses protecting both Autodiallers were intact
- We will return to site on 23rd May 2018 in order to confirm which Rescue Service numbers the Autodiallers were programmed with.

9 SITE VISIT 4

Date : 23rd May 2018

Time : 10.00

Venue : Deer Park Road, South Wimbledon

Present: Arthur Green, Associate Vertical Transportation, WSP
Eric Richards, Independent Lift Test Engineer
Jim McQuen, MPS Investigating Officer, Metropolitan Police
Forensic Police Photographer

9.1 PURPOSE OF VISIT

- To apply mains power to the Autodiallers.
- To obtain set up parameters for the Windcrest Autodiallers on both units.
- To obtain the stored telephone numbers of the rescue services.
- To confirm the status of the batteries.

9.2 GENERAL

The lift controllers were positioned near to the roller shutter doors at the side of the building.

Photographs of the condition of the controllers were taken before work commenced

A temporary 240 vac supply was provided in order to power up the Windcrest Autodiallers

9.3 WINDCREST AUTODIALLERS

H091

- A button for communicating with the top of the lift car was damaged. However, this may have been caused when removing the controller from the machine room.
- The label on the outside of the Autodialler provided details of the type of unit, Windcrest AD1000EN-4R
- The label on the outside of the Autodialler, dated 31/05/2005, indicated that the battery should have been tested/changed in May 2008.
- This suggests that the battery should be tested / changed every three years i.e. 2011, 2014 and 2017. This needs to be confirmed.
- The Autodialler was opened. We noticed that the Autodialler was compliant with BS EN 81-28. This is a British & European standard for remote alarms on passenger and goods passenger lifts that was introduced in 2003.
- The label indicated that the unit had not been registered when first installed.

- All redundant wiring was removed in order to prevent wiring shorting or earthing and causing damage to the Autodialler.
- The battery was disconnected in order to maintain its present state.
- There was no other information on the battery.
- 240 volt ac was connected to the live, neutral and earth terminals of the Autodialler unit.
- Green and red LED's were illuminated on the Autodialler.
- A Windcrest programming unit was connected to the D socket on the Autodialler in order to check the system parameters.
- The display indicated that version 12 software was installed in the Autodialler.
- We contacted Windcrest in order to obtain details of how to use the programming unit to check the system parameters.
- Photographs of all system parameters were taken
- This Autodialler has the capacity to store five telephone numbers. If the first number is not available then the system will connect to the second number. If the second number is not available then the third number will be dialled etc. up to the fifth number.
- We simulated an alarm button being pressed using a temporary jumper. The following telephone numbers were programmed into the Autodialler:
- [redacted]
-
-
-
-
- James McQuen contacted the telephone number. Details are as follows:

  Lift Line

  292 Kensal Road

  W10 5BE

  Tel: [redacted]

  Tel;

  Contact name Jim Green

We noticed that there was no voice recorded message programmed on the Autodialler. This means that in the event of a trapped passenger the rescue service would not be able to identify the location of the lift in accordance with 4.1.6 of BS EN 81-28, Remote Alarms which states:

"4.1.6 Identification

The alarm equipment shall enable the rescue service to identify at least the installation even when testing."

The battery was reconnected in order to charge it up and ascertain if sufficient power could be retained to operate the Autodialler when the 240 vac was disconnected. After a period of approx. 15 minutes the 240 vac power was removed. The Autodialler failed to operate.

H090

- We followed an identical procedure to unit number H090.
- Our findings were identical with the following exception
- The following telephone numbers were programmed into the Autodialler:
- [redacted]
- James McQuen contacted the telephone number. Details are as follows:

  RBKC Housing Management

  292a Kensal Road

  W10 5BE

  Contact name Jerome (refused to provide surname)

  Email: patrick.barrett@rbkc.gov.uk

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10 OBSERVATIONS

10.1 SITE VISIT 2

The incoming earth wire to the main isolator of lift H091 was extended and wrapped with insulation tape before being concealed inside the conduit. This is poor / bad practice. The earth wire should have been replaced during the modernisation works.

We were unable to determine where the second fireman's switch was connected to the controllers.

We were unable to determine why the lift cars were positioned approx. 75mm to 100mm above the 10th floor. This may be the result of the fire affecting the shaft positioning system.

Although the top of car emergency stop on Lift H091 was in the stop position this may have been caused by others accessing the top of the lift cars after the fire.

The gaps between the car guides may have occurred as a result of the fire.

As the fireman's switch on the 2nd floor (walkway) was not connected to the controllers we can only assume that it was never tested at regular intervals.

As there was no event log of the fireman's switch on the ground floor being operated we can only assume the lifts were in normal service at the time of the incident. This means that passengers were able to call the lift to a floor during the fire or maybe the fire brigade used them on normal service until such time as they failed to operate.

As the mechanism on the fireman's switch on the ground floor was defective then we can assume this had not been examined by the lift service company at regular intervals.

10.2 SITE VISIT 3

The fault/event log on lift H090 on the date of the incident did not include any reference to the lift returning to the designated landing from the building alarm system.

Event log 190 (LOST LDG PUSH FEED) on lift H090 may have been caused by the fire at position 11 (the 10th floor). The landing push feed fuses on both controllers were blown, possibly due to a short or connection to earth.

The controller thermostat on lift H091 was damaged. This may have occurred when the controller was removed from the machine room.

The fault/event log on lift H091 at the time of the incident was dominated by two faults (log nos 1 through 195). SE COMM OK SE5 and SE COMMS FAILURE. This indicates the processor in the controller had repeatedly attempted and failed to communicate with the shaft encoder.

As the event logs for both lifts did not record the following:

(68) FIRE ALARM RECALL - Lift returns to fire floor, no calls can be entered

(70) *FIRE SERVICE* - Lift on fire service

We can safely assume that the lift controllers did not receive any signal for a recall to the designated landing (Log 68) and that the lifts were not switched to fireman's Service (Log 70)

10.3 SITE VISIT 4

The date on the label on the outside of the Autodialler suggests the battery should be changed in May 2008 i.e. every three years.

The batteries within the Autodiallers appeared to be original from 2005 as the cable tie used to secure them were intact. There were no additional labels on the batteries indicating a later replacement date.

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The telephone numbers for the rescue service were different on the two Autodiallers. We are unsure if the staff have been trained on how to respond to the alarm or if they are manned 24 hours per day 365 days per year as recommended by clause 4.2.1 of BS EN 81-28 which states:

"The alarm system shall be able to operate at all times when the lift is intended to be accessed by users"

Both Autodiallers were not programmed with the location of the lift. This is in contravention to clause 4.1.6 of BS EN 81-28. This is of particular importance should the passenger be disabled or unable to communicate. In this case the rescue service would not be able to identify where the trapped passengers were located.

After attempting to recharge the batteries by applying 240 vac to the Autodiallers for a period of time they failed to provide a backup supply to the Autodialler when the power was removed. It appears the batteries were defective i.e. unable to be recharged. This is in contravention to clause 4.1.3 of BS EN 81-28 which states:

"4.1.3 Emergency electrical power supply

Any alarm shall not be impeded or lost even in cases of electrical power supply switching or power supply failure.

Where a rechargeable emergency electrical power supply is used, means shall be provided to inform automatically the rescue service as soon as the capacity is lower than needed to provide one hour of function of the alarm system."

We need to ascertain if the rescue service had received a message of this type.

11 INDUSTRY GOOD PRACTICE

In order for a lift to react and operate correctly in the event of a fire it should be checked at regular intervals.

These periodic checks will include the return to a designated floor from the building alarm system and the operation of the lift after the fireman's key switch has been operated.

We would recommend that power failure tests are conducted, and recorded, at regular intervals in order to ensure trapped passengers can communicate effectively with the rescue service. Power failure tests include the following:

1 Is it possible to open the landing and car doors?

2 Does the alarm function correctly?

3 Does the yellow pictogram illuminate?

4 Does the green pictogram illuminate?

5 Does the Autodialler connect to the rescue service?

6 Is the communication quality satisfactory?

7 Does the emergency lighting function correctly?

8 Does the hand winding floor level indicator function correctly?

9 Does the rope brake remain in its normal position?

10 Does the sheave brake remain in its normal position?

11 Does the guide clamp remain in its normal position?

12 Does the governor device remain in its normal position?

The drop key used to operate the fireman's switches proved to be very difficult to operate and may prevent the fireman from gaining use of the lift to fight the fire. We would recommend these are replaced by triangular type keys in accordance with clause 5.8.2 of BS EN 81-72 which states:

"5.8.2

Operation of the firefighters lift switch shall be by means of the unlocking key, which fits the unlocking triangle as defined in EN 81-20:2014, 5.3.9.3. Other keys may be used to operate the firefighters lift switch only when a car key switch is used (see Introduction). The operating positions of the switch shall be bi-stable and clearly marked '1' and '0'. There shall be clear visual indication on which position the switch is. In position '1' firefighting operations is initiated.

An additional external control or input may be used only to automatically return the firefighters lift to the fire service access level and keep the firefighters lift at that level with open doors. The firefighters lift switch shall still be operated to the '1' position to complete the Phase 1 operation."

LEIA (Lift and Escalator Industry Association) have produced several articles relating to the behaviour of lifts in the event of a fire. Guidance note 24 provides details of the Maintenance Responsibilities, Owner Responsibilities, Lift Contractor Responsibilities, Weekly, Monthly and Yearly Checks together with a sample report. We would recommend this advice is acted upon and that each lift has a "Firefighting Log Card" to record these tests.

We would recommend that the last telephone number programmed into the Autodialler would be the lift maintenance 24 hour call-out number.

Appendix A

CONTROLLER EVENT MESSAGES

wsp

As Displayed...	Verbose Description...
(0) POWER-ON RESET	CPU has reset after power-up or "reset" button pushed (see Note 1)
(1) LOST LAR	Lift Available Relay de-energised
(2) NOT USED	
(3) NOT IN DOOR ZONE	Lift stopped outside door zone
(4) D/OPEN PR. T/OUT	Door opening protection fault
(5) GL LOST : STOPPED	Gate lock fault whilst the lift was idle
(6) GL LOST : HI-SPEED	Gate lock tipped whilst the lift was on high speed
(7) GL LOST : LO-SPEED	Gate lock tipped whilst the lift was on low speed
(8) PRE-LOCK FAIL	Gate pre-lock failure
(9) D/CLOSE PR T/OUT	Door closing protection fault
(10) 110% OVERLOAD	Weight switch indicates 110% of full load
(11) ENGN'R ATTENDED	Engineer made note of a previous visit
(12) CALL TF'D/CNCL'D	Call transferred or cancelled
(13) POSITION RESET	The MPU lift position has been reset at a terminal floor
(14) MULT START FAILS	Multiple start failures
(15) DOOR NUDGING	Limited force door closing in operation
(16) RAM FAILURE	CPU Non-Volatile Random Access Memory Failure
(17) STACK ERROR	CPU NVRAM or program failure
(18) SELF-TEST ERROR	Lift-in service self-test error
(19) EPROM FAILURE	CPU program failure
(20) FRONT SE OVERTIME	Safety edge is holding the front doors open for too long
(21) START FAILURE	Lift has failed to start
(22) EVENT LOG RESET	Event Logger has been reset
(23) – (25) NOT USED	
(26) LOST CAR PUSH FD	The feed to the car push has been lost
(27) LOST LDG PUSH FD	The feed to the landing push has been lost
(28) EARTHQUAKE	Earthquake routine activated
(29) EMERGENCY SUPPLY	Normal power replaced by emergency power
(30) NOT USED	
(31) GT LOCKS BRIDGED	Gate lock signal present after doors have opened
(32) NOT USED	
(33) LTLR TIMEOUT	Lift has taken excessive time to obtain floor level
(34) STUCK LEVELLER	Levelling proximity/relay contact operated incorrectly
(35) DRIVE ERROR	A drive monitor device has led to motor power removal
(36) STUCK CAR CALL	A car push is stuck or is being held in
(37) STUCK DOWN CALL	A landing down push is stuck or is being held in
(38) STUCK UP CALL	A landing up push is stuck or is being held in
(39) STUCK REAR CCALL	Rear car call is stuck or being held
(40) STUCK REAR DCALL	Rear down landing call is stuck or being held
(41) STUCK REARUCALL	Rear up landing call is stuck or being held
(42) *TEST CONTROL*	The lift is currently under Engineer's test control

wsp

(43) REAR SE OVERTIME	Safety edge is holding the rear doors open for too long
(44) REAR D/OPEN PR.	Rear doors opening protection fault
(45) RR. DOOR NUDGING	Limited force rear door closing in operation
(46) SEEK NXT FLR SE5	Shaft encoder SE500P seeking next floor
(47) FULL DIVE SE5	Shaft encoder SE500P lost its position – seeking terminal floor
(48) SE COMMS FAILURE	Communication failed between M6809 & shaft encoder
(49) RR. CLOSE PR T/O	Rear door closing protection fault
(50) SE COMMS OK SE5	Shaft encoder SE500P communications successful
(51) LIGHT DUTY	System bias to DOWN calls
(52) UP HEAVY DUTY	System bias to UP calls
(53) DOWN HEAVY DUTY	System bias to DOWN calls
(54) UP PEAK DUTY	Car returns to main floor & ignores intermediate down calls
(55) HEAVY MAIN FLOOR	Invokes UP peak for a limited time
(56) DOWN PEAK DUTY	Ignore intermediate UP calls & return car to uppermost hall call
(57) HOSPITAL SERVICE	Adjustments to RTC are recorded with new time/date
(58) M-G SET SHUT DOWN	Corruption of the real time clock data register has been detected
(59) LOBBY RETURN	Hall calls cancelled/transferred, lift returns to main floor until LRET released
(60) VIP RETURN	Lift calls to predetermined floor
(61) EMERGENCY RECALL	Lift calls to predetermined floor & shuts down
(62) LEVELLER/DIR ERR	Leveller or direction error
(63) NOT USED	
(64) THERMISTER TRIP	Recorded when the Motor Room Temperature monitoring device is exceeded
(65) COMPENSATOR RESET	Load weighing device auto calibration has taken place
(66), (67) NOT USED	
(68) FIRE ALARM RECALL	Lift returns to fire floor - no calls can be entered
(69) LANDING INHIBIT	Set if Landing Calls Disabled due to DDS or PTT
(70) *FIRE SERVICE*	Lift on Fire Service
(71) *SPECIAL SERVICE*	Lift on Special Service
(72) DESPATCH FAILURE	'Bus-stop' routine invoked due to loss of LPF or CPF and homing is enabled.
(73) – (81) NOT USED	
(82) PWR ON MEM TEST	Memory error detected on power up
(83) RUN MEM TEST	Memory error detected while running
(84) – (85) NOT USED	
(86) RTC CLOCK RESET	Out of range time/date value recorded
(87) RTC CLOCK CHANGE	Adjustments to RTC are recorded with new time/date
(88) RTC REGS UPDATE	Corruption of the real time clock data registers has been detected
(89) NOT USED	
(90) COUNTERS RESET	Journey and door counters have been reset to

	0,000,000
(91) LCD OVERFLOW ERROR	LCD screen construction error
(92) LCD INIT FAILURE	LCD module initialisation failure
(93) SETTINGS MENU ENTRY	User has entered the Settings Menu from the secure password entry screen
(94) CONFIG MENU ENTERED	User has entered the Configuration Menu from the config password entry screen
(95) SETTINGS PWD ALTERED	User has changed the settings security password
(96) CONFIG PWD ALTERED	User has changed the config security password
(97) FACTORY DEFAULTS	All parameters have been reset to factory defaults including the event logs, timers, passwords and feature settings
(98) SHADOW SET	Shadow RAM majority verdict
(99) EEPROM BUSY	Miscellaneous serial EEPROM error

Appendix B

LEIA GUIDANCE NOTE

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LEIA

THE QUALITY AND TECHNICAL COMMITTEE

GUIDANCE NOTE No. 24

Fire-fighting Lift Testing

General

We have been contacted by the Fire service over concerns they have in relation to their findings that some Fire-fighting lifts fail to operate correctly when required.
A Fire-fighting lift is an important tool to Fire-fighters especially when there is a fire and a failure is likely to delay fire-fighting with possible serious consequences.

In this guide the term Fire-fighting should be understood to mean any special service provided on a lift to enable it to be driven by a Fire-fighter. It therefore includes Fireman's lifts and in some buildings, typically Hospitals, it can include emergency recall service or some form of Evacuation service etc.

Maintenance responsibilities

Many members use the LEIA type A or B model service contract or a variation of it and these contracts include, inspection and adjustment of the plant. This means all the plant unless a specific exclusion is agreed in the contract. The result of this is that all parts of the lift and its features should be inspected at some regular interval and if defective, either repaired or at least reported to the customer.

The responsibility for ensuring plant is safe and operating correctly ultimately rests with the owner but this does not exclude other parties from their responsibilities to carry out their work.

Owner responsibilities

Those persons responsible for the day to day operation of a building have a legal duty to ensure its emergency procedures and equipment are maintained in good working order.

BS9999 provides advice on the maintenance of Fire Safety Installations and includes lifts in its advice along with sprinkler systems hydrants etc. In relation to lifts it provides the following advice.

Weekly
It states for the owner in BS9999 Annex V that the operation of the Evacuation lift and Fire-fighting lift switches should be tested once a week and should be repaired or replaced if found defective.

Monthly
It also states for the owner that once per months a failure of the primary electricity supply should be simulated. If a generator provides the standby supply it should energize the lift(s) for at least 1 hour.

Yearly
In addition arrangement should be made for an annual test of various Fire-fighting plant including, Evacuation and Fire-fighting lifts and a certificate of test should be obtained and retained by the owner. This test should ensure that all the lift operations related to Fire-fighting operation are checked not just that the car returns to the main landing. As many such lifts will be connected to a building management system (BMS) the testing needs to be co-ordinated with those conducting testing of any BMS.

Lift contractor responsibilities.

To maintain the lift and its features in accordance with the contract and to correct or report any issues to the customer.

To liaise with the customer for a yearly test of the Evacuation or Fire-fighting lift to be conducted and to issue a report of the test results to the customer. An example report form follows. Please not the example is for a Fire-fighting lift and a different report would need to be compiled, along similar line, for other special service features such as Evacuation service.

Other information

New lifts are required to be accompanied by instructions according to BSEN13015. This means there should be information provided to the owner regarding how the lift should operate on any particular special service it may have and we would suggest it includes advice to the owner on the need for weekly and monthly tests by the owner and yearly tests by the lift maintainer in liaison with the owner.

Example report

Annual Fire-fighting lift condition report

Name of the company making the examination
Address
Contact name
Contact details

Building name
Address
Lift reference number
Customers lift identification number or name

Date of test

Name of the special service feature checked e.g. Fire fighting service.

a)	Did the lift recall to the fireman's main landing without undue delay?	Yes	No
b)	Did the lift on arrival at fireman's main landing stand with doors open?	Yes	No
c)	Does the lift respond correctly to car calls entered?	Yes	No
d)	Are landing calls disabled?	Yes	No
e)	On arrival at a floor do doors operate as intend?	Yes	No

Note Fire fighting lift door open in response to door open button. Fireman's lift doors open automatically.

f)	Is lift connected to a building alarm or BMS system?	Yes	No
g)	Was the reaction of the lift to an Alarm or BMS signal tested?	Yes	No
h)	Was the reaction of the lift to loss of supply tested?	Yes	No
i)	Do all indicators relevant to the special service operate correctly?	Yes	No
j)	Is the special feature working correctly?	Yes	No

If the answer to any question is No provide details of the problem and corrective action required by customer.

Name of company representative

Signed on behalf of

WSP House
70 Chancery Lane
London
WC2A 1AF

wsp.com

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Appendix 4

MET00039807

BRE Global Client Report

Grenfell Tower Fire Investigation - On Site Investigation

Prepared for: Metropolitan Police Service

Date: 20th February 2019

Report Number:P109378-1000 Issue: 2

[only lift-related pages included]

bre

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BRE Global Client Report

Grenfell Tower Fire Investigation - On-Site Investigation

LEGALLY PRIVILEGED – PROTECT

Prepared for: Metropolitan Police Service

Date: 20th February 2019

Report Number: P109378-1000 Issue: 2

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RHO00000004_0142

Prepared by

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Date	20 February 2019	20 February 2019	20 February 2019
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Peer Reviewed by

Name	Martin Shipp
Position	Technical Development Director, Fire Safety
Date	20 February 2019
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Version history

Version	Detail	Date
Issue 1	Initial report	10 December 2018
Issue 2	Editorial amendment requested by MPS Correction regarding cladding exhibit No changes to findings or conclusions	20 February 2019

Executive Summary

On 14th June 2017, a fire broke out in Grenfell Tower, Grenfell Road, London, W11 1TG (the Tower). The fire spread extensively, resulting in 71 deaths, 74 confirmed hospitalisations due to injuries (admissions up until midday on 15th June 2017), and many more people being evacuated from their homes both in the Tower and the surrounding area.

BRE Global Ltd (hereafter BRE) was commissioned by the Metropolitan Police Service (MPS) to provide support to MPS in relation to the investigation of the fire.

The aims and objectives for the BRE on-site investigation were as follows:

- To collect as much physical evidence as possible in relation to
  - Patterns of fire damage, fire spread and smoke spread at Grenfell Tower (externally and internally)
  - The fire protection systems at Grenfell Tower
  - The general construction of Grenfell Tower relevant to fire safety
- To compare the physical evidence of the construction and fire protection of Grenfell Tower with the recommendations of the edition of Approved Document B (Building Regulations 2010 Approved Document B (Fire safety) – Volume 2: Buildings other than dwellinghouses (2006 edition incorporating 2010 and 2013 amendments) which was in effect at the time of the last building work to be carried out at Grenfell Tower.

Grenfell Tower, as originally built, appears to have been designed on the premise of providing very high levels of passive fire protection.

- The structure and compartment walls/floors afforded a much higher degree of fire resistance than would currently be recommended by Approved Document B. Had the modern standard of fire resistance been provided, in BRE's opinion, given the severity of spalling to concrete including exposure of reinforcing steelwork, it is likely that the Tower would have collapsed, whether fully or partially.
- The original façade of Grenfell Tower, comprising exposed concrete and, given its age, likely timber or metal frame windows, would not have provided a medium for fire spread up the external surface.

Evidence collected and recorded during the on-site investigation have indicated that various routes for fire spread appear to have been introduced by the 2014-2016 refurbishment, whether via the addition of fuel or shortcomings in compartmentation:

- The cladding over the façade appears to have introduced a medium for fire spread up the façade;
- Subdivision of the fuel load presented by the cladding system via cavity barriers appears to have been inadequate;
- The manner in which new windows were connected to the cladding system lacked any barriers to fire spread between flats and the cladding system (or to fire spread between the cladding system and flats);
- The lack of door closers on a number of fire doors have introduced weaknesses into the separation between flats and the common parts (lobbies and stairwell).

A detailed gap analysis with the guidance in Approved Document B has provided a number of lines of enquiry for the BRE programme of work and wider MPS investigation into the fire.

Table of Contents

RHO00000004_0148

1 Introduction

1 On 14th June 2017, a fire broke out in Grenfell Tower, Grenfell Road, London, W11 1TG (the Tower). The fire spread extensively, resulting in 71 deaths, 74 confirmed hospitalisations due to injuries (admissions up until midday on 15th June 2017), and many more people being evacuated from their homes both in the Tower and the surrounding area. Figures related to deaths and hospitalisations were provided by MPS.

2 BRE Global Ltd (hereafter BRE) was commissioned by the Metropolitan Police Service (MPS) to provide support to MPS in relation to the investigation of the fire.

3 MPS gave BRE the following overarching aims:

3.1 To establish the circumstances surrounding all, or as many as possible, of the deaths resulting from the fire.

3.2 To establish whether there have been any failings of duty of care owed to the victims of the fire (both fatalities and surviving residents).

3.3 To provide expert witness support in relation to any criminal prosecution, public inquiry or inquests arising from the above.

4 In order to address the above objectives, it was agreed that BRE's programme of work would be to address the following objectives:

4.1 How the fire spread from the item or items first ignited to involve the façade of Grenfell Tower (noting that identifying the actual cause of the fire was dealt with by other organisations working as part of the MPS investigation).

4.2 How the external envelope of Grenfell Tower performed in relation to:

4.2.1 spread of fire and smoke and the deaths of the victims;

4.2.2 compliance with Building Regulations [1];

4.2.3 compliance with the Regulatory Reform (Fire Safety) Order 2005 [2]; and

4.2.4 any other fire safety related duty of care owed by duty holders to the victims of the fire.

4.3 How the general construction and fire precautions at Grenfell Tower performed in relation to:

4.3.1 spread of fire and smoke and the deaths of the victims;

4.3.2 compliance with Building Regulations;

4.3.3 compliance with the Regulatory Reform (Fire Safety) Order 2005; and

4.3.4 any other fire safety related duty of care owed by duty holders to the victims of the fire.

5 A programme of work was developed by BRE and agreed with MPS. It was anticipated that the programme of work would need to evolve as findings from the programme of work were gained; however at the time of writing the programme of work included the following tasks:

bre

5.1 A detailed on-site examination gathering all relevant physical evidence regarding the building and its fire safety systems.

5.2 Standard fire tests and derived experiments to be carried out on relevant fire safety features such that their fire performance could be determined.

5.2.1 Small scale British Standard tests relevant to the regulatory compliance of components of the façade [3][4][5].

5.2.2 Small scale European standard tests and classification relevant to the regulatory compliance of components of the façade [6][7][8][9][10].

5.2.3 Small scale British Standard tests for determination of fire properties of components from across and within the Tower [11].

5.2.4 Large scale British Standard tests and ad-hoc experiments on the façade system [12].

5.2.5 British Standard and European fire resistance tests on doors [13][14].

5.2.6 Experimental fridge freezer fires utilising the International Standard fire test room [15], to quantify the size of fire such a fridge freezer could produce in a compartment fire. BRE understands from Key Forensic, London Fire Brigade and Bureau Veritas that the fire started in a fridge freezer in the kitchen of Flat 4-6 (Flat 16) on the 4th floor.

5.3 A reconstruction of the fire [16] in the flat of origin, in particular examining spread of the fire to the façade system.

5.4 A review of building documentation and evidence from the fire to determine the design and actual (i.e. as built) construction of the block and (as far as was possible) the level of performance afforded by the fire safety systems that were provided. This will include support to MPS to assist its officers with the process of reviewing all documentation disclosed by all relevant parties and parties under investigation.

5.5 A review of the locations where deceased were found with respect to the flats where these residents lived or were visiting to identify possible movement (if any) through the building immediately prior to death.

5.6 A review of witness statements, 999 call transcripts, and eyewitness photographs and videos to establish the spread of fire and smoke and the performance of building fire safety systems as witnessed (or recorded and/or obtained posthumously) by people in and around the Tower. This will include support to MPS to assist its officers with the process of taking witness statements and interpretation of photographic and video data of the fire.

5.7 Computer modelling of smoke movement and fire spread throughout common parts of the block to establish how the performance of the building and its fire safety systems may have impacted upon:

5.7.1 the ability and willingness of residents to use means of escape, and

5.7.2 the effectiveness of fire and rescue response by London Fire Brigade. (Note: However, BRE will not be commenting upon the effectiveness of fire and rescue response by London Fire Brigade, or on the performance of any of the emergency services.)

bre

5.8 A review of all of the above work packages (upon their completion) to identify whether any need to be revisited in light of evidence obtained from previous work packages. There will also be ongoing interaction with the Forensic Examination Review Group (FERG) setup by MPS to provide independent oversight of the entire forensic process in relation to Grenfell Tower.

5.9 Review of all above points to identify fire spread and fire safety issues relevant to the circumstances of each fatality.

5.10 Review of all the above points in relation to fire safety related duties of care owed by all duty holders in respect of:

5.10.1 initial construction of the block;

5.10.2 refurbishments between construction and 2014;

5.10.3 refurbishment of the block in 2014-2016;

5.10.4 ongoing management of fire safety by the responsible person under the Regulatory Reform (Fire Safety) Order 2005; and

5.10.5 ongoing management of tenants in relation to the Housing Acts [17][18]and the Smoke and Carbon Monoxide Alarm Regulations [19].

5.11 Expert witness support to any criminal prosecutions, inquests and the Public Inquiry as needed.

5.12 General technical support in relation to the Public Inquiry whether assisting MPS in its role as Core Participant to the Public Inquiry or when requested via the Memorandum of Understanding signed between MPS and the Public Inquiry [20].

6 This report is primarily concerned with findings in relation to the on-site investigation (item 5.1 above); however the status of all work programme items (i.e. at the time of writing) is provided at Chapter 8 of this report.

7 This report is not, in its current format, prepared fully in accordance with the requirements of Part 19 of the Criminal Procedure Rules [21]. However, it has been prepared in anticipation of such a need arising. To that end, it is confirmed that the contents of this report have been prepared impartially, with honesty and due care. This report makes clear where opinions are being expressed and where any assumptions have had to be made. Opinions are expressed only where BRE staff are competent to render such an opinion. Staff that have carried out work for this report but are not authors of this report are listed at Appendix A. CVs of the authors and peer reviewer are provided at Appendix B.

8 This report is based upon information gathered by BRE staff and other members of the MPS led team involved in investigating the fire that occurred on 14th June 2017. Where possible photographs taken by MPS have been used and referenced in accordance with the MPS structure; however, there are some photographs taken by BRE which have necessarily been used and these are referenced in accordance with BRE's structure. Plans have been taken from the Building Manual where these are useful to illustrate the layout of Grenfell Tower. These plans should not be treated as definitive but rather for illustrative purposes only.

9 Any new information or changes to current information and/or assumptions may necessitate review or modification of the findings of this report.

3 Building Overview and Internal Common Parts

3.1 Introduction

18 In addition to a building overview this chapter further includes analysis and some of the findings relevant to the investigation for reader convenience (i.e. to avoid the need for excessive cross-referencing).

19 Appendices C to Z include short individual reports for the common parts of each floor from the ground to 23rd floors. Summary information on the lobbies and trends across the building are given in this chapter (here) but the reader is advised to consult the appendices for information on common parts on specific floors.

3.2 Overview

20 Grenfell Tower is a 24 storey block of flats. The 3rd to 23rd floors are exclusively flats and common areas serving these flats. There are six flats on each of floors 4 to 23 numbered clockwise around the Tower, two of these having one bedroom (Flats 1 and 4) and four having two bedrooms (Flats 2, 3, 5 and 6) (see Figure 1). The ground floor contains communal facilities, the electrical intake, refuse chamber, a community room and a nursery. The 1st floor contains four flats and a community room (which appears to have been used as a store room at the time of the fire). The 2nd floor contains one flat and a boxing club. The 3rd floor contains four flats.

21 The Tower has a basement which houses the water and gas intakes and the communal boilers. There is a plant space at roof level which houses the lift motor room, water tanks and ventilation/smoke extract equipment.

3.4.6 Lifts and lift well

44 There are two lifts which serve all floors from ground to Floor 23, opening into the lobby on every floor. The lifts were labelled as “H090” on the left and “H091” on the right, see Figure 8. Both lifts share a single lift well separated only by a metal grille. Both lift cars were severely damaged by fire and for safety reasons it was not possible to enter the cars; however, MPS safely photographed the lift car interiors.

45 Some of the findings below were determined following a survey of the lift well itself by a member of the MPS team. This survey involved rappelling into the lift well to photograph its interior; BRE used these images to inform our findings below.

45.1 There was a single set of landing call buttons (up or down) in the lobby on each floor and each lift had a display unit mounted to the wall just above head height (Figure 8). It was assumed this display unit showed the location of the lift and/or an indication of direction of travel. This could not be confirmed by physical examination. The landing call buttons also had a sign indicating the floor number; however, this numbering was misleading. For example, on the 10th floor of the Tower this sign stated that it was the 7th floor which was the old numbering of the floors, see Figure 9.

45.2 Each lift car had a single door leaf. Each car was labelled as having a maximum load of 900kg. Each car had a car control station which allowed passengers to access each floor and at least one car had an additional low level accessible car control station. The walls and ceilings of both cars appeared to be metal.

45.3 It did not appear from the images of the lift car interiors in combination with images of the car roofs that an emergency trap door was fitted to the lift cars. BS EN 81-72:2015 (and 2003 version) [26][28] state that for a firefighting lift an emergency trap door shall be fitted to the car roof and it shall be at least 0.5m x 0.7m opening area. However, whilst minimum dimensions for emergency trap doors are provided in BS EN 81-20:2014 [29] (and BS EN 81-1:1998+A3:2009 [30]) they are not necessarily required for passenger lifts. The absence of a trapdoor therefore indicates that the lift cars were unsuitable for use as a firefighting lift.

45.4 There was a Fire Control Switch between the lifts on the ground floor above head height. There was an additional Fire Control Switch located on the 2nd floor also between the lifts above head height. A survey of the lifts was undertaken by WSP and this included inspection of these switches to ascertain whether they were functioning and what function they provided. Findings of this survey were to be reported separately by WSP. At the time of writing this report the level of control intended to be afforded by this switch is not known. This switch may only have been intended to provide a function to return the lifts to the ground floor and thereby preventing occupants using the lifts (firemen’s lift) or it may have provided firefighting lift functionality.

45.5 The lift motor room is located directly above the lift well and lobby. This room is located at roof level and is separate to the main plant room. The lift motor room houses the two lift motors and associated electrics and control systems; each lift motor had its own power supply and control system. A secondary independent power supply was not located by BRE investigators. According to BS EN 81-72:2015 [26] (and 2003 edition [28]) firefighting lifts should have a secondary power supply.

45.6 The lift well itself is formed of reinforced concrete walls and contained the lift cars and associated moving equipment. As mentioned above the well is divided approximately in half by a metal grille separating the two halves of the lift well. On the north wall of the lift well in the back corner, lighting was installed, see Figure 10. These plastic light fittings were discoloured

but did not show any signs of heat distortion. However, the lift landing doors on the lift well sides were blackened and some had clearly suffered heat damage particularly from the 7th to the 23rd floors. Based on this evidence, the primary route for smoke spread into the lift well was, in BRE's opinion, via the lift landing doors.

45.7 Throughout the left hand side of the lift well were a number of holes in the walls with services passing through. There was very little evidence of smoke staining around these holes and so these holes did not appear to provide a significant route for smoke or fire spread into the lift well.

Figure 8 – Ground floor lift lobby showing lift identification, the fire control switch and landing call buttons. (Ground_2526639_SCM_0020_card_2.jpg annotated by BRE)

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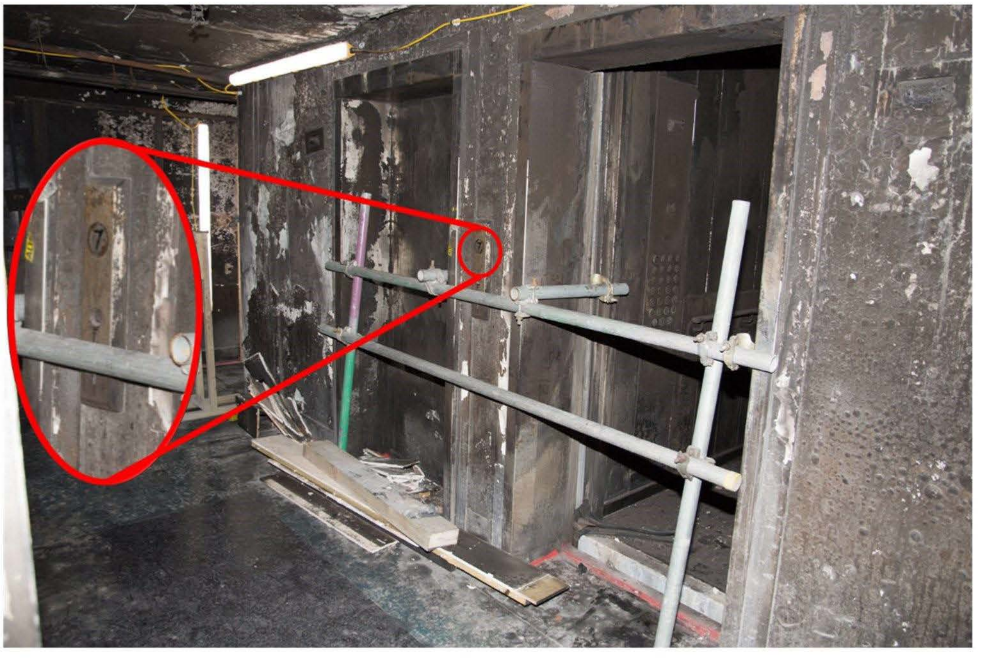

Figure 9 – Lift lobby on 10th floor with floor sign indicating 7th floor (inset is zoom and crop of image). (2661147_C1_dsc_0017.jpg cropped and annotated by BRE)

Figure 10 – Lighting unit on north wall of lift well (2661146_Card2__DSC_0076.jpg)

3.5 Waste Chute Rooms

46 Waste chute rooms are accessed from all of the lobbies on the 4th to 23rd floors. These rooms are ventilated to address the smells from the chute and are separated from the lobby via a fire resisting door. It is worthy of note that every one of the waste chute rooms had survived intact, having been protected by the fire resisting door, see Figure 11 and Figure 12.

7 Key Findings

184 These key findings summarise the most significant of the more detailed information presented above, with, where appropriate, some supplementary observations, and with BRE's interpretation.

7.1 Fire spread and damage across Tower

185 As mentioned above, BRE understands from Key Forensic, London Fire Brigade and Bureau Veritas that the fire started in a fridge freezer in the kitchen of Flat 4-6 (Flat 16) on the 4th floor.

186 The fridge freezer is understood to have been situated within 1m of the kitchen window in Flat 4-6 (Flat 16) and the large casement of the kitchen window (left of the fan light) is understood to have been in the tilt-open position. In BRE's opinion, based upon evidence gathered at the scene, the smaller casement (under the fan light) was in the fully open swing position; details of this analysis are provided in the flat summary for Flat 4-6 (Flat 16) in Appendix G. This window was severely damaged but its construction appears to be consistent with that described in Chapter 4. BRE has, in the past, carried out forensic experiments involving fridge freezers [37]. A fire involving the fridge freezer would, in BRE's opinion, generate flaming sufficient to impinge upon the construction of the kitchen window. The construction of the window, in BRE's opinion (and based on the evidence presented above), did not provide any substantial barrier to fire taking hold on the façade outside.

187 Given the foregoing, it is BRE's opinion that there were the following options which need to be considered for the path of fire spread to the façade:

187.1 Flames extending to and out of the open window, impinging on the aluminium external skin of the façade, melting the aluminium and igniting the polyethylene core underneath;

187.2 Flames extending to and out of the open window, then igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the ACM;

187.3 Flames extending to and out of the open window, then entering the façade cavity via a gap in the ACM panels and igniting the rigid foam insulation facing into the cavity;

187.4 Flames igniting the extractor fan and/or the infill panel it was installed in, then flaming from these impinging on the aluminium external skin of the façade, melting the aluminium and igniting the polyethylene core underneath;

187.5 Flames igniting the extractor fan and/or the infill panel it was installed in, then flaming from these igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the ACM;

187.6 Flames igniting the extractor fan and/or the infill panel it was installed in, then flaming from these entering the façade cavity via a gap in the ACM panels and igniting the rigid insulation facing into the cavity;

187.7 Flames burning and/or deforming the construction around the window (uPVC, insulation and rubberised membrane), igniting the polyethylene core of the aluminium cladding material at one of the cut edges of the ACM;

of being exposed to severe fire attack from the lobbies. Some of the stairwell doors, particularly in the upper half of the building, had failed, however this tended to correspond with areas of high fire damage generally. Physical evidence indicates that some of the stairwell doors were open for a significant period when undergoing fire attack, but the reasons for and the timings of this need to be subject to further examination (see above).

205.3 Flat front doors on the 4th floor and above were found, by BRE, to be predominately composite construction incorporating plastic and metal components. Where these doors had been closed they provided some level of protection against spread of smoke and fire into the protected lobby. However, their fire resistance rating is unknown as the doors were not marked with this information. In addition, a significant proportion of flat front doors either had no door closer or the door closer was not working which resulted in some doors remaining open when the evacuating residents had not closed doors behind them. NOTE: Approved Document B recommends door closers are installed on the front doors of flats because it is accepted that in a fire situation people evacuating may forget to close doors behind them when leaving.

7.2.2 Active systems

206 Some of the smoke and heat detectors within flats were variously heard beeping during the course of the investigation as a result of the disconnection of electricity supplies to the Tower following the fire. However, other than these, their effectiveness during the course of the incident is not currently known; where possible this will be established in due course by calling upon witness testimony and 999 transcripts from the incident.

207 The smoke control system appears, based upon the physical evidence gathered, to have been operating (either properly or partially). However, smoke control systems are normally only designed to cope with the smoke generated by a single fire in one fire compartment. The smoke control system in the Tower is likely to have been overwhelmed by the number of fires, particularly given that some flat doors were left open. It is, in BRE's opinion, unlikely that the smoke control system could have been reasonably expected to maintain clear air in the lobbies and stairwell for evacuation in the means of escape in this particular incident. However, the smoke control system may have influenced smoke movement in and around the stairwell and as such may have impacted upon the time at which the stairwell became unavailable.

207.1 As would normally be the case, the smoke control system was designed to extract from only one floor (the fire floor). This floor was determined by smoke detection in the lobbies. If an override switch was activated on another floor, the dampers on the original floor closed so that there was always only one floor being extracted. Whether an override switch was activated during the incident will need to be established in due course by examination of firefighter witness statements.

207.2 The pressure switch incorporated in this system appeared to enable the function that fans slowed down if the stairwell door was closed since this would lead to a pressure differential greater than 25 kPa between the lobby and stairwell. However this assumed that all other doors onto the lobby of the fire floor were also closed. If one was open and was open to the outside (i.e. open front door to a flat where windows were open), then the pressure differential would never be achieved and fans would have continued to operate at full speed. If this flat was also on fire then smoke (and possibly flames) would be drawn into the lobby by the system.

207.3 The makeup air for the smoke control system appeared to be intended to come from the stairwell and the permanently open vent at the top of the stairwell. As described at Chapter 7.1,

the pattern of damage in the stairwell indicated a possibility that the flow of air in the stairwell might have been influenced by the smoke control system. As previously discussed, this will need further investigation in due course via the computer modelling to be carried out.

208 The Tower was only provided with a dry rising main. BRE witnessed some testing of the dry rising main which was undertaken on 23rd to 25th June 2018 at the Tower by Dr Ivan Stoianov, a Public Inquiry expert. BRE's interest in these tests were in relation to whether sufficient water flow and pressure could be achieved from a single pump appliance at the top floor of the Tower to deal with a single fire in a flat at that level.

209 Approved Document B recommends wet rising mains for buildings over 50m. BRE's understanding of the reason for this guidance is based upon a report by BRE for the Office of the Deputy Prime Minister on Hydraulic calculation of wet and dry risers, hoses and branches which was published in December 2004 [38]. This research assessed different pump, hose and branch configurations to determine the maximum elevations where a defined pressure is available at a firefighting branch. Very simplistically, there are certain pump, hose and branch configurations which are not capable of achieving a flow rate suitable for extinguishing a fire above 56m. Given that only a dry rising main was provided there are a number of possibilities to consider in assessing suitability of such a fire main for normal operating conditions:

209.1 That pumps on London Fire Brigade appliances are sufficiently powerful to send water at sufficient pressure and flow up to 70m (the approximate height of the Tower – the highest outlet is on the roof);

209.2 That connecting multiple fire engine pumps in series might have generated enough power to send water at sufficient pressure and flow up to 70m. However, given that vehicle access was only for one fire engine (see Chapter 3.8), the feasibility of this also needs to be considered;

209.3 That firefighting could not have taken place at the top of the Tower in any event because water flow and pressure would have been insufficient.

210 In BRE's opinion, it appears from the tests BRE witnessed that a single London Fire Brigade appliance pump was capable of sending water at a sufficient pressure and flow to the top floor (23rd floor) of the Tower such that a single compartment fire could (potentially) be extinguished. However, the effectiveness of the dry rising main will need to be further established via examination of witness testimony from firefighters. It remains likely, in BRE's opinion, that the presence of the dry rising main rather than a wet rising main resulted in a delay in response to the fire in Flat 16. Whether and to what extent a wet rising main would have reduced the delay and provided any opportunity for simultaneous firefighting across a greater number of flats will also need to be considered. This will need to be undertaken in due course using engineering calculations.

211 It is noted that there was no sprinkler system in the Tower. Whilst no assessment of the potential performance of a sprinkler system on the night of 14th June 2017 can be made as there was none, the potential benefits and limitations of having a sprinkler system in the Tower may in due course become of relevant as part of the wider MPS investigation.

211.1 Sprinklers suppress fires and significantly reduce the risk of fires spreading. However, in order to do so the sprinkler system must be capable of getting water onto the items burning; the sprinkler head(s) must be located such that they are able to respond to the heat of the fire, there must be sufficient pressure and water supply, and the sprinkler head(s) must be located such that they are able project water onto the burning item(s). In the specific circumstances of this incident, the initiating fire is understood by BRE to have taken hold inside of a fridge freezer

adjacent to a window and cladding system. Had a sprinkler system been installed, it is BRE's opinion that compliance with BS 9251 [37][40] would have been achieved via the installation of a single sprinkler head in the middle of the kitchen ceiling or on the back wall of the kitchen opposite the window. It is therefore possible that the metal chassis of the fridge freezer might have shielded the fire from the sprinkler. Such shielding could have prevented the application of water or delayed the effectiveness of the system.

211.2 Sprinkler systems can only be designed to provide a given amount of water (i.e. pumps and pipework will have a maximum flow of water they can provide). Typically in a block of flats, sprinkler systems are only designed to have a maximum of four heads discharging water (BS 9251 specifies a minimum of two heads for a Category 2 system), and pumps, tanks, pipes and other components are sized accordingly. Once fire had taken hold across the façade and ignited more than four flats, it is BRE's opinion that the sprinkler system is very unlikely to have made any appreciable difference to the spread of the fire.

211.3 Given the foregoing, it is BRE's opinion that a sprinkler system designed and installed to current standards could only have significantly altered the outcome of the fire if it had been able to prevent the fire from leaving Flat 16 and igniting the cladding.

212 The lift cars were both stopped on the 10th floor of the Tower. At the time of writing it is unknown whether or not the lifts were firefighting lifts or firemen's lifts [41] but the evidence outlined in Chapter 3.4 suggests that the lifts were not robust enough to serve as firefighting lifts. Firemen's lifts are not suitable for use during a fire since they only have the functionality to return to the fire service access floor and thereby prevent their use by occupants. However, firefighting lifts can be used by firefighters during an incident and as such move under their control between floors. At the time of writing it is not known when the lifts stopped working and what their performance was prior to stopping. Witness statements and possibly information from the lift management system will inform this later in the investigation.

7.3 Approved Document B Comparison

213 Approved Document B (Fire safety) of the Building Regulations provides guidance on how to satisfy the requirements of Part B of Schedule 1 of the Building Regulations. The status of Approved Documents is set out at Sections 6 and 7 of the Building Act 1984 [41], such that Approved Documents are generally considered to be "deemed to satisfy" guidance [22],[43] and [44]. This means that if someone doing building work has complied with the guidance in the relevant Approved Document, they are often deemed to have satisfied the requirements of the Building Regulations, although this is ultimately a decision for Building Control or a court in the case of a dispute. The person doing building work may choose not to follow the guidance in the relevant Approved Document, but they are then responsible for demonstrating compliance with the Building Regulations by some other means. Given this status as statutory guidance, Approved Document B has been used here at this first stage of the BRE programme of work and investigation to conduct a gap analysis. Where fire safety measures in Grenfell Tower have been found to comply with the guidance of Approved Document B, then these are unlikely to be of significant further interest to MPS with regards to an investigation to identify failure to comply with fire safety legislation. Conversely, where there exists a difference between the guidance and what was present at Grenfell Tower, the BRE programme of work and wider MPS investigation will need to seek to establish whether a valid alternative solution exists (or existed) which demonstrates (or demonstrated) compliance with the Building Regulations, or whether there has been a potential breach of the Building Regulations.

214 The edition of Approved Document B which has been used by BRE in this report is the 2006 edition incorporating 2007, 2010 and 2013 amendments (the "current" edition at the time of writing). This appears to BRE (based on such evidence as is available at the time of writing) to have been the edition in

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effect at the time plans were drawn up for the refurbishment of 2014-2016, although it is noted that there are nine changes affecting the findings below between this edition and the original unamended 2006 edition [45]. None of these changes alter the technical findings and opinions of BRE.

214.1 Paragraph 1.5 is updated to reflect BS 5446 [46] Part 1 being superseded by BS EN 14604 [47].

214.2 A new Note 5 to Table 10 makes provision for internal linings in other circulation spaces (including common areas of blocks of flats) to be lined with products which achieve Class C (European Class) provided they are bonded to a Class A2 (European Class) substrate.

214.3 Appendix A, under Fire Resistance, makes reference to the 2007 edition of BS EN 13501 Part 4 [48], where previously it made reference to xxxx edition (a reference to the most recent edition).

214.4 Appendix A, under Reaction to Fire, makes reference to the 2007 edition of BS EN 13501 Part 1 [10], where previously it made reference to the 2002 edition [49].

214.5 Appendix A, under Internal Linings, makes reference to the use of standard substrates under BS EN 13238 [50], where previously it did not.

214.6 Appendix B makes reference to the 2008 edition of BS EN 1634 Part 1, where previously it made reference to the 2000 edition.

214.7 Appendix B makes reference to the 2008 edition of BS EN 1634 Part 2, where previously it made reference to the xxxx edition (a reference to the most recent edition).

214.8 Appendix B makes reference to the 2004 edition of BS EN 1634 Part 3, where previously it made reference to the 2001 edition.

214.9 Appendix B makes reference to the fire resistance testing of lift landing doors under BS EN 81 Part 58, where previously it did not.

215 Approved Document B Volume 2 deals with all types of building except dwellinghouses (which are covered by Volume 1). The parts of the guidance in Approved Document B which are relevant to a building are based upon a number of key factors, in particular:

215.1 The purpose group of the premises

215.2 The height of the building

215.3 The height of the top storey of the building

215.4 The number of storeys above and below ground

215.5 The area and cubic capacity of the building

215.6 The shortest distance between the perimeter of the building and a relevant boundary

216 Grenfell Tower is predominantly a block of flats (Purpose Group 1(a)) but included a number of other uses, in particular a community room and nursery on the ground floor, a community meeting room on the 1st floor, and a boxing club on the 2nd floor. All of these uses fall within the description of the Assembly and recreation Purpose Group (Purpose Group 5). Given that one of the uses of the Tower is a block of flats, each of the purpose groups in the building needs to be considered in its own right.

217 Grenfell Tower contains 24 storeys above ground, plus the plant room above. The upper surface of the plant room roof is approximately 70m above ground, whereas the top storey (23rd floor) is approximately

63m above ground. The Tower has sides of approximately 22m, with an overall area per floor of approximately 484m^2.

218 Table 10 summarises the relevant sections of Approved Document B outlining the guidance provided within and compares the physical evidence found at Grenfell Tower with the guidance in the relevant sections of the guidance. It further provides a list of implications for any future work and for the ongoing investigation.

219 Note that, in any event, all features of the building, once fully investigated, will, in due course, need to be considered in terms of their contribution to the overall package of fire safety which was afforded by the building; the fire safety provisions within a building cannot be considered in isolation but together provide (or should provide) an integrated and inter-dependent safety system. Therefore, even where a feature is indicated in Table 10 as needing no further investigation because it exceeds current recommendations, some further work may be necessary in due course with regards to assessing the overall fire safety package of measures that existed in the Tower.

Table 10 – Comparison of physical evidence at Grenfell Tower with relevant guidance in Approved Document B [22]

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Section 1			
Fire alarm and fire detection systems	Mains powered smoke and heat detectors in accordance with the recommendations of BS 5839 Part 6 to at least a Grade D Category LD3 standard: mains powered smoke detectors (additional heat detectors optional), each with an integral standby power supply, detectors to be provided in all circulation spaces that form part of the escape route from the flat.	Mains powered smoke and heat detectors interlinked within each flat. Communal automatic fire detection system (no alarm sounders) in lift lobbies, linked to panel at ground floor entrance lobby, linked to smoke control system.	At present no further investigation regarding potential failure to comply recommended.
Section 2			
Means of escape from flats	All habitable rooms to have direct access to a protected entrance hall within flat.	Original construction of original flats and flats introduced by refurbishment appear to comply.	This feature of the Tower, insofar that it relates to original flats, is one which, in BRE's opinion, would be difficult and expensive

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
			to change as part of any refurbishment. At present no further investigation regarding potential failure to comply recommended.
	Single means of escape in common parts only acceptable if: • the flat is separated from the common stair by a protected lobby or common corridor, and • the protected lobby is protected by a smoke control system, and • the stairwell is ventilated.	Conformed with guidance.	On the basis that smoke control and stairwell ventilation were provided, this layout needs no further investigation. However the adequacy of smoke control and stairwell ventilation needs to be examined in due course.
	Stairs which are also firefighting stairs should be at least 1100mm wide.	Stairs in stairwell narrower – 1.02m (~1020mm). Staircase in atrium narrower still – 0.94m (~940mm)	This feature of the Tower, insofar that it relates to original construction, is one which, in BRE's opinion, would be difficult and expensive to change as part of any refurbishment. This feature of the building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	Protected lobbies and stairs to be enclosed by fire resisting construction.	Based upon Fire Grading of Buildings, walls and floors exceed guidance. Door fire performance cannot be established from on-site evidence.	This feature of the building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection. Doors to be subjected to standard fire resistance tests in due course.
	The protected stair should discharge directly to the final exit or by way of a protected exit passageway to a final exit, having at least the same standard of fire resistance and lobby protection as the stairway.	The single stairwell discharges into an atrium, although the atrium appears to be separated from the remainder of the building via suitable fire resisting construction.	Housekeeping (i.e. the maintenance of an orderly, clean and neat place of work) of the atrium would be particularly important (e.g. avoiding any build-up of combustible materials); this may need to be considered as part of the review of fire risk assessments of the Tower.
	Gas service and installation pipes not to be installed in stairways unless in accordance with the requirements for installation and connection set out in Pipelines Safety Regulations 1996 [57] and the Gas Safety (Installation and Use) Regulations 1998 [58].	Gas installation being inspected by Corgi.	Implications to be considered in due course pending findings from Corgi.
	Basements should be served by a separate stair.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	The stairs may serve both flats and other occupancies provided the flat is ancillary to the main use of the building and is provided with an independent alternative escape route, the stair is separated from any other occupancies on lower stories by protected lobbies, any automatic fire detection and alarm system with which the main building is fitted also covers the flat.	This does not conform as the flats are the main use of the building and there was only one staircase.	This feature of the Tower, insofar that it relates to original flats, is one which, in BRE's opinion, would be difficult and expensive to change as part of any refurbishment. This feature of the building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Section 5			
Fire resistance of enclosures, doors and glazed elements	Fire resistance should be: • 120 minutes for loadbearing walls • 120 minutes around the protected shaft / firefighting shaft • FD60S for all doors enclosing the protected shaft / firefighting shaft and stairwell doors.	Based upon Fire Grading of Buildings, walls and floors exceed guidance. Door fire performance cannot be established from on-site evidence.	This will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection. Doors to be subjected to standard fire resistance tests.
Door fastenings	Door fastenings should not impede use in the direction of escape. Locks, whether physical or electronic, should be easily overridden by those making their escape.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Direction of door opening	Where practicable, doors should open in direction of escape.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Construction of stairs	Stairs should be constructed of limited combustibility materials.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Headroom in escape routes	Clear headroom of not less than 2m.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Floor coverings	Should minimise slipperiness when wet.	The floor coverings in the lobbies appear to have been slip resistant. The stairwell floor comprises bare concrete. One member of the BRE team slipped on these stairs on 14th June 2017 when there was firefighting water flowing down the stairs, despite the individual wearing safety footwear at the time.	At present no further investigation regarding potential failure to comply recommended. In due course may need to be considered if there are any indications that residents evacuating also encountered difficulty.
Final exits	Should be at least as wide as escape routes and facilitate dispersal of persons away from a building.	Final exit doors are 1m (~1000mm) wide (main entrance) and 0.85m (~850mm (east face entrance). This appears not to conform with guidance.	This will need to be reviewed in conjunction with the review of witness statements to establish whether there are any indications that residents evacuating encountered difficulty as a result of narrow escape routes.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Lighting of escape routes	Adequate artificial lighting in all common escape routes. Standards according to BS 5266 Part 1 [59]	No lighting measurements carried out as soot staining to luminaire components, walls and ceilings prevents accurate measurement of lighting levels. Appears to conform with guidance based on frequency of luminaires with battery backups.	At present no further investigation regarding potential failure to comply recommended.
Exit signs	Except within a flat, signage in accordance with the Health and Safety (Safety signs and signals) Regulations 1996 [60] and BS 5499 Part 1 [61] (superseded by BS ISO 3864 Part 1 [62]).	Exit signs were provided on the ground to 3rd floors but not on the 4th floor and floors above.	This will need to be considered in conjunction with the review of witness statements to establish whether there are any indications that residents evacuating encountered wayfinding difficulties.
Evacuation lifts	Where provided, these should comply with BS 5588 Part 8 [63] (superseded by BS 9999 [64]). Firefighting lifts (see Section 17) may be used for evacuation of disabled people as part of a management plan.	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not at the time of writing known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of relevant documents will indicate whether or not fire resisting. Given doors were subjected to being prised open and wedged (for safety while the shaft was searched) it was not possible to obtain a sample of the doors suitable for testing.

Relevant section of Approved Document B	**Guidance in Approved Document B**	**Physical evidence at Grenfell Tower**	**Implications for future work and ongoing MPS investigation**
Lift construction	Lift shaft should be enclosed within fire resisting construction so as to minimise smoke travel between lobbies on different floors.	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not currently known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of relevant documents will indicate whether or not fire resisting. Given doors were subjected to being prised open and wedged (for safety while the shaft was searched) it was not possible to obtain a sample of the doors suitable for testing.
Lift machine rooms	Lift machine rooms should be sited over the lift well.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Refuse chutes	Should be constructed in accordance with BS 5906 [65] and be separated from other parts of the building by fire resisting construction, and should not be located within protected stairways or protected lobbies.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
<u>Section 6</u>			
Wall and ceiling linings	Wall and ceiling linings of common escape routes should be Class 0.	Not yet known; samples taken.	Samples of paint and substrate from common escape routes have been taken and in due course will be tested for their composition.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	Wall and ceiling linings within small rooms (no more than $4m^2$) should be Class 3.	Appears to comply, notwithstanding residents' own modifications and items below.	At present no further investigation regarding potential failure to comply recommended.
	Wall and ceiling linings of circulation spaces within dwellings should be Class 1.	MDF board was introduced to box in the water supplies to flats, which is relevant to this.	A review of documentation may clarify the fire rating of this product. No testable samples were recovered from the scene due to water and/or fire and smoke damage.
	Parts of rooms (less than half the floor area and no more than $20m^2$) may be Class 3.	Both the uPVC around the windows and the PURL board on/near the external walls are relevant to this.	uPVC to be tested in due course. PURL board cannot be tested due to the presence of asbestos.
Section 7			
Fire resistance	Current guidance does not permit unsprinklered buildings above 30m and as such does not provide a minimum period of fire resistance for loadbearing elements in such buildings. However, loadbearing elements in sprinklered buildings above 30m should provide a minimum of 120 minutes fire resistance.	Conforms or exceeds, although noting sprinklers are now a stipulation.	The balance of excessive fire resistance versus a lack of sprinklers in this building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Section 8			
Provision of compartment walls and floors	Every wall separating a flat from any other part of the building and	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	every floor should be a compartment wall/floor.		
Sprinklers	Blocks of flats over 30m tall should be fitted with sprinklers inside flats (common areas need not be sprinklered).	Does not conform.	Further investigation of the decision making process at design stage of the refurbishment needed.
Construction of compartment walls and floors (generally – not including walls around firefighting shaft)	Should form a complete barrier to fire spread between the compartments they separate and provide 60 minutes fire resistance.	Based upon Fire Grading of Buildings, walls and floors exceed guidance.	This will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Doors	Doors in compartment walls should have the following fire resistance (European equivalent in brackets): • Separating flat from common space – FD30S (E30 S_a) • Enclosing a protected shaft forming a stairway situated wholly or partly above the adjoining ground in a building used for Flats etc. – FD30S (E30 S_a) • Any door forming part of the enclosure to a protected entrance hall or protected landing in a flat – FD20 (E20)	Fire resistance of doors cannot be established from on-site evidence.	A sample of doors to be subjected to standard fire resistance tests in due course.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Protected shafts	Current guidance does not permit unsprinklered buildings above 30m and as such does not provide a minimum period of fire resistance for protected shaft enclosures in such buildings. However, protected shafts in sprinklered buildings above 30m should provide a minimum of 120 minutes fire resistance.	Conforms or exceeds, although noting sprinklers are now a stipulation.	The balance of excessive fire resistance versus a lack of sprinklers in this building will need to be considered in conjunction with other fire safety measures as to whether the building as a whole provided sufficient protection.
Protected shafts conveying gas	Any pipe containing natural or LPG should be of screwed or welded steel construction, installed in accordance with the Pipelines Safety Regulations 1996 [57] and the Gas Safety (Installation and Use) Regulations 1998 [58].	Gas installation being inspected by Corgi.	Implications pending findings from Corgi.
Ventilation of protected shafts conveying gas	Ventilated direct to outside air by ventilation openings at high and low level in the shaft.	Gas installation being inspected by Corgi.	Implications to be considered in due course pending findings from Corgi.
<u>Section 9</u>			
Provisions of cavity barriers	At the junction of all external cavity walls with compartment walls and floors.	Cavity barriers present but not adequate.	Further investigation in due course to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barrier inadequacies to be reproduced in later large scale cladding

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
			experiments to assess significance.
	Around openings, including windows.	No cavity barriers found.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barrier inadequacies to be reproduced in later large scale cladding experiments to assess significance.
	At intervals no greater than 20m where the lining is Class 1 or Class 0, or no greater than 10m for any other class.	Cavity barriers present but inadequate.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be reproduced in later large scale cladding experiments to assess significance.
Construction and fixings for cavity barriers	Cavity barriers should provide at least 30 minutes fire resistance.	Inappropriate use of fixings.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be reproduced in later large scale cladding experiments to assess significance.

Relevant section of Approved Document B	**Guidance in Approved Document B**	**Physical evidence at Grenfell Tower**	**Implications for future work and ongoing MPS investigation**
Section 10			
Fire stopping of pipes	Pipe stacks should be no more than 160mm diameter, branches 110mm, provided they are non-combustible, lead, aluminium, aluminium alloy, uPVC, or fibre cement construction. Other materials up to 40mm diameter.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Fire stopping of ventilation ducts	Air handling ducts can be protected in three ways: Method 1 – Protection using fire dampers Method 2 – Protection using fire-resisting enclosures Method 3 – Protection using fire-resisting ductwork	Bathroom extract ducts are 200mm diameter with 150mm diameter branches and do not have fire collars installed.	Review of documentation to establish whether a design decision was taken or existed to justify the use of these ducts.
Fire stopping generally	May be made of cement mortar, gypsum-based plaster, cement or gypsum based vermiculite/perlite, glass fire, crushed rock, blast furnace slag or ceramic-based products and intumescent mastics.	Varying types of fire-stopping used. Not confirmed at the time of writing if mastics used were intumescent but all internal fire-stopping appeared to perform adequately.	At present no further investigation regarding potential failure to comply recommended.
Section 12			
External surfaces above 18m	Class 0 or Class B-s3, d2 or better.	Cannot be established from on-site evidence.	Standard fire tests to be carried out in due course.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
External surfaces below 18m	Index (I) or not more than 20 or Class C-s3, d2 or better, or timber.	Cannot be established from on-site evidence.	Standard fire tests to be carried out in due course.
Insulation materials/products	Any insulation, filler material (not including gaskets, sealants and similar) etc. used in the external wall construction should be limited combustibility.	Various components appear to be combustible.	Standard fire tests to be carried out in due course.
Cavity barriers	Should be provided as per Section 9.	Cavity barriers present but inadequate.	Further investigation to determine whether inadequacies arise from design, supply, workmanship or other issues. Cavity barriers inadequacies to be reproduced in later large scale cladding experiments to assess significance.
Alternative approach	If not the above approach, the performance criteria in BR 135 [66] should be met using full scale test data from BS 8414 Part 1 or 2 [12][67].	BRE understand from MPS that at the time of writing no evidence of a BS 8414 test has been discovered.	Large scale cladding test to be carried out in due course.
<u>Section 13</u>			
Space separation	Refer to BR 187 [68].	Appears to conform with guidance, although detailed analysis not yet carried out. Building-to-building fire spread did not occur.	At present no further investigation regarding potential failure to comply recommended.

bre

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Section 14			
Roof coverings	Roof to provide 30 minutes fire resistance from below for means of escape from plant room.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Roof covering CC or better, subject to distance to relevant boundary.	Appears to conform with guidance.	At present no further investigation regarding potential failure to comply recommended.
Section 15			
Fire mains	Wet fire main should be provided.	Dry rising fire main provided. Does not conform with guidance.	On site tests indicated that sufficient water flow and pressure can be achieved with a single fire appliance to reach the top floor. Review of firefighter statements to establish whether dry main caused any delay in response to fire in Flat 16. Carry out analysis to assess whether a greater number of firefighting branches could have been deployed given a wet rising main.
	Fire main outlets should be within stairwell (as flats open directly onto lobby).	Fire main outlets within lobbies. Does not conform with guidance.	Dry rising outlet in lobby not stairwell may have caused problems with firefighting tactics – to be checked against witness statements in due course.

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Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	Hydrants should be within 90m of fire main inlet	Distances conform with guidance but some hydrants were found not to conform with guidance concerning marking to assist firefighters to locate them.	Witness statements of firefighters to be examined in due course to confirm whether any difficulties in locating water supplies.
Section 16			
Vehicle access	Access for a pumping appliance to within 18m of inlet.	Possible for a single appliance to gain access within 18m of inlet.	Witness statements to be checked in due course to ensure route was not blocked. To be considered in conjunction with dry rising main.
	Roadways and hardstandings to be sufficiently wide, high and loadbearing for fire appliances used by the local fire and rescue service.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Section 17			
Provision of firefighting shafts	Provide firefighting shaft with firefighting lifts.	Lifts appear not to conform with standard for firefighting lift. May comply with fireman's lift.	Lift inspected by WSP and findings available in WSP report. In due course further investigation needed of documentary evidence to establish why the lifts were not upgraded.
	Firefighting shafts should serve all floors through which they pass.	Conforms with guidance noting that shaft need not serve basement.	At present no further investigation regarding potential failure to comply recommended.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
	Every part of every storey should be no more than 60m from a fire main in a firefighting shaft.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Design and construction of firefighting shafts	Firefighting shaft equipped with fire mains with outlet connections and valves at every storey.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Firefighting lift shaft should conform with clauses 7 and 8 of BS 5588 Part 5 [69].	The lift enclosure structure appears to conform with guidance. The fire resistance of lift landing doors is not at the time of writing known.	Given that the lifts are firemans/firefighting lifts (see below) it is expected that inspection of relevant documents will indicate whether or not fire resisting. Given doors were subjected to being prised open and wedged (for safety while the shaft was searched) it was not possible to obtain a sample of the doors suitable for testing.
	Firefighting lift installation should conform with BS EN 81 Part 72 [27][28] and BS EN 81 Part 1 [30]	Inspection of systems ongoing by others, however a secondary power supply for the lifts has not been located indicating potential non-conformance.	Testing of fire alarm system planned to establish whether any links to lift system were operational. Review of firefighter statements and building documentation also recommended.
	Flats allowed to open directly onto lift lobby provided lift doors no more than 7.5m from firefighting stair.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

Relevant section of Approved Document B	Guidance in Approved Document B	Physical evidence at Grenfell Tower	Implications for future work and ongoing MPS investigation
Section 18			
Provision of smoke outlets	Smoke outlets should be provided.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Smoke outlets should be situated at high level.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
	Each compartment should have direct access to venting.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.
Natural smoke outlet provisions	Combined clear cross sectional area not less than 1/40th of the floor area.	Although only viewed and not specifically measured, appears to conform with guidance.	At present no further investigation regarding potential failure to comply recommended.
Construction of outlet ducts or shafts	Outlet ducts or shafts should be of non-combustible construction.	Conforms with guidance.	At present no further investigation regarding potential failure to comply recommended.

Appendix C Ground Floor Surveys

Common Parts

The common parts of the ground floor of the building consisted of an atrium housing entrances and stairway, a lift lobby, office/control room, communal room with kitchenette (open plan), toilets, a bin room and a nursery. The ground floor was not affected by the fire.

Atrium/Entrance

The main entrance to the building was on the south elevation; a key-fob operated glazed security door opening into a three storey atrium. Within the atrium, there was a glazed partition incorporating a further key-fob operated glazed security door, separating the entrance lobby from the stairwell, both in the atrium. However this partition did not provide any fire separation as it was ground floor height only. The entrance lobby provided access to the lift lobby and to the ancillary accommodation.

The stairwell accessed two balconies within the atrium, at 1st (mezzanine) and 2nd (walkway) floor levels. Each of the balconies provided access to the relevant lift lobby, flats and other accommodation. There was a second entrance directly into the stairwell (ground floor) on the east elevation, also a key-fob operated glazed security door.

The atrium was enclosed in glazing (external walls) incorporating a number of automatic opening vents (AOVs) for emergency ventilation and there was a suspended ceiling (2nd floor ceiling), above which was the fan and duct array for the ventilation/smoke control system.

Ancillary Accommodation

There were a number of rooms in the south west corner of the building; office/control room, communal room with kitchenette (open plan) and toilets. These were broadly of a cellular layout.

The office/control room housed a number of computers and control equipment associated with the building management, fire alarm, security cameras and key-fob access systems.

Lift Lobby

Smoke Detection

There was one smoke detector located in the middle of the lift lobby ceiling, which had no visible damage.

Service Risers

There were two service risers located in the lift lobby area on this floor; one was situated on the right side of the door from the lift lobby to the stairwell, and the other was located on the left side of the stairwell door.

Service Riser to the Left Side of Lifts

This riser had a door of timber construction and had a “fire door keep locked” sign in place and an intumescent strip present in the frame. There was no door closer present. The door was unlocked and undamaged at the time of inspection. This service riser contained a dry riser access point, which appeared to be disconnected. There were several lagged and unlagged pipes in the riser which were possibly waste and water pipes and appeared to be adequately fire stopped in concrete at the floor and ceiling where visible. There were electrical cables present in the riser which had no fire stopping present at floor level, with observed gaps of approximately 50mm.

The service riser was not damaged by fire or smoke.

Service Riser across from Lifts

This riser had a door of metal construction which was vented. There were four hinges in place, with no self-closing mechanism or intumescent strips present. The door was unlocked and undamaged at the time of inspection. There were three lagged water pipes located in the riser which were observed to have gaps around the pipe penetrations at the ceiling which were filled with insulation. The penetrations into the floor were not visible due to lagging. Waste pipes present in the riser appeared to be well stopped in concrete at both floor and ceiling levels. One gas pipe was located in the riser, which was stopped in concrete at floor level and appeared to be stopped in mastic at ceiling level.

The service riser was not damaged by fire or smoke.

This service riser provided access to the electrical intake room, which was also unaffected by fire.

Lift Doors

Both lift doors were closed with no smoke staining or damage present. There was a Fire Control Switch present on the wall between the lift doors.

Door into Stairwell

The door from the lift lobby into the stairwell was a timber door set into a timber frame with a toughened glass panel in place. There was a door closer in place which was operational; however the door was found to not fit properly into the frame. The door appeared to have had four hinges; however only two of these were in place at the time of inspection. There was one intumescent strip identified; however there was space in the frame for two strips. It could not be determined if the door was open at the time of the fire. There was a magnetic locking system in place. The door was undamaged with no smoke staining present.

Paint and Surface Finishes

There was no smoke or fire damage sustained to the ground floor; therefore paint and surface finishes were undamaged.

Bin Room

The bin room was located on the ground floor level and was only externally accessible.

Nursery

The nursery was located on the ground floor of the building. The nursery consisted of a corridor, a lobby area, a kitchen, a toilet and nine other rooms. The nursery was unaffected by smoke and fire but is included in this report for completeness.

Lobby

The door to the nursery lobby was a fire escape door which was a double glazed glass fronted door with brush seals and a self-closing mechanism present. There was fire exit signage present above the door. There was a fire alarm control panel and activation point present in the lobby. One smoke detector was present on the ceiling. There were no signs of smoke or fire damage in the nursery lobby area.

Corridor

The door to the nursery corridor was of solid timber construction and was fitted into a timber frame. The door had “fire door keep locked” signage present and there was an overhead door closer present;

Appendix D 1st Floor Surveys

Common Parts

For atrium access see Ground Floor Surveys (Appendix C).

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no visible damage to the detector.

Service Cupboard

There were no doors to the service cupboard located on this floor. The service cupboard was not accessible from the 1st floor lift lobby. The service cupboard was accessible from the ground floor lobby and appeared to span both the ground and the 1st floor levels.

South Service Riser

There was no accessible south service riser located on this floor.

North Service Riser

There was no accessible north service riser located on this floor.

Lift Doors

Both lift doors were closed and undamaged. There was no smoke staining visible; however, some water damage was observed.

Door into Atrium

The door to the atrium from the lift lobby was of timber construction with a toughened glass panel insert and a “fire door keep shut” sign in place. There was a door closer present and it was operational. The door was observed to be undamaged with no smoke staining present. The door was observed to have magnetic locks in pace which attach to a magnetic frame when the door is closed. This arrangement prevented the door from closing properly.

Refuse Chute

There was no refuse chute cupboard present on this floor. Access into the refuse chute was made from the community room via an access hatch as part of the search of the building.

Paint and Surface Finishes

The walls in the lift lobby were undamaged and no smoke staining was observed.

Gas Pipes

A gas pipe penetrated through the floor next to the doorway, and was not fire stopped at floor or ceiling level.

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Appendix E 2nd Floor Surveys

Common Parts

For atrium access see Ground Floor Surveys (Appendix C).

Door between Atrium and Stairwell

The door from the atrium into the stairwell was of timber construction with a toughened glass panel insert and a “fire door keep shut” sign in place. There were three hinges supporting the leaf and an overhead door closer present and operational. There were intumescent strips in the frame but no cold smoke seals. The door was damaged at the time of inspection so it could not be ascertained whether it closed properly. The door was also a security door, with a key-fob operated lock.

Door between Atrium and Gym

Refer to Gym below.

Door between Lift Lobby and Stairwell

The door from the lift lobby into the stairwell was of timber construction with a toughened glass panel insert and a “fire door keep shut” sign in place. The glazing was smashed and taped over at the time of inspection. There appeared to have been three hinges attached, although only two hinges were present at the time of inspection. There were intumescent strips in the frame but no cold smoke seals. There was a door closer present and operational, and the door was observed to close properly into the frame.

Door between Lift Lobby and Gym

The door from the lift lobby into the gym was of solid timber construction and was undamaged with no smoke staining present. There was no self-closing mechanism present. There were three hinges in place and intumescent strips present in the door frame but no cold smoke seals. There was a push-bar present on the gym side of the door and a “fire door keep locked” sign on both sides. There was no handle, lock or other such ironmongery on the lift lobby side to enable access to the gym; this door appears to have been for emergency exit use only.

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no visible smoke staining observed to the detector; only some water marks were present.

South Service Riser

The door to this service riser was of timber construction which had a “fire door keep locked” sign in place and an intumescent strip present in the frame. There appeared to have been three hinges present, although only two remained at the time of the inspection. A dry riser outlet cabinet had been cut into the door leaf; it is unclear whether this cabinet provided the same fire resistance as the door leaf into which it was cut. There were signs of forced entry to the door post fire. There were ten lagged pipes present in the riser; however the adequacy of fire stopping could not be determined due to the presence of suspected asbestos lagging. There were three unlagged pipes in the riser which appeared to be well stopped in concrete at both floor and ceiling levels. There were also four pipes which ran through the wall near the ceiling, and appeared to have no fire stopping visible; gaps were observed of approximately 100mm x 250mm. Three cables present in the riser did not appear to be fire stopped at floor level, with only two cables fire stopped at ceiling level.

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North Service Riser

This door to this service riser was of timber construction which had a "fire door keep locked" sign in place and an intumescent strip present in the frame. There were signs of forced entry to the cupboard, which appeared to have been made post fire. This riser contained an access point to the dry riser. There were several lagged pipes present in the riser; however the adequacy of fire stopping could not be determined due to the presence of suspected asbestos lagging. There were also several unlagged pipes present in the riser which appeared to be well stopped in concrete at both the floor and ceiling where visible. The electrical cabling present in the void penetrated both the floor and ceiling. At floor level, gaps were observed of approximately 200mm x 70mm. At ceiling level, the majority of the cables appeared to be stopped in concrete where visible, although the larger cables penetrated through a hole in the ceiling of approximately 200mm x 70mm with no fire stopping present.

Lift Doors

Both the lift doors were closed and undamaged. There was no smoke staining visible; however some water damage was observed. There was a Fire Control Switch present on the wall between the lift doors.

Refuse Chute

The door to the refuse chute cupboard was of timber construction and had a "fire door keep locked" sign in place. There were three hinges in place and an intumescent strip present in the frame. There was damage to the door where entry had been forced post fire. The refuse chute was located in this cupboard and appeared to be stopped in concrete at the floor; however a gap of approximately 30mm was present at the ceiling penetration. The refuse chute had an open intake door with no cover present. There was one unlagged pipe in the cupboard which had no fire stopping present at floor level, with an observed gap of approximately 30mm. There were four lagged pipes in the cupboard; however the adequacy of fire stopping could not be determined due to the presence of suspected asbestos lagging. There was also an electricity cable in the cupboard which was not fire stopped at the floor, with a gap present of approximately 20mm.

Paint and Surface Finishes

The walls in the lift lobby are undamaged and no smoke staining was observed.

Gas Pipes

The gas pipes were located in the stairwell on this floor and were boxed-in by plasterboard. The gas pipe was observed penetrate through the floor and ceiling, with no fire stopping visible.

Appendix F 3rd Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no observed visible damage to the detector.

Service Riser North

The chipboard panels covering the void were removed to carry out this inspection. The void had no evidence of smoke staining on the inside or outside. There were eight lagged pipes in the void; however fire stopping adequacy could not be determined due to the presence of suspected asbestos lagging. There was one unlagged black pipe which was capped above the floor but appeared to be well stopped at the ceiling, and also one unlagged yellow pipe which was well stopped at the floor but the ceiling penetration was not visible. Two waste pipes in the void appeared to be well fire stopped in the floor concrete and in the wall where visible. Two lagged pipes also were visible which ran into the suspended ceiling, and five water pipes were observed above the suspended ceiling; however no penetrations were visible. There were also a number of electrical cables located in the void, which appeared to be stopped in concrete where visible.

Service Riser South

The chipboard panels covering the void were removed to carry out this inspection. The void had no evidence of smoke staining present. There were five lagged pipes located in the void; however the fire stopping could not be determined due to the lagging. There were three waste pipes present in the void which were fire stopped in concrete at the floor; one of which appeared stopped in concrete at the ceiling, one appeared stopped in concrete at the wall, and the other penetration was not visible. There were two metal conduits containing electrical cables which were stopped in concrete at the floor; however the ceiling penetrations were not visible. There was one dry riser pipe located in the void which was approximately 150mm in diameter and had a sleeve around the base at the floor and ceiling. The sleeves appeared to be well stopped in concrete at both ends. There were also a number of cables present in the void which appeared to be stopped in concrete at the floor; however the stopping at the ceiling was not visible.

Lift Doors

Both lift doors were closed and undamaged. There was no smoke staining visible; however some water damage was observed on the left door.

Door into Stairwell

The door to the stairwell from the lift lobby was a solid timber door fitted into a timber frame. There was a "fire door keep shut" sign in place, three hinges and an intumescent strip present on the frame. The door was undamaged and was found to be a good fit into the frame.

Refuse Chute

The refuse chute cupboard was smaller on this floor than seen on other floors throughout the building. The door to the refuse chute cupboard was of solid timber construction fitted into a timber frame. The door was unlocked and had three hinges and a door closer in place which was operational. There was no signage on the door. The intake door to the refuse chute appeared to be well stopped in concrete. The refuse chute itself could not be inspected as it was located behind a concrete wall.

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Appendix G 4th floor surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was some smoke damage observed to the detector.

Service Cupboard

The double doors to the service cupboard were fire doors which had “fire door keep locked” signs, locks and brush strips in place. On opening the double doors, slight smoke staining was revealed around the hinges of the doors. The doors appeared to have adequately resisted the passage of smoke from the lobby area, as no smoke staining was observed on the inside of the service cupboard.

The back wall of the service cupboard was made from concrete, with the front and side walls constructed from what appeared to be plasterboard.

The control unit for the smoke control system was in good condition and no smoke staining or damage was observed.

On the left side of the service cupboard there were two lagged pipes which penetrated the floor and ceiling. Both pipes were adequately fire stopped in the floor; however, no fire stopping was visible at the ceiling as both pipes ran through two holes of approximately 300mm in diameter, with fire stopping appearing to be achieved from the upper surface of the floor slab. Five lagged pipes penetrated the left wall of the service cupboard; however, the visibility of fire stopping was obscured by the lagging. One electrical penetration into the ceiling did not appear to be fire stopped.

On the right side of the service cupboard was one lagged pipe which penetrated into the floor and appeared to be adequately fire stopped in concrete with electrical wiring wrapped around the base of the pipe. Three electrical penetrations into the floor were adequately fire stopped in concrete. One lagged pipe and one electrical penetration into the ceiling did not appear to be fire stopped as they went through holes in the ceiling of approximately 300mm in diameter, however fire stopping may have been present on the underside of the floor slab above.

South Service Riser (Facing Flat 3)

The service riser void appeared to be undamaged with no visible signs of smoke staining. Electric wiring was in place and appeared to be adequately fire stopped in the floor and ceiling. All pipes in the void were adequately stopped at the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The service riser void appeared to be mostly free from smoke staining or damage, with only slight smoke staining visible on the right hand side of the void. Five large lagged pipes and one smaller lagged pipe were adequately fire stopped in the floor and ceiling. Electrical wiring was fire stopped in the floor and fire stopped with mastic in the ceiling.

Lift Doors

Both lift doors were closed and undamaged, with some smoke staining present on the front of the doors, covering approximately the top quarter of both doors.

Appendix H 5th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The outer cover of the detector had melted away and was badly smoke damaged.

Service Cupboard

The double doors to the service cupboard had fire door signs and a floor number attached. The doors were badly smoke stained at the top and had some water damage at the bottom. Inside the service cupboard on the left side there were three electrical wiring bundles and one lagged pipe which penetrated through the floor and the ceiling. These penetrations were fire stopped in concrete at the floor; however there was no fire stopping at the ceiling of the cupboard as the pipe and electrics penetrated through a hole in the ceiling which was approximately 300mm in diameter. There were five lagged pipes penetrating through the left wall of the cupboard; however the fire stopping of these pipes was not visible due to lagging. On the right side of the service cupboard there were three lagged pipes which were fire stopped in the concrete floor but not fire stopped in the ceiling as they penetrated through a hole of approximately 300mm in diameter. There were five lagged pipes penetrating the right wall of the service cupboard but fire stopping was not visible due to lagging.

South Service Riser (Facing Flat 3)

The void was covered by chipboard panels which were smoke stained both internally and externally. On the right hand side of the void two pipes appeared to be adequately fire stopped in the floor and ceiling. Two electrical penetrations into the ceiling appeared adequately fire stopped, as did one electrical penetration into the floor. All electrical cables appeared fire stopped in the floor and ceiling. One pipe on the far left of the void appeared fire stopped into the floor but not into the ceiling, as there was a gap of approximately 10mm around the pipe.

North Service Riser (Facing Flats 4 and 5)

The void was covered by chipboard panels which were flaking and smoke stained both internally and externally. The concrete back wall of the void was also smoke stained. On the left hand side of the void the electrical wiring appeared adequately stopped with mastic into the floor and ceiling. Six lagged pipes in the centre of the void all appeared adequately fire stopped. On the right hand side of the void the electrical wires all appeared adequately fire stopped. One foil coated lagged angled pipe with a tap appeared adequately fire stopped.

Lift Doors

Both the lift doors were closed and had heavy smoke staining. There was a gap in the staining near the top of the right hand door.

Doors into Stairwell

The door into the stairwell from the lift lobby had a “fire door keep shut” sign attached with intumescent strips and a smoke damaged but operational door closer attached. The door was not warped but there was smoke staining present mainly at the top of the door. The fit of the door leaf into the frame was undetermined due to lighting cables which passed through the area.

Appendix I 6th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. A small amount of smoke staining was present on the detector.

Service Cupboard

The double doors to the service cupboard had fire signs and floor number signs attached and were unlocked. Both doors had three hinges intact and a brush seal in place, but no door closer was identified. A small amount of smoke staining was present on the door leaf; however the doors appeared to have adequately resisted the passage of smoke from the lift lobby area.

The control unit was in good condition and no smoke staining or damage was observed.

The back wall of the service riser was constructed from concrete, with the front and side walls constructed in what appeared to be plasterboard. There was no smoke staining present inside the cupboard.

On the left hand side of the service cupboard were three pipes penetrating the floor which were adequately fire stopped in concrete. Two of these pipes penetrated the ceiling through a hole of approximately 300mm in diameter, with no fire stopping visible. Five lagged pipes penetrated the wall, however, fire stopping was not visible due to lagging.

On the right hand side of the service cupboard, one pipe penetration was fire stopped in concrete with a small hole in the stopping on one side. One electrical penetration was also fire stopped in concrete. There were five lagged pipes penetrating through the wall; however, fire stopping was not visible due to the insulation. One further pipe penetration was identified in the ceiling and fire stopping was not visible.

South Service Riser (Facing Flat 3)

The void was covered by chipboard panels which had slight smoke staining on the inside bottom edge. Inside the void there was a bundle of eight cables, four further electrical cables and a pipe, all of which appeared to be adequately fire stopped in concrete at the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The panels to the void were of a chipboard construction and did not appear to be smoke stained. On the inside of the void were six lagged pipes, a silver foiled covered pipe and electrical cables. These all appeared adequately fire stopped into the floor and ceiling.

Lift Doors

Both the lift doors were closed and undamaged, with some smoke staining present on the frame and water marks on the doors.

Doors into Stairwell

The door into the stairwell had a “fire door keep shut” sign attached with three intact hinges, brush strip and an operational door closer in place. The door did not appear to be warped and was undamaged with no smoke staining evident. The fit of the door into the frame was undetermined due to lighting cables which passed through the area.

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Appendix J 7th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector had melted away leaving the metalwork remaining and severe smoke staining evident.

Service Cupboard

The double doors to the service cupboard had fire door signs and floor number signs in place and were unlocked. Both doors had three intact hinges and a brush strip present; however there was no door closer identified. A small amount of smoke staining was observed around the hinges, and the doors appeared to have adequately resisted the passage of smoke from the lift lobby area to the inside of the service cupboard.

The back wall of the service cupboard was constructed from concrete, with the front and side walls constructed of what appeared to be plasterboard.

The control unit was in good condition and no smoke staining or damage was observed.

On the left side of the service cupboard there were three pipes penetrations in the floor which appeared to be adequately fire stopped in concrete. Two of these pipes also penetrated the ceiling and were located in two holes in the ceiling of 300mm in diameter which did not appear to be fire stopped, although the pipes appeared to be stopped in the floor slab of the floor above. Two insulated pipes penetrated the wall; however it was not possible to assess fire stopping as the insulation obscured the view.

On the right side of the service cupboard there was one pipe penetration which was fire stopped in concrete, with the pipe having an electrical cable wrapped around it at the base. The electrical penetration was adequately fire stopped in concrete. There were five insulated pipes penetrating the wall and the fire stopping was undetermined due to the insulation present. There was one pipe penetrating the ceiling in a hole of approximately 300mm in diameter which did not appear to be fire stopped; however the pipe appeared to be fire stopped at the floor slab of the floor above.

South Service Riser (Facing Flat 3)

The panels to the south service riser void were constructed of chipboard and were heavily smoke stained on the exterior, with light smoke staining around the interior edges of the panels. Inside the void on the right side were two metal pipes and an electrical cable which were adequately fire stopped in concrete at the floor and ceiling. Eight black cable bundles next to the pipes are fire stopped in the floor but no stopping was observed in the ceiling. A yellow, green and white cable was fire stopped in the floor but there was no stopping in the ceiling with an approximate gap of 30mm in diameter. Two further cables and a pipe were adequately fire stopped in the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The panels to the north service riser which were constructed of chipboard, which was destroyed by the fire. The area in the void was severely smoke damaged. There were seven lagged pipe penetrations; however it was not possible to determine fire stopping due to the lagging. One electrical penetration was adequately fire stopped in concrete and another electrical penetration passed from floor to ceiling through holes of approximately 50mm in diameter, with no evidence of any fire stopping. A group of electrical penetrations were fire stopped in concrete at ceiling level; however, fire stopping was not visible at floor level.

Lift Doors

Both lift doors were closed and were severely smoke stained but no further damage was evident.

Doors into Stairwell

The door into the stairwell had a “fire door keep shut” sign attached, and had a toughened glass insert in the door leaf. The door did not appear to be damaged, with only smoke staining observed on the lift lobby side. There were three intact hinges and an operational door closer in place. The fit of the door leaf into the frame was undetermined due to lighting cables which ran through the area.

In the stairwell there was some smoke staining present above the doorway and at the top sides of the door into the lift lobby area. There was less smoke staining observed away from the door into the stairwell.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover the pipes entering the flats and had been removed from above the flat entrances for intrusive works. The remaining plasterboard was severely smoke damaged and was flaking in some areas.

Refuse Chute

The door to the refuse chute cupboard had a “fire door keep shut” sign in place and was unlocked. A layer of the door leaf had burned away. There was a door closer attached; however it was not possible to determine if this was operational as the door leaf was badly damaged. A brush strip was also present.

The inside of the refuse chute cupboard was severely smoke damaged. Fire stopping around the intake door to the refuse chute appeared to be concrete, but there was no stopping at the top of the opening which left a gap between the intake door and the wall of approximately 5mm. The refuse chute itself was not inspected as it was behind a concrete wall.

Paint and Surface Finishes

On the right side of the lift lobby there was extensive fire damage with blistering observed on the walls and no surface finishes in some areas with tiles mostly gone. There was extensive smoke damage on the left side with only slight blistering observed on some of the walls.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. There were no gas pipes present in the lift lobby.

Appendix K 8th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector was heavily smoke stained.

Service Cupboard

The doors to the service cupboard were constructed of timber set into a timber frame with three hinges on each door and a lock for both doors. There was a brush seal and intumescent strip around the doors but no self-closing mechanism. There was a “fire door keep locked” sign attached to both doors and smoke staining to the outside of the doors and on the inside some staining around the top two hinges of each door. Inside the riser was light smoke staining around the room.

The back wall of the service riser was constructed in concrete, with the front and side walls constructed in what appeared to be plasterboard.

On left hand side of the service cupboard were five lagged hot water pipes penetrating through the left wall. The fire stopping was obscured by the insulation. Two hot water pipes appeared adequately fire stopped in the floor in white material. It was not possible to assess ceiling penetration due to the insulation. One capped pipe appeared adequately fire stopped in white material in the floor.

On the right hand side of the service cupboard were five lagged hot water pipes passing through the right hand wall. It was not possible to assess fire stopping due to the insulation. Four electrical cables were present and penetrated through the ceiling. It was not possible to assess fire stopping in the ceiling due to insulation present in the hole but the cables appeared to be adequately fire stopped in the floor. Three red cables passed through at ceiling height and appeared to be fire stopped in a mastic-like material. Two clear cables passed to the back wall and the right hand side wall. Both appeared to be fire stopped in a mastic-like material.

South Service Riser (Facing Flat 3)

The walls to the south service riser void were constructed from chipboard panels. The exterior of the panels had heavy smoke staining on the left side and lighter smoke staining on the right side. The interior of the panels were lightly smoke stained, as was the inside of the void. On the right side of the service riser void were two pipes which appeared to be adequately fire stopped in the floor, but no fire stopping was noted at the ceiling. A large electrical cable bundle appeared stopped in concrete at the floor and stopped with mastic in the ceiling. On the far left of the service riser void was a black cable and a metal pipe, both of which appeared to be fire stopped in concrete at the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The panels to this void were constructed of chipboard and were heavily smoke stained on the exterior but only a light staining was observed on the inside of the panels. On the left side of the void was a black cable which appeared to be adequately stopped in concrete at the floor and ceiling. There were six lagged pipes which appeared to be fire stopped in concrete in the floor and ceiling. Located next to these was an electrical cable bundle which was stopped in concrete at the floor, but no fire stopping was observed at the ceiling; a gap of approximately 20mm in diameter was noted. A large electrical cable bundle on the far right of the service void was adequately fire stopped in concrete at the floor and the ceiling.

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Lift Doors

Both lift doors were closed and were smoke stained but no further damage was evident.

Doors into Stairwell

The door to the stairwell was a solid door with a toughened glass insert and an overhead closer. The closer appeared to be damaged; however this may have occurred after the fire. The door leaf did not appear to be damaged but was smoke stained on the lift lobby side on the top 500mm, with very little smoke staining observed on the stairwell side. The fit of the door into the frame was undetermined due to the presence of lighting cables which ran through the area.

In the stairwell there was little smoke staining evident. The door to the stairwell appeared to have resisted the passage of smoke from the lift lobby.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover the pipes entering the flats above the doorways.

Refuse Chute

The refuse chute intake door appeared adequately fire stopped in a mastic type material apart from along the bottom edge, though no gaps were evident. The chute was not inspected as it was located behind a concrete wall.

The door to the refuse area had a “fire door keep shut” sign in place and was unlocked. There was an operational door closer attached and brush seals were present on the door frame. Smoke staining on the door leaf was observed on the lift lobby side, while there was no smoke staining present on the door leaf on the refuse chute side. The inside of the refuse chute cupboard also showed no evidence of smoke staining, showing that the door adequately resisted the passage of smoke from the lift lobby area.

Paint and Surface Finishes

The walls in the lift lobby were smoke stained from floor to ceiling with some paint peeling away near Flat 5 and some blistering was observed on approximately the top 200mm section of the walls next to Flat 6.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe branched horizontally and penetrated into the lift lobby area. There was no fire stopping present around the pipe penetration from the stairwell to the lift lobby, with a gap of approximately 20mm observed around the pipe. The gas pipe which penetrated from the lift lobby into Flat 2 and was adequately fire stopped in mastic.

Appendix L 9th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector had melted away and was smoke stained.

Service Cupboard

The double doors to the service cupboard had fire door signs and a floor number attached, and were unlocked. Both doors had brush strips present on the top and sides of the door leaf. The doors appeared to have adequately resisted the passage of smoke from the lift lobby area, with smoke stains only evident on the lift lobby side of the doors.

The back wall of the service cupboard was constructed in concrete and the front and side walls were constructed from plasterboard.

The control unit was in a good condition and no smoke staining or damage was observed.

Three cables in the floor area appeared adequately fire stopped in concrete. Four pipes penetrating through the floor were lagged, therefore, obscuring the view of any fire stopping. The mains water pipes serving the flats were lagged; therefore, the adequacy of fire stopping was unclear at the time of inspection. The smoke control system detection pipework appeared adequately stopped in mastic on the side wall at the back near the ceiling. An electrical cable was wrapped around the right hand pipe and penetrated through the ceiling. Fire stopping was not visible due to the presence of the insulation material near the ceiling. The cables for the smoke detector and smoke control unit appeared adequately stopped in mastic at the ceiling level.

South Service Riser (Facing Flat 3)

The panels covering the void were of a chipboard construction and were heavily smoke stained on the exterior, with only light smoke staining on the inside of the panels. The inside of the void was heavily smoke stained. There were no pipes or cables located on the right hand side of the void. On the left side of the void there was a large bundle of cables which appeared to be adequately fire stopped in concrete at the floor, with a gap of around 20mm between the cables and concrete at the ceiling. A black cable on the left was fire stopped in mastic at the floor and ceiling. A pipe was located on the far left of the void and was stopped in concrete at the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The panels to the void had burned away at the top but appeared to be panels of chipboard construction which were fixed to vertical timber supports. There was heavy smoke staining present on the exterior and interior of the panels, and on the interior of void. There were seven lagged pipes present in the void, however the lagging prevented a view of the fire stopping. Located to the right of the pipes were three bundles of cables. Two of these bundles appeared to be adequately fire stopped in concrete, while the third had a gap of approximately 35mm around the cables. Located at the far right of the void was another bundle of cables which appeared to be fire stopped in concrete at the ceiling but were partially melted. Another large bundle of cables which was also melted, appeared to be fire stopped in concrete at the floor, with a gap of around 20mm at the ceiling.

Both lift doors were closed and were heavily smoke stained but no further damage was evident.

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Appendix M 10th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector had melted away leaving only the metalwork remaining.

Service Cupboard

The double doors to the service cupboard had fire door signs and a floor number sign attached and were unlocked. Both the doors were badly fire damaged with the outer layer of wood peeling away. The doors were constructed of solid timber. The left hand door had two hinges missing, with only the bottom hinge remaining. There was no intumescent strip visible on the left door and only the partial brush seal remained on the hinge edge. The left door was smoke and fire damaged around the top left corner by the frame, and the frame itself was heavily fire damaged. The right door was heavily fire damaged on the outside leaf, and around the top right corner including the frame. At the time of the survey only the top two hinges remained, with the top hinge being fixed to the door with only two screws instead of four. The right door had no visible intumescent strips or brush seals in place.

Inside the service riser there was smoke staining present around the back wall and on the ceiling. There were ten water pipes located here and all appeared to be adequately fire stopped in concrete in the ceiling and through the floor they were stopped in a plaster type material. One small pipe was found to only have penetrated through the floor and was fire stopped in a plaster like material. There were two electrical penetrations through the ceiling and one penetration through the floor; both appeared adequately fire stopped in a plaster type material. Three electrical penetrations coming out of the riser into the lobby appeared to be adequately fire stopped in a mastic type material. One small electrical penetration on the right side of the service riser into the lobby was not fire stopped and there was approximately a 3mm gap visible.

South Service Riser (Facing Flat 3)

There were two compartments in the south service riser which were separated by a brick wall. The outer wall of the compartment nearest to the lobby had burned away and the inner walls were constructed of concrete and were heavily smoke stained. Two pipe penetrations were fire stopped in concrete and eight electrical penetrations were adequately fire stopped in the floor but not at the ceiling, leaving a hole of approximately 200 x 100mm visible. The outer wall of the back compartment had mostly burned away; the inner walls were made of concrete and were heavily smoke stained. In this area there were five electrical penetrations of which only three appeared fire stopped in concrete. The other two penetrations had gaps between the wiring and concrete with no fire stopping visible. There was a further pipe penetration but fire stopping was not visible.

North Service Riser (Facing Flats 4 and 5)

The outer walls had burnt away exposing a heavily smoke stained void. There were seven lagged pipes present, but the lagging prevented a view of the fire stopping, although one of the pipes appeared to have no fire stopping at the ceiling with a gap of approximately 10mm observed between the pipe and ceiling. Four electrical penetrations were present but only two of the penetrations appeared to be fire stopped in concrete.

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Lift Doors

The lift door on the left hand side was partially opened; the lift door on the right was fully open, exposing a heavily smoked stained interior with lights inside that had melted.

Doors into Stairwell

The door into the stairwell had a “fire door keep shut” sign attached and a door closer in place. It was not possible to determine if the closer was operational as the door was jammed in place. The door was heavily fire damaged, with layers burned away on the lift lobby side and the toughened glass missing. The fit of the door into the frame was undetermined due to lighting cables which passed through the area.

In the stairwell there was heavy smoke staining observed on the ceiling which came from the lift lobby area and continued to the floor below and the floor above. There was heavy smoke staining present on the walls near to the lift lobby area, with the smoke staining covering approximately half of the wall further away from the door. There were signs of heat and fire damage on the walls and ceiling around the doorway, with the surface paint observed to be flaking away.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover up the pipes entering the flats above doorways in the lift lobby. The plasterboard had burned away on this floor, leaving only the aluminium framework in place. The aluminium framework did not cover the entire lift lobby ceiling.

Refuse Chute

The refuse chute cupboard did not have any smoke staining or damage inside. There was no fire stopping visible on the intake door to the refuse chute, with gaps of approximately 5mm between the wall and opening. The refuse chute itself was not inspected as it was behind a concrete wall.

The door to the refuse chute cupboard had a “fire door keep shut” sign in place and the remains of a brush strip were present in the door frame from the bottom to approximately three quarters of the way up. Hinges were still attached with the top and middles hinges noted to be fire damaged. The door leaf was badly fire damaged and smoke stained on the lift lobby side with the top layers peeling away. The door appeared to have adequately resisted the passage of fire or smoke into the chute area as no signs of fire or smoke damage were evident within the cupboard.

Paint and Surface Finishes

All the ceiling and walls in the lift lobby area were heavily smoke damaged with the paint peeling away. There was blistering evident on the walls by the lift doors, outside Flats 1 and 2 and along the bottom edge of the wall, approximately 500mm up, outside Flats 3 to 6.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The pipe was observed to be smoke stained and penetrated through the floor and ceiling with no fire stopping observed. The gas pipe branched horizontally and penetrated into the lift lobby area. There was no fire stopping present around the pipe penetration from the stairwell to the lift lobby, with gaps present around the pipe. The gas pipe penetrated into Flat 2 and appeared to be adequately fire stopped.

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Appendix N 11th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector had melted away leaving only the metalwork remaining.

Service Cupboard

The double doors to the service cupboard had fire door signs and a floor number sign in place. The doors were heavily smoke stained on the outer leaf, with peeling and damage observed to the wood. The doors had a brush strip present at the top and sides. The doors were unlocked but appeared to have been forced open as the top and middle hinges on both doors were detached. The doors appeared to have resisted the passage of smoke from the lift lobby to the service cupboard due to the lack of smoke staining observed on the interior of the cupboard.

The back wall of the service riser was constructed in concrete with the front and side walls constructed in what appeared to be plasterboard. This appeared to have a degree of fire resistance and no smoke staining was evident inside the riser.

The control unit was in a good condition, with no smoke staining or damage observed.

The view to fire stopping in the floor of the service cupboard was blocked by debris sacks piled in this area. Fire stopping of the pipe penetrations into the wall were obscured by the insulation around them. There were three pipe penetrations into the ceiling which did not appear to be fire stopped and each pipe went into a hole of approximately 200mm in diameter.

South Service Riser (Facing Flat 3)

The outer chipboard panels of the service riser were still intact and were removed to inspect the inside of the void. There was smoke staining present on the panels and inside the void. Inside the void there were two unlagged pipe penetrations which were fire stopped in concrete. There was one metal casement penetration fire stopped in concrete, and one electrical bundles penetration which was fire stopped in concrete at the floor, however no fire stopping was visible at the ceiling. There were a further two electrical bundles, one of which had no fire stopping observed. There were also eight wiring penetrations observed in the void which were fire stopped in ceramic at the floor, with no fire stopping visible at the ceiling as they passed up to the next floor.

North Service Riser (Facing Flats 4 and 5)

The outer panels of the service riser had burned away exposing a heavily smoke stained inner concrete wall. There were seven lagged pipe penetrations observed; however, the fire stopping at these penetrations was not visible due to the lagging. The second pipe from the right appeared to have no fire stopping as a gap of approximately 10mm was visible between the pipe and concrete. One unlagged pipe appeared to be adequately fire stopped in concrete. There were five electrical penetrations, two of which appeared to be adequately fire stopped in concrete.

Lift Doors

Both the lift doors were closed and were heavily smoke stained and there was also some water damage present.

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Appendix O 12th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector had burned away leaving only the metalwork remaining.

Service Cupboard

The double doors to the service cupboard had “fire door keep locked” signs attached, and the doors were found to be closed and unlocked. There were three hinges present on each door, with smoke staining present around the hinges and on the inside of the door leaf. The surface of the doors on the outer leaf had burned away, and the top left section of the door frame was destroyed by fire.

The back wall of the service riser was constructed in concrete, with the front and side walls constructed from plasterboard. There was some smoke staining evident on the ceiling, and there were three holes observed in the right wall of the service cupboard, which were approximately 20mm in diameter.

The smoke control unit appeared to be in good condition with no signs of smoke staining at the time of the inspection.

Four pipe penetrations were located in the floor of the service cupboard, and were all fire stopped in concrete. The right hand pipe had an electrical cabling wrapped around it at the base. One electrical penetration in the floor was fire stopped in concrete. There were five pipe penetrations through the right and left walls but fire stopping was not visible due to the insulation around the pipes. Two pipe penetrations were located in the ceiling on the left side and were observed to have no fire stopping, as they passed through holes in the ceiling of approximately 200mm in diameter. One pipe and one electrical penetration located on the right side of the service cupboard had no fire stopping and both were situated in a hole in the ceiling of approximately 200mm in diameter.

South Service Riser (Facing Flat 3)

The outer wall of the service riser was constructed of chipboard panels and remained intact, although was heavily smoke stained and flaking in some areas. This was removed to inspect the inside of the void, which was smoke stained. Inside the void there were four unlagged pipe penetrations, one of which was fire stopped in concrete and the other fire stopped in mastic. There were two metal casements and two electrical bundles which were stopped in concrete. One further electrical bundle was stopped in concrete at the floor, but had no fire stopping visible at the ceiling; with a gap present of approximately 10mm. There were also eight electrical wire penetrations which were fire stopped in ceramic at the floor, with no fire stopping at the ceiling as they passed to the floor above through a hole of approximately 300mm x 100mm.

North Service Riser (Facing Flats 4 and 5)

The outer face of the void, which comprised chipboard panels, was destroyed, exposing the void which had a concrete back wall and was heavily smoke stained. There were seven lagged pipes present in the void, three of which appeared to be fire stopped in concrete, while lagging obscured the view of fire stopping around the remaining four pipes. One pipe penetration which was separate from the group of seven pipes was fire stopped in the ceiling, however the material of stopping was undetermined due to smoke damage. Three electrical penetrations were located in the void. Two of these penetrations were not fire stopped at the ceiling as they penetrated through a hole of around 20mm, while the third electrical

penetration was stopped in the floor but had a 2mm gap present in the ceiling. One electrical bundle was present in the void, which appeared to be adequately fire stopped in concrete.

Lift Doors

Both lift doors were closed at the time of the inspection. There was no damage identified to the door; however they were both heavily smoke stained.

Doors into Stairwell

The door into the stairwell had a "fire door keep shut" sign attached and a toughened glass panel in place; although this was cracked. There was an operational closer present on the door and three smoke stained hinges were in place. The fit of the door into the frame was undetermined due to the presence of lighting cabling which ran through the area. The door was heavily smoke stained and the outer layer had begun to peel away.

In the stairwell there was heavy smoke staining observed on the ceiling above the doorway spreading to the floors above and below. There was also heavy smoke staining present at the top of the stairwell walls; which was heavier around the doorway and lessened as it passed further into the stairwell. Water damage was also noted on the walls in the stairwell.

Suspended Ceiling

The suspended ceiling comprised plasterboard fixed to an aluminium frame which was used to cover the pipework leading into the flats.

The suspended ceiling had burned away, leaving only the aluminium framework remaining outside Flat 1 to 3 and 4 to 6.

Refuse Chute

The door to the refuse chute cupboard had a "fire door keep shut" sign attached a toughened glass panel insert, and was closed and unlocked at the time of inspection. The door had an operational door closer in place and was self-closing, with three intact hinges and a brush strip present on the frame. The outer leaf of the door was heavily smoke stained, with the outer layer peeling away and the exposed wood was observed to be cracking. There was little smoke staining observed inside the refuse chute cupboard therefore the door appeared to have adequately resisted the passage of smoke form the lift lobby area.

The intake door to the refuse chute appeared to have no fire stopping, with gaps of around 2mm observed around the outer edge of the intake door. The refuse chute itself was not inspected as it was located behind the concrete wall.

Paint and Surface Finishes

There was a high degree of blistering observed on the walls both outside flats and next to the lift doors. There was some tiling remaining on the walls between Flats 2 and 3 and Flats 5 and 6.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe branched horizontally and penetrated into the lift lobby area, with no fire stopping present and a gap of approximately 15mm visible around the pipe. The pipe penetrated from the lift lobby into Flat 2 and was observed to be rusted, with no fire stopping present and a gap of approximately 2mm visible.

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Appendix P 13th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. No detectors remained, only the metalwork and wiring.

Service Cupboard

No doors remained to the service cupboard on this floor. The doors had burned away, with only a small amount of charred wood remaining at the bottom of the metal frame on both sides.

The back wall of the service cupboard was constructed from concrete which was heavily smoke damaged. The front and side walls appeared to be constructed from plasterboard, with two layers in place. The left side inner wall had a hole of around 200mm in diameter, while the outer wall was destroyed. On the right side, the inner wall was intact but the outer wall was destroyed.

The control unit had melted away leaving only the wiring visible.

On the left side of the service cupboard there were three pipes penetrating the floor that appeared adequately fire stopped in concrete. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above however this was not visible. Five pipes penetrated the wall, however fire stopping was not visible due to smoke stained insulation.

On the right side of the service cupboard there was one pipe and electrical penetration which penetrated through the floor where they were both adequately fire stopped and the ceiling where they penetrated through a hole of 200mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however fire stopping was not visible due to insulation.

South Service Riser (Facing Flat 3)

The chipboard panels to the service riser had burned away exposing a heavily smoke stained void which had a concrete back wall. Two pipe penetrations were adequately stopped at both floor and ceiling level. Four electrical penetrations were located in the service riser, with only one of these penetrations observed to be fire stopped both at the floor and ceiling. The remaining three penetrations were not fire stopped at the ceiling, with two of the penetration having gaps of approximately 20mm visible, and stopping at the floor was obscured by debris. A further four electrical cables appeared to be fire stopped in ceramic at the floor, with no fire stopping visible at the ceiling.

North Service Riser (Facing Flats 4 and 5)

The chipboard panels to the service riser had burned away exposing a void with a concrete back wall which was heavily smoke stained. There were seven lagged pipes present in the void, with three of these appearing to be fire stopped in concrete. The fire stopping for the remaining pipes was not visible due to the lagging present. There was an unlagged pipe present which was fire stopped in concrete where visible. One electrical penetration was fire stopped in smoke stained mastic at the floor and ceiling. Another four electrical penetrations were observed to have no fire stopping present at the ceiling, with the stopping at floor level not visible due to debris in the area. A metal box was present in the void which had fallen to the floor, and panelling on the left side of the void had become detached revealing electrical cabling.

Lift Doors

Both lift doors were closed and had heavy smoke staining present. The panelling around the left lift door was destroyed, and the panelling around the right door was peeling away.

Doors into Stairwell

No door remained from the lift lobby to the stairwell as it had burned away.

The stairwell was heavily smoke stained and there was water damage present on the walls. The paint and surface finishes around the doorway on the walls and ceiling were observed to be flaking away.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover up the pipes entering the flats above the front doors. The plasterboard ceiling had burned away leaving only a sagging frame outside Flats 1 and 2 and Flat 6. There was no frame remaining outside Flats 3, 4 and 5.

Refuse Chute

The door to the refuse chute cupboard had a “fire door keep shut” sign in place which was fire damaged. There was a toughened glass insert panel which only had glazing remaining on the cupboard side, with the lobby side glazing destroyed. The outer layers of the door leaf were destroyed, and the frame was partially burned away. It was not possible to determine if the door closer was operational or if the door had any seals in place, as the door was badly damaged and was stuck in position and could therefore not be opened.

It was not possible to conduct an inspection of the inside of the refuse chute cupboard as access to the cupboard could not be gained due to the damaged door.

Paint and Surface Finishes

No paint remained on the walls between Flats 1 and 3. Paint to the right hand side of the lift doors was flaking away as was the remaining paint on the wall between Flats 4 to 6.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard which was observed to be smoke stained upon removal. The pipe penetrated through the floor and ceiling, and no fire stopping was observed, with a gap of approximately 10mm observed between the pipe collar and the pipe. The gas pipe branched horizontally and penetrated into the lift lobby area. There was no fire stopping present around the pipe penetration from the stairwell to the lift lobby. The gas pipe penetrated from the lift lobby into Flat 2, with no fire stopping present and a gap of approximately 2mm observed around the pipe.

Appendix Q 14th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. No detector remained, only the metalwork and wiring was present at the time of inspection.

Service Cupboard

There were no doors to the service riser remaining, as the doors had burned away leaving a small amount of charred frame in some parts.

The back wall of the service cupboard was constructed in concrete which was heavily smoke stained. The front and side walls were constructed of what appeared to be plasterboard, with a hole of 100mm in diameter located in the plasterboard on the left side, and three holes and a breakage of the plasterboard on the right side.

The control unit was badly smoke and heat damaged with the cover observed to be melting inwards. Some smoke staining was observed on the insulation of the pipes within the service cupboard.

On the left side of the service cupboard there were three pipes penetrating the floor that appeared adequately fire stopped in concrete. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter. Therefore, there was no fire stopping present, although the pipes may have been fire stopped on the underside of the floor slab above; however this was not visible. Five pipes penetrated the wall; however fire stopping was not visible due to smoke stained insulation.

On the right side of the service cupboard there was one pipe and electrical penetration which penetrated through the floor where they were both adequately fire stopped and the ceiling where they penetrated through a hole of 200mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however fire stopping was not visible due to insulation.

South Service Riser (Facing Flat 3)

The chipboard panels to the service riser had burned away exposing a heavily smoke stained void with a concrete back wall. There were three pipe penetrations located in the void which appeared to be adequately fire stopped in concrete. Five electrical penetrations appeared to be fire stopped in concrete at the floor; however only two of these penetrations were fire stopped at the ceiling. A further four electrical penetrations were stopped in ceramic at the floor but had no fire stopping present at the ceiling, passing through holes of approximately 20mm in diameter.

North Service Riser (Facing Flats 4 and 5)

The chipboard panels to the service riser had burned away exposing a heavily smoke stained void with a concrete back wall. There were seven lagged pipe penetrations present in the void, of which three were fire stopped in concrete at ceiling level, with the fire stopping of the remainder of the pipes not visible due to lagging. One unlagged pipe was stopped in concrete where visible. One pipe and electrical penetration were stopped in concrete at the floor; however only the pipe appeared to be stopped in concrete at the ceiling. Electrical cabling present on the far right of the void was not fire stopped at the ceiling, with a gap of around 20mm identified, while fire stopping at floor level was not visible. Another electrical penetration in the void was stopped in mastic at both the floor and ceiling.

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Lift Doors

Both the lift doors were closed and heavily smoke stained.

Doors into Stairwell

There was no door remaining from the lift lobby to the stairwell as it had burned away.

The stairwell was heavily smoke stained, with the paint and surface finishes around the doorway and on the walls and ceiling observed to be flaking away.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover up the pipes entering the flats above the front doors. The plasterboard ceiling had burned away leaving only the framework outside Flat 6 and was partial between Flats 1 and 2.

Refuse Chute

The door to the refuse chute cupboard has a "fire door keep shut" sign in place and was unlocked and open. There was a door closer in place; however it was not possible to test if the closer was operational as the door was stuck open. Three hinges were identified on the door but were rusted and smoke stained. The toughened glass insert was missing on the lift lobby side of the door leaf, and the outer layers of the door leaf were observed to have been destroyed.

It was not possible to gain access to the refuse chute cupboard due to debris present in the cupboard; however the inside of the cupboard did not appear to be heavily smoke stained.

Paint and Surface Finishes

The plasterboard surrounding the service riser had been mostly destroyed. Paint on the lift lobby walls was noted to be flaking; however no blistering was observed on this floor.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard which was observed to be smoke stained on both the outside and inside. The pipe penetrated through the floor and ceiling, with no fire stopping observed and a gap of approximately 10mm present between the collar and the pipe. The gas pipe branched horizontally and penetrated into the lift lobby area. There was no fire stopping present around the pipe penetration from the stairwell to the lift lobby, with a gap of approximately 15mm identified. The gas pipe penetrated from the lift lobby to Flat 2, where no fire stopping was observed and a gap of approximately 2mm identified around the pipe.

Appendix R 15th Floor Surveys

Common Parts

Smoke detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector was destroyed, with only metalwork and wiring remaining.

Service Cupboard

The double doors to the service cupboard had “fire door keep locked” and floor number signs in place. The doors were smoke stained, with the outer surface destroyed on the right door. There were three hinges observed to be in place on each door. On the inside of the doors there was smoke staining present around the hinges. There was a brush strip present on the edge of the doors.

South Service Riser (Facing Flat 3)

The panels covering the service riser were constructed of chipboard and were heavily smoke stained and had sustained fire damage in some areas. The concrete wall at the back of the service void was also smoke stained. Inside the void there were two unlagged pipes, one of which was stopped in concrete and the other stopped in mastic. There were two metal casement penetrations which were stopped in concrete and one electrical penetration stopped in concrete at the floor and mastic at the ceiling. There were two electrical bundle penetrations which were fire stopped in concrete. There were also four electrical wiring penetrations which were stopped in ceramic at the floor with no fire stopping at the ceiling as they pass to the floor above through a hole of approximately 300mm x 100mm.

North Service Riser (Facing Flats 4 and 5)

The panels covering the service riser were constructed of chipboard and were heavily smoke stained and had sustained fire damage in some areas. The concrete back wall of the service riser was also smoke stained. Inside the void there were three lagged pipes for which the fire stopping was not visible due to lagging. There were also two unlagged pipes which were stopped in concrete. There were two metal casements which were stopped in concrete and two electrical penetrations; one of which was stopped in concrete and one stopped in mastic.

Lift Doors

Both lift doors were closed and heavily smoke stained. There was also some water damage visible on the doors.

Doors into Stairwell

The door into the stairwell was heavily smoke stained, with “fire door keep shut” and “dry riser” signs in place, and a panel of toughened glass in situ which was observed to have cracked. There were three hinges in place but rusted, an operational door closer in place and brush strips fitted around the door edges. It was not possible to determine the fit of the door due to the presence of lighting cables in the area.

The walls and ceiling in the stairwell were heavily smoke stained, as was the stairwell area on the floor above and below. Water damage was also present on the walls in the stairwell.

Appendix S 16th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. The detector was destroyed, with only the metalwork and wiring for the detector remaining.

Service Cupboard

There were no doors to the service cupboard remaining on this floor as they had been destroyed by fire, with only a small portion of the charred frame still in place.

The back wall of the service cupboard was constructed from concrete, with the front and side walls constructed from what appeared to be plasterboard. The front layer of plasterboard was observed to be smoke stained and damaged. Both the left and right walls of plasterboard were observed to be cracked, while the right wall had some sections of plasterboard missing. The front inner layer of plasterboard was still intact. There was smoke staining observed on the inside of the service cupboard, particularly on the ceiling, back wall and at the top of the front and side walls.

The control unit inside the service cupboard had sustained heat and smoke damage, with the outside edges warped and the cover melting inwards on itself.

On the left side of the service cupboard there were three pipes penetrating the floor; however insulation around these pipes obscured the view of fire stopping. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above; however this was not visible. Five pipes penetrated the wall; however fire stopping was not visible due to insulation around the pipes.

On the right side of the service cupboard there was one pipe and electrical penetration which penetrated through the floor where they were both adequately fire stopped, and the ceiling where they penetrated through a hole of 200mm in diameter. There were two further electrical bundles which also penetrated through this hole in the ceiling. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however fire stopping was not visible due to insulation around the pipes.

South Service Riser (Facing Flat 3)

The chipboard panels which covered the service riser had been destroyed by fire, exposing a heavily smoke stained void with a concrete back wall. There were three compartments separated by brick walls. One pipe penetration was adequately fire stopped in the ceiling concrete; however fire stopping at the floor was not visible due to the debris in the area. One electrical penetration was adequately stopped in concrete at the floor and appeared to have been fire stopped in mastic at the top but a gap of approximately 5mm could be seen between the wiring and the concrete ceiling. Two electrical penetrations had no fire stopping visible at the floor, and only one penetration which was encased in metal, was adequately fire stopped in the ceiling concrete, while the other penetration had a gap of approximately 20mm visible. One electrical bundle was fire stopped in concrete at the top but with a 5mm gap, while the bottom fire stopping was not visible. One electrical bundle penetration was fire stopped in a mastic type material. Four electrical cable penetrations that protruded from a box were adequately fire stopped in ceramic at the floor but had no fire stopping at ceiling level and penetrated through a hole of approximately 200mm x 100mm. Two unlagged pipe penetrations were adequately fire stopped in concrete at both the floor and ceiling.

North Service Riser (Facing Flats 4 and 5)

The chipboard panels cover the riser were smoke stained on both sides. The concrete back wall of the void was also smoke stained. Inside the void there were seven lagged pipe penetrations, with fire stopping not visible due to the lagging. One unlagged pipe penetrated the ceiling only, where it was stopped in concrete. One electrical penetration was fire stopped in mastic. Three electrical bundles were present, with two bundles stopped in concrete and one bundle located in a gap of approximately 100mm in the concrete ceiling. One metal casement was stopped in concrete.

Lift Doors

Both the lift doors were closed and heavily smoke stained. On the left door, the vertical metal panels appeared to be warped as neither side was flush with the surrounding concrete panel. There was a gap of approximately 10mm observed at the top of the left door between the door and surrounding wall, while the door was flush with the wall at the bottom. On the right door, the left side metal panel was flush with the concrete but the right panel was only flush at the bottom and appeared to be warped at the top with a gap of approximately 15mm visible.

Doors into Stairwell

There was no door remaining from the lift lobby to the stairwell as it had been destroyed by fire.

All the walls and ceiling in the stairwell were heavily smoke stained leading to the floors above and below. There was also some water damage present on the walls.

Suspended Ceiling

The suspended ceiling in the lift lobby was constructed from plasterboard on an aluminium frame to cover the pipes entering the flats above front doorways.

There were only parts of the suspended ceiling remaining which was sagging, between Flats 1 and 2 and outside Flat 5. The aluminium framework was remaining between Flat 4 and 5 and outside Flat 6.

Refuse Chute

The door to the refuse chute cupboard was unlocked with a “fire door keep shut” sign in place. A toughened glass panel was in situ in the door leaf and was present on the cupboard side of the door, but destroyed on the lift lobby side of the door leaf. Three hinges were in situ but were rusted, and a brush seal was in place on the door frame. An operational door closer was fitted, and the door was found to self-close. The lift lobby side of the door leaf was heavily smoke stained, with the outer layer of wood on the leaf having burned away, with cracking visible to the remainder. There was some light smoke staining present inside the refuse chute cupboard; therefore the door appeared to have adequately resisted the passage of smoke from the lift lobby into the refuse chute cupboard.

Inside the refuse chute cupboard, the walls were observed to be lightly smoke stained at the top and right side. The ceiling also appeared to be slight smoke stained, with some water marks present. The intake door to the refuse chute was fire stopped in concrete, with some gaps of approximately 2mm visible between the intake door and the surrounding concrete. The refuse chute itself could not be inspected as it was located behind a concrete wall.

Paint and Surface Finishes

The surface finishes were destroyed on this floor with the remaining paintwork flaking away. No blistering was identified on this floor.

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Appendix T 17th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no detector remaining, only the metalwork and wiring which was smoke stained.

Service Cupboard

There were double doors in place to the service cupboard which were unlocked, with a “fire door keep locked” and floor number sign attached. There was a brush strip in place on the inside edge of the doors; however no door closer was identified. There was smoke staining on the lift lobby side of the doors, with the outer layer of the leaf peeled away. Light smoke staining was observed on the inside door leaf around the hinges.

The back wall of the service cupboard was constructed from concrete, with the front and side walls constructed from plasterboard. The back wall was smoke stained; however there was no smoke staining present on the front and side walls.

The control unit was in good condition with no smoke staining apparent, only some water marks present.

On the left side of the service cupboard there were three pipes penetrating the floor but the insulation obscured the view of the fire stopping. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above. However this was not visible. Five pipes penetrated the wall; however the fire stopping was not visible due to smoke stained insulation.

On the right side of the service cupboard there was one pipe with electrical cabling around the base, and three electrical penetrations which penetrated through the floor where they were adequately fire stopped in concrete; and through the ceiling where they penetrated through a hole of 200mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however the fire stopping was not visible due to the insulation present.

South Service Riser (Facing Flat 3)

Two outer chipboard panels on the left side of the riser remained and were heavily smoke stained. The other chipboard panels were destroyed, exposing a smoke stained void with a concrete back wall and three partitions separated by bricks. Four electrical penetrations were visible which appeared fire stopped in ceramic at the floor level but no fire stopping was apparent in the ceiling. Four electrical bundles, three of which were encased in metal and were fire stopped in concrete and one which had no fire stopping visible, went through a hole of approximately 20mm in diameter.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels on the left and right sides of the service riser were in place and smoke stained, with the outer layer peeling off in places. The panels were removed to inspect the void. The concrete back wall of the void was heavily smoke stained. Inside the void there were seven lagged pipes, three of these pipes were stopped in concrete while fire stopping on the remainder was not visible due to lagging. One unlagged pipe was stopped in concrete. Three electrical bundles were stopped in concrete and one electrical penetration was stopped in mastic.

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Lift Doors

Both the lift doors were closed and heavily smoke stained but no further damage was observed.

Doors into Stairwell

The door into the stairwell had a "fire door keep shut" sign in place, and a toughened glass panel in situ. Three hinges were in places but rusted; a brush strip was present on the hinge edge of the door and an operational door closer was in place. The adequacy of the fit of the door was undetermined due to the cabling for lighting in the area. The door was heavily smoke stained on the lift lobby side, with slight smoke staining on the stairwell side.

All the walls and the ceiling in the stairwell were heavily smoke damaged leading to the floors above and below. There was also some water damage present which came from the ceiling and went down the walls.

Suspended Ceiling

The suspended ceiling was constructed from plasterboard on an aluminium frame to cover the pipes entering the flats above the front doorways.

Partial plasterboard remained between Flats 1-3 but showed some signs of smoke staining and flaking. The remaining plasterboard between Flats 5 and 6 was smoke stained. Aluminium framework remained in all places excluding sections outside each flat which had been removed for intrusive works. The aluminium was smoke stained in places, but showed no signs or warping.

Refuse Chute

The door to the refuse chute cupboard was unlocked and had a "fire door keep shut" sign and a toughened glass panel in place. There were brush strips present on the frame, and the hinges were intact although rusted. The door closer was in place, but the door was not self-closing. There was heavy smoke staining on the lift lobby side of the door leaf, but no smoke staining on the cupboard side of the door leaf; therefore the door appeared to have adequately resisted the passage of smoke from the lift lobby into the refuse chute cupboard.

The inside of the refuse chute cupboard was in good condition and free from smoke staining. The intake door to the refuse chute appeared to have been fire stopped in mastic but only a small amount remained, with the intake door observed to be coming away from the wall on the left side, leaving a gap of approximately 10mm between the door and the concrete. The refuse chute itself was not inspected as this was located behind a concrete wall.

Paint and Surface Finishes

All the surface finishes in the lift lobby area were heavily smoke stained. Blistering was observed on all the painted surfaces between Flats 4-6, on the walls by the lift doors and on the walls between Flats 1-3.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The plasterboard was observed to be smoke stained on both the outside and inside upon removal. The gas pipe penetrated through the floor and ceiling, with no fire stopping was observed and gaps of approximately 10mm visible between the pipe and the collar. The gas pipe branched off horizontally and penetrated the stairwell into the lift lobby area. There was no fire stopping visible for this penetration, with a gap of approximately 20mm visible around the pipe. The gas pipe penetrated from the lift lobby into Flat 2, where the pipe was observed to be rusted with no fire stopping present, and a gap of approximately 2mm visible around the pipe.

Appendix U 18th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no detector remaining, only metalwork and wiring which was smoke stained and warping away from the ceiling.

Service Cupboard

There were no doors remaining to the service cupboard, as they had been burned away.

The back wall of the service cupboard was constructed in concrete, with the front and side walls constructed in plasterboard. The back wall was smoke stained, with smoke staining also present around the doorway and pipe penetrations in the walls. The control unit was partially smoke stained, and the plastic was warped due to heat damage, with the cover melting in on itself. There were two small holes in the plasterboard above the control unit.

On the left side of the service cupboard there were three pipes penetrating the floor; however the fire stopping could not be assessed due to the presence of insulation. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above but this was not visible. Five lagged pipes penetrated the wall; however fire stopping was not visible due to insulation.

On the right side of the service cupboard there were two lagged pipe penetrations, one which had electrical wiring wrapped around its base; and one electrical penetration which all penetrated through the floor where they were adequately fire stopped. Both pipes and the electrical bundle also penetrated through the ceiling, where they penetrated through a hole of 200mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however fire stopping was not visible due to insulation, but smoke staining was visible around the pipes.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service riser were destroyed, exposing a smoke stained void with a concrete back wall. Three unlagged pipes were present in the void and appeared to be fire stopped in concrete. One electrical penetration was fire stopped in mastic, and one electrical penetration was encased in metal and adequately fire stopped in concrete. There were two electrical bundles in the void, one was stopped in concrete, while the other penetrated through a hole of approximately 20mm with no fire stopping present. Four electrical cables also penetrated into the floor above where there was no fire stopping; and below, where they appeared to be fire stopped in ceramic.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed, exposing a smoke stained void with a concrete back wall. One electrical penetration appeared to be fire stopped in mastic at the top and bottom. There was one unlagged pipe penetration through the ceiling which appeared to be fire stopped in concrete. Seven lagged pipe penetrations were present in the void, with four pipes appearing to be fire stopped in concrete; and fire stopping for the remaining pipes not visible due to lagging. Two electrical bundle penetrations were fire stopped in concrete at ceiling level but fire stopping was not visible in the floor due to the debris in the area.

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Lift Doors

Both the doors were closed with heavy smoke staining present. Around the left door, the metal panel surround on the left had warped away from the concrete outer panel, protruding approximately 15mm instead of being flush, and exposing a wall of concrete beading. The concrete around the metal panel on the right side had started to crack. Around the right door, the metal panel was also warped away from the outer concrete panel, leaving a gap of approximately 10mm at the top, while it remained flush at the bottom.

Doors into Stairwell

The door into the stairwell from the lift lobby was destroyed. An overhead closer which was found in Flat 1 on the floor appeared to be from this door.

In the stairwell area, all the walls and the ceiling were smoke damaged. There was also some water damage from the ceiling passing down the walls. The wall on the right of the doorway was slightly less smoke damaged than other areas.

Suspended Ceiling

The suspended ceiling was a plasterboard construction fitted to an aluminium framework to cover the water pipes which entered the flats above front doorways.

On this floor there was no plasterboard remaining. Some aluminium framework remained outside Flat 5 and Flat 6, but this was warped. The framework between Flats 1-3 was also warped and some had fallen away from the ceiling.

Refuse Chute

There was very little smoke staining on the ceiling above the cupboard doorway or on the walls in this area.

The door to the refuse chute cupboard had a rusted “fire door keep shut” sign in place, three rusted hinges, a brush strip on the door frame and a door closer fitted. It was not possible to determine if the door closer was operational as the door was jammed closed. The lift lobby side of the door leaf was smoke stained, with the outer layer burned away. There was no smoke staining evident on the hinge edge of the door showing that the door was closed at the time of the fire. It appeared that the door had adequately resisted the passage of smoke from the lift lobby to the refuse chute cupboard.

Due to debris piled in this area, the refuse chute could not be inspected.

Paint and Surface Finishes

There was no blistering present on the walls or ceiling on this floor; however the paintwork was severely damaged. There was no paint remaining between Flats 4 and 5 and paintwork was flaking on the walls between Flats 1 and 3, 5 and 6, and on the wall by the lifts.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The plasterboard was observed to be smoke stained on the inside upon removal. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe did not penetrate from the stairwell into the lift lobby on this floor.

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Appendix V 19th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no detector remaining, with only the metalwork and wiring in place at the time of the inspection.

Service Cupboard

No doors to the service cupboard remained, as they had been destroyed by the fire.

The back wall of the service cupboard was constructed in concrete, with the front and side walls constructed in plasterboard. The back wall was smoke stained, with smoke staining also present around the doorway, above the smoke control unit, and around the pipe penetrations in the walls. The control unit had a small amount of smoke staining present, and the plastic cover was warped.

On the left side of the service cupboard, five lagged pipes penetrated into the wall and all appeared to be adequately fire stopped. Two larger diameter pipes penetrated the floor and were adequately stopped in concrete.

On the right side of the service cupboard, five lagged pipes penetrated the wall and all appeared to be fire stopped. Two larger diameter pipes penetrating into the floor were also adequately fire stopped. There was a small amount of staining on all the pipes, but no visible damage was seen to the fire stopping.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service rise were destroyed by fire, exposing a heavily smoke stained void with a concrete back wall. One unlagged pipe and electrical penetration appeared to be adequately fire stopped. Two electrical penetrations were adequately fire stopped in the floor but not at ceiling level, where gaps were left around the penetrations of approximately 10mm.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void with a concrete back wall. One electrical penetration was adequately fire stopped in the floor but had an approximate gap of 10mm in the ceiling penetration. Seven lagged pipe penetrations were all adequately fire stopped in the ceiling but the view to the floor penetrations was obscured by the insulation. Smaller pipes appeared to be adequately fire stopped through the floor. Two electrical bundles were adequately fire stopped through the floor, and the right bundle was adequately stopped through the ceiling; however the left bundle had an approximate 20mm gap around the penetration.

Lift Doors

Both the lift doors were closed and heavily smoke stained. The left door was observed to have the metal panel on both sides warping away from the top of the concrete, exposing the wall, although it remained flush at the bottom. The concrete was observed to be cracked on the left side with approximately 15mm extrusion of the metal panels noted at the top. The same degree of warping of metal panels from the concrete was observed on the right door panel.

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Appendix W 20th Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. There was no detector remaining, with only metalwork which was detached from the ceiling and observed to be hanging down from the penetration in the wall of the service riser remaining. The electrical wiring was also observed to be exposed.

Service Cupboard

There were no doors remaining to the service riser as they had been destroyed by fire. The door frame was also partially burned away, with only the top left hinge observed to remain.

The back wall of the service riser was constructed in concrete and was smoke stained, and the front and side walls were constructed in what appeared to be plasterboard. The outside front wall was smoke stained and the plasterboard was missing in places, with the left side of the outer wall also missing. The inside front and sides of the service cupboard were undamaged, with only slight smoke staining observed on the front inside wall above the doorway.

The control unit within the service cupboard had a small amount of smoke damage present, and the plastic cover had started to warp.

On the left side of the service cupboard there were three pipes penetrating the floor that appeared adequately fire stopped in concrete. Two of these pipes also penetrated the ceiling through holes of approximately 200mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above however this was not visible. Five pipes penetrated the wall; however fire stopping was not visible due to smoke stained insulation.

On the right side of the service cupboard there were two lagged pipes and four electrical bundles penetrating through the floor where they were all adequately fire stopped; and the ceiling where they penetrated through a hole of 300mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. There were five lagged pipes penetrating the right wall; however the fire stopping was not visible due to insulation. Smoke staining was observed around the pipes.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void and concrete back wall. There were three pipes in the void which were all fire stopped in concrete at the floor and ceiling. There was one electrical penetration which was fire stopped in a smoke stained material, and a metal casement which was fire stopped in concrete. Two electrical bundles in the void has no fire stopping present, with visible gaps of approximately 5mm to 10mm. Four electrical penetrations on the void appeared to be fire stopped in ceramic at the floor; however they penetrated to the floor above so fire stopping was not visible at the top.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed by fire, exposing a smoke stained void and concrete back wall.

Seven lagged pipes were present in the void, five of which were adequately stopped in concrete at the floor and ceiling level. The fire stopping of the remaining two pipes was not visible due to the lagging. One electrical wire, one electrical bundle, and one metal casement appeared to be adequately fire stopped in concrete. One electrical wiring was fire stopped in mastic at floor level, but no fire stopping was seen at ceiling level, with a gap of approximately 5mm observed between the wire and concrete.

Lift Doors

Both the lift doors were closed and heavily smoke stained. The left door was observed to have both of the left and right vertical panel trims around the door displaced, leaving a gap of approximately 10mm visible. The right door was observed to have both the left and right panel trims around the door displaced from the wall, leaving a visible gap of approximately 20mm.

Doors into Stairwell

There was no door remaining from the lift lobby into the stairwell as this had been destroyed by fire.

In the stairwell area, the ceilings and all walls were observed to be heavily smoke damaged on this floor and leading to the floors above and below. There were no visible signs of fire or heat damage within the stairwell.

Suspended Ceiling

The suspended ceiling was of plasterboard construction fitted to an aluminium framework which covered the service pipes passing into the flat above the doorways.

The plasterboard remaining between Flats 1 and 2 and 2 and 3 was smoke stained. The aluminium framework which remained between Flats 1 and 2, 2 and 3 and the outside of Flat 6 was also smoke stained.

Refuse Chute

The door to the refuse chute cupboard was unlocked and had a fire damaged “fire door keep shut” sign in place. There was a toughened glass panel in place, three hinges, a brush strip on the door frame, and a door closer fitted. It was not possible to determine if the door closer was operational due to debris sacks which were blocking the door. The outer surface of the door leaf on the lift lobby side had peeled away, and the exposed wood was badly smoke stained and cracked. There was no smoke staining present around the hinge edge of the door, which suggested that the door was closed at the time of the fire. It appeared that the door had adequately resisted the passage of smoke from the lift lobby into the refuse chute cupboard. Inside the refuse chute cupboard was undamaged and free from smoke staining. It was not possible to view the intake door of the refuse chute due to debris sacks piled in this area.

Paint and Surface Finishes

Blistering was observed on the walls in the lift lobby around Flats 1 and 2, and near to Flat 3. All the other painted surfaces in the lift lobby were smoke stained, and the paint was observed to be cracking and flaking away. There were no tiles remaining in the lift lobby on this floor.

Gas Pipes

There was a gas pipe located on the stairwell on this floor, which was boxed-in with plasterboard. The plasterboard was observed to be smoke stained on the inside upon removal. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe did not penetrate from the stairwell to the lift lobby on this floor.

Appendix X 21st Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. No smoke detector remained, only rusted metalwork and wiring remained and was detached from the ceiling.

Service Cupboard

There were no doors remaining to the service cupboard as they were destroyed by fire.

The back wall of the service riser was constructed in concrete and was smoke stained, and the front and side walls were constructed of plasterboard. The outside front wall was destroyed, exposing the cupboard. The side walls were smoke stained at the top and around the doorway on the inside. There was a small hole on the front wall in the bottom right hand corner and also holes on the right side wall behind the control unit.

The control unit within the service riser was observed to be melted and warped and the wiring was exposed.

On the left side of the cupboard there were two lagged pipes penetrating the floor however fire stopping was obscured by debris in the area. These two pipes also penetrated the ceiling through holes of approximately 300mm in diameter; therefore there was no fire stopping although the pipes may have been fire stopped on the underside of the floor slab above. Five lagged pipes penetrated the wall, however fire stopping was not visible due to insulation..

On the right side of the cupboard there were two lagged pipes and four electrical penetrations in the floor which were stopped in concrete. The two pipes and four electrical penetrations passed through holes of approximately 300 in diameter to the floor above. There was no fire stopping present, however this may have been present on the underside of the floor slab above. Five lagged pipes penetrated the wall, however stopping was not visible due to insulation.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void and concrete back wall. Inside the void there were one unlagged pipe and one metal casement which were fire stopped in concrete. One electrical wiring was fire stopped in mastic. There were two electrical bundles but only one was fire stopped in mastic and the other had a gap of approximately 20mm between the wires and the concrete. Four electrical bundles appeared adequately fire stopped in ceramic at the bottom but as these penetrated to the floor above, the fire stopping at the top was unable to be viewed.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void and concrete back wall. Inside the void there were seven lagged pipes which were all stopped in concrete at ceiling level, however stopping at floor level was obscured by insulation. One metal casement was fire stopped in concrete and one electrical bundle was fire stopped in concrete at the top; the bottom was not visible.

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Lift Doors

Both the lift doors were closed and smoke stained. On the left and right hand doors, the vertical lift door panel surrounds were displaced from the wall leaving a gap of approximately 10mm.

Doors into Stairwell

There was no door remaining from the lift lobby into the stairwell as this had been destroyed by fire.

In the stairwell area, all ceilings and walls were heavily smoke damaged on this floor and leading to the floors above and below. There were no visible signs of fire or heat damage.

Suspended Ceiling

The suspended ceiling was a plasterboard construction fitted to an aluminium framework to cover the service pipes into the flats above the doorways.

No plasterboard remained on this floor. The aluminium framework remained outside Flat 1 and between Flats 2 and 3 and Flats 5 and 6.

Refuse Chute

Access to the refuse area was not possible as metalwork was trapped in the door and the door could not be fully opened. Inside, the area did not appear to be smoke stained.

The door to the refuse area was unlocked and had a "fire door keep shut" sign attached but it was fire damaged. The toughened glass insert was still in situ and there was also an operational door closer. The paintwork on the lobby side had peeled away and the wood was heavily smoke stained and fire damaged. The door frame had a part missing from the top left hand corner. It appeared that the door had resisted the passage of smoke from the lobby into the refuse area.

Paint and Surface Finishes

There was no tiling remaining on this floor and all the paintwork had either burned away or was cracked and flaked off. No blistering was identified.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe branched horizontally and penetrated into the lift lobby area, with no fire stopping present and a gap of approximately 10mm visible around the pipe. The pipe penetrated from the lift lobby into Flat 2 and was observed to be smoke stained and rusted, with no fire stopping present and a gap of approximately 5mm visible.

Appendix Y 22nd Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. No detector remained, only smoke stained metalwork and wiring remained and was detached from the ceiling and hung down from the penetration in the service riser wall.

Service Cupboard

There were no doors remaining to the service cupboard as they had been destroyed by fire. There were three hinges remaining on the left hand side and two hinges remaining on the right hand side.

The back wall of the service cupboard was constructed in concrete and the front and side walls constructed in what appeared to be plasterboard. Inside there was slight smoke staining above the door and holes of approximately 100mm in diameter in the front walls on both sides of the door. The outer front plasterboard wall was missing and the back concrete wall was smoke stained.

The smoke control unit within the service cupboard was slightly smoke stained and the plastic cover had melted and was warped out of shape.

On the left hand side of the service cupboard there were three lagged pipes penetrating the floor which were stopped in concrete. Two of these pipes also penetrated the ceiling through holes of approximately 300mm in diameter. There was no fire stopping visible here, although fire stopping may have been present at the underside of the floor slab above. Five lagged pipes penetrated the wall but the visibility to the fire stopping was obscured by the insulation.

On the right hand side two lagged pipes and four electricals penetrated the floor where they were all stopped in concrete. The two pipes and four electricals also passed through a hole of approximately 300mm in dimeter to the floor above. There was no fire stopping visible, although fire sotpping may have been present on the underside of the floor slab above. Five lagged pipes penetrated the wall but the view of the fire stopping was obscured by the insulation.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void. There were three pipes in the void which were stopped in concrete. One electrical wiring was fire stopped in mastic. Two electrical bundles had no fire stopping at the ceiling level and had gaps of approximately 5mm to 10mm; the fire stopping at the floor was unable to be viewed. Four electrical bundles appeared to be adequately fire stopped in ceramic at the bottom and two unlagged pipes appeared to be adequately fire stopped in concrete at both floor and ceiling level.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void. There were seven lagged pipes in the void which were all stopped in concrete at ceiling level, but fire stopping at floor level was obscured by the insulation. One electrical wiring was fire stopped in mastic with a slight gap of approximately 5mm at the top. One unlagged pipe appeared to be adequately fire stopped in concrete. One metal casement was fire stopped in concrete and one electrical bundle was not fire stopped at the top, and the bottom penetration was not visible. One electrical wiring was fire stopped in concrete but had an approximately 10mm hole at the top.

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Lift Doors

Both the doors were closed and smoke stained. On both doors the vertical lift door panel surrounds were displaced from the wall leaving a gap of approximately 10mm on the inner panels and approximately 25mm on the outer panels.

Doors into Stairwell

There was no door remaining from the lift lobby into the stairwell as this had been destroyed by fire.

In the stairwell area, all the ceilings and walls were heavily smoke damaged on this floor and leading to the floors above and below. There were no visible signs of fire or heat damage.

Suspended Ceiling

The suspended ceiling was a plasterboard construction fitted to an aluminium framework to cover the service pipes into the flats above doorways.

No plasterboard remained on this floor. The aluminium framework outside Flat 6 and between Flats 1-2 and 2-3 remained but had rusted.

Refuse Chute

Inside the refuse chute area there appeared to only be slight smoke staining around the light fitting. The intake door to the refuse chute was fire stopped in concrete and the chute was behind a concrete wall.

The door to the refuse area was unlocked and had a “fire door keep shut” sign attached but it was fire damaged. There was a toughened glass insert in situ, a brush strip on the door frame and an operational door closer. The paintwork on the lobby side no longer remained and the wood on the door and the door frame was charred with the top left of the door frame missing. It appeared that the door had resisted the passage of smoke from the lobby into the refuse area.

Paint and Surface Finishes

No tiling remained on this floor and all the paintwork was smoke stained, cracked and flaking off. No blistering was identified.

Gas Pipes

There was a gas pipe located in the stairwell on this floor, which was boxed-in with plasterboard. The plasterboard was observed to be smoke stained on the inside upon removal. The pipe penetrated through the floor and ceiling, and no fire stopping was observed. The gas pipe did not penetrate from the stairwell into the lift lobby on this floor.

Appendix Z 23rd Floor Surveys

Common Parts

Smoke Detection

One smoke detector was located in the centre of the lobby ceiling across from the lift doors. No detector remained, only rusted metalwork and wiring remained which was detached from the ceiling and hung down from a penetration in the service cupboard wall.

Service Cupboard

There were no doors remaining to the service riser as they had been destroyed by fire.

The back wall of the service cupboard was constructed of concrete and was smoke stained, and the front and side walls were formed of plasterboard partitions with a metal studwork frame. The plasterboard partition walls were severely damaged by fire with some of the outer layer of plasterboard having fallen away from the metal frame and also further fire damage to the internal layer. There was smoke staining above the door opening and at the tops of the side partition walls.

The control unit within the service cupboard had no cover remaining and the internal wiring was exposed. The unit was smoke damaged and had melted, with the edges distorted.

On the left hand side of the service cupboard there were three lagged pipes in the floor which were stopped in concrete. Five lagged pipes penetrated the wall, with fire stopping appearing to be adequate. There were no penetrations in the ceiling.

On the right hand side of the service cupboard there were two lagged pipes and four electrical penetrations adequately fire stopped in the floor. The two lagged pipes passed through the back wall of the cupboard and were stopped in concrete. Five lagged pipes penetrated the side wall and appeared to be adequately fire stopped.

South Service Riser (Facing Flat 3)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void and concrete back wall. One metal pipe which was assumed to be a gas pipe penetrated the floor and was stopped in concrete with a gap of approximately 20mm around the edge of the pipe. There was one electrical cable which was embedded in concrete at floor level. One metal conduit was stopped in concrete at the floor. Two electrical bundles penetrated the floor with no fire stopping visible. The electrical penetrations all passed through a rectangular hole in the ceiling with approximate dimensions of 100mm x 200mm. There was no fire stopping in this hole.

North Service Riser (Facing Flats 4 and 5)

The outer chipboard panels to the service riser were destroyed by fire, exposing a heavily smoke stained void. There were seven lagged pipes with some of the lagging missing. Two of the pipes were stopped in concrete at ceiling level and two of the pipes were not fire stopped at ceiling level, gaps of approximately 15mm and 25mm respectively. The lagging around the remaining pipes obstructed the view of fire stopping. One electrical cable was present and fire stopped in mastic.

Lift Doors

Both the lift doors were closed and were fire damaged. The door frames had been displaced from the door openings at the top, leaving gaps of approximately 20mm on the left side of the left door and left side of right hand door and approximately 10mm at the side.

Doors into Stairwell

There was no door remaining from the lift lobby into the stairwell as this had been destroyed by fire.

In the stairwell area, the walls were heavily smoke stained. The wall to the left of the doorway was less smoke stained.

Suspended Ceiling

The aluminium framework for the suspended ceiling remained but had fallen from the ceiling and was hanging down the wall between Flat 2 and 3. No plasterboard remained and the pipework above was fire damaged.

Refuse Chute

The door and its frame were severely fire damaged on the lobby side. The glazed vision panel was intact and the overhead door closer was operational. The door had a “fire door keep shut” sign attached which was heat damaged. The chute side of the door remained intact with no fire damage and no obvious signs of smoke penetration. The door had adequately resisted the passage of smoke and fire from the lobby.

Paint and Surface Finishes

No tiling remained on this floor and all paintwork on ceilings and walls had burned away.

Gas Pipes

A gas pipe approximately 120mm in diameter passed through a sleeve approximately 150mm in diameter. The quality of fire stopping could not be assessed. The pipe passed up into a grille and branched; it did not appear to enter the lobby.

Appendix 5

RHO00000001

Inspection meeting BRE

Briefing Note

Date: 1 March 2019

Inspection meeting BRE

ARUP

Subject Briefing Note

Date 1 March 2019 **Job No/Ref** 258294

Briefing Note (legally privileged and confidential)

This briefing note is a record of witnessing inspections of a fire control switches taken from Level Ground and 2 in Grenfell Tower; as well as an exemplar fire control switch, for comparison purposes.

All activities were carried out by the MPS.
No photographic record of the removal of the two fire control switches was seen during this inspection.

Inspection Location

BRE Building Research Establishment
Bucknalls Lane
Watford, Hertfordshire, WD25 9XX
UK

Date

15th February 2019

Present

(MT)	CSM Martin Tucker	Forensic Manager - MPS
(JT)	Jeff Turner	Locksmith - for MPS
(AH)	Andre Horne	Marks & Traces - for MPS
(CH)	Ciara Holland	BRE
(RP)	Rupert Pool	Metallurgist - BRE
(DC)	David Crowder	Fire Expert - BRE
(RH)	Roger Howkins	Lift Expert - GTI
	Exhibits Officer	MPS
	Photographer	MPS

Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

Observations

MT started the meeting and informed all present that the MPS photographer would take photos and would distribute them after the meeting. Also, if any specific photographs were required, the MPS photographer would take them and would be distributed.

The following exhibits were to be examined:

* **ER/1** the 'express' drop key provided to the MPS by WSP. This was a general Sample of the type of 'express' drop key. This was not the 'express' drop key used on the night of the fire.
* **ER/2** the unused new version of the fire control switch, this was provided to the MPS by WSP
* **BJG/74** the fire control switch taken from Level Ground of Grenfell Tower
* **BJG/75** the fire control switch taken from Level 2 of Grenfell Tower

A photographic record of exhibits was taken the detailed before examination started.

Note: all draft photographs used in this file note were taken by the MPS photographer - as agreed.

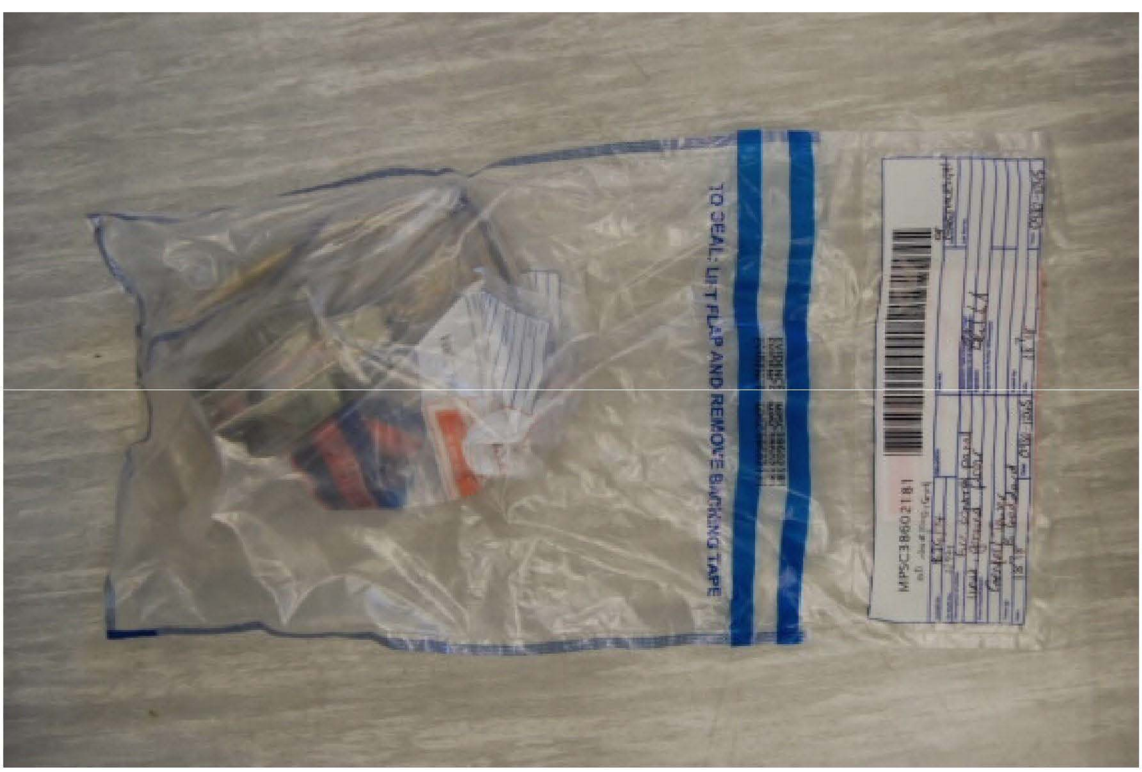

Photo 1 Evidence bag BJG/74

Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

Photo 2 Fire control switch – BJG/74 and fixing lugs (front view)

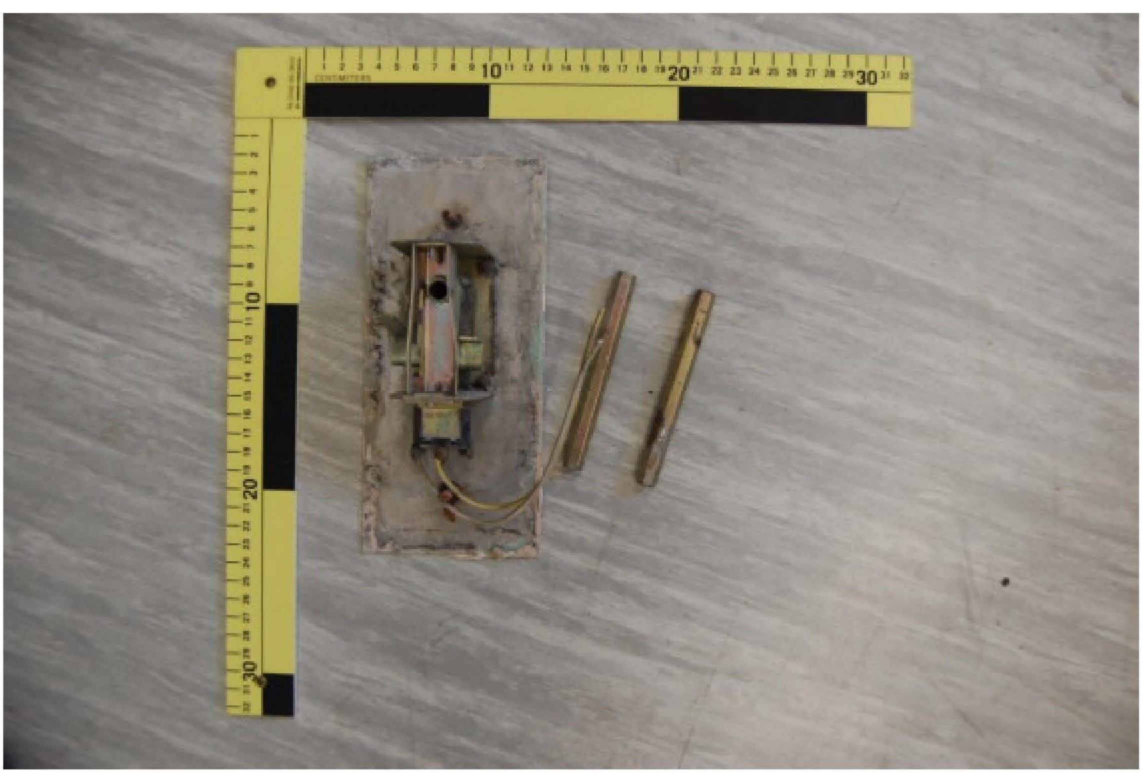

Photo 3 Fire control switch – BJG/74 and fixing lugs (rear view)

Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

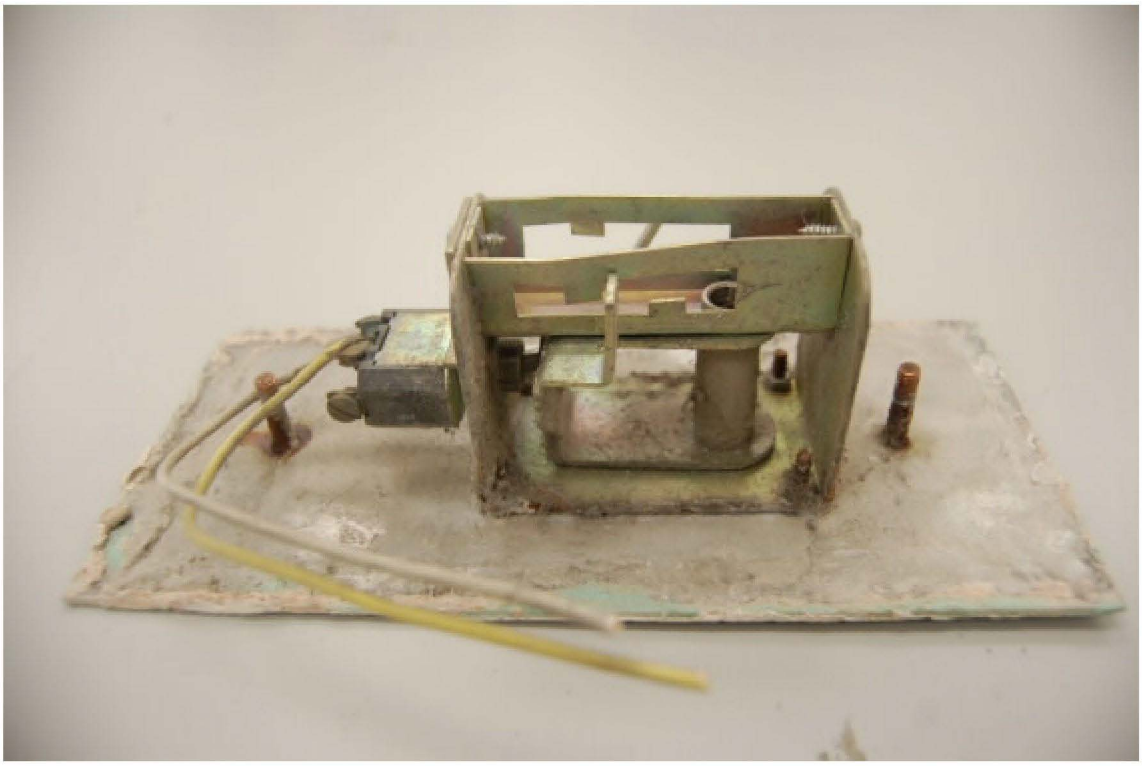

Photo 4 Fire control switch – BJG/74 (side view)

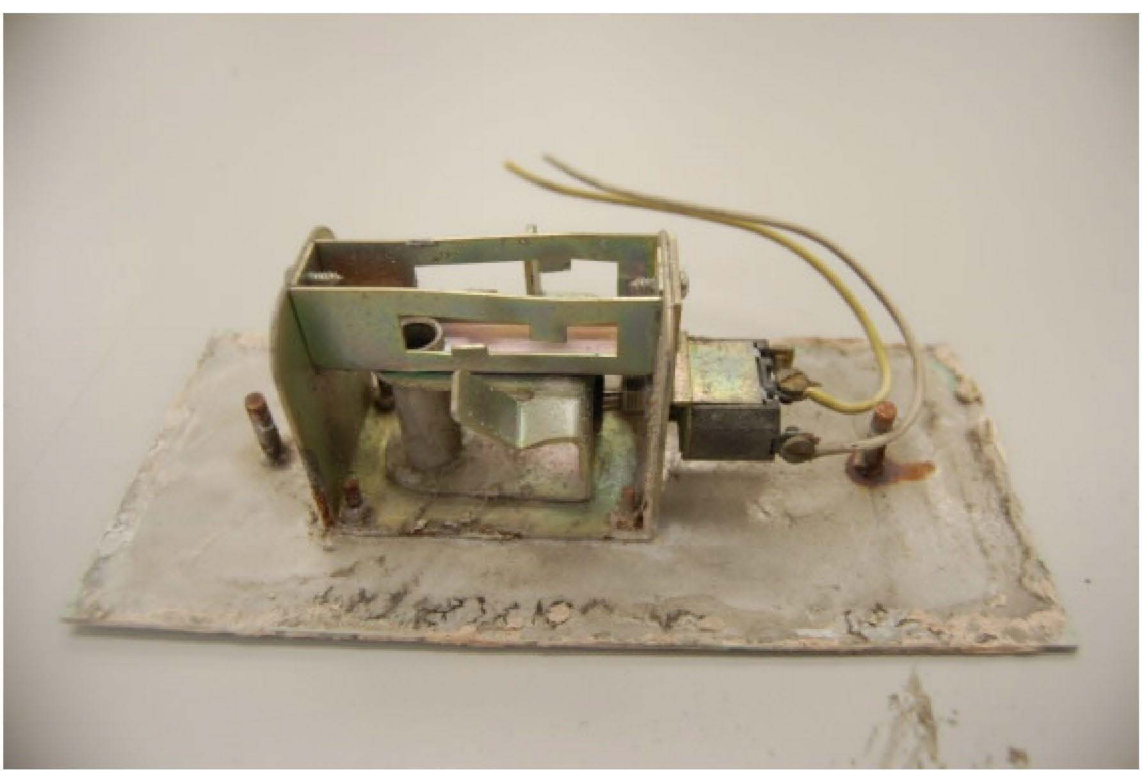

Photo 5 Fire control switch – BJG/74 (side view)

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Subject Briefing Note

Date 1 March 2019 **Job No/Ref** 258294

Photo 6 Evidence bag and new fire control switch ER/2

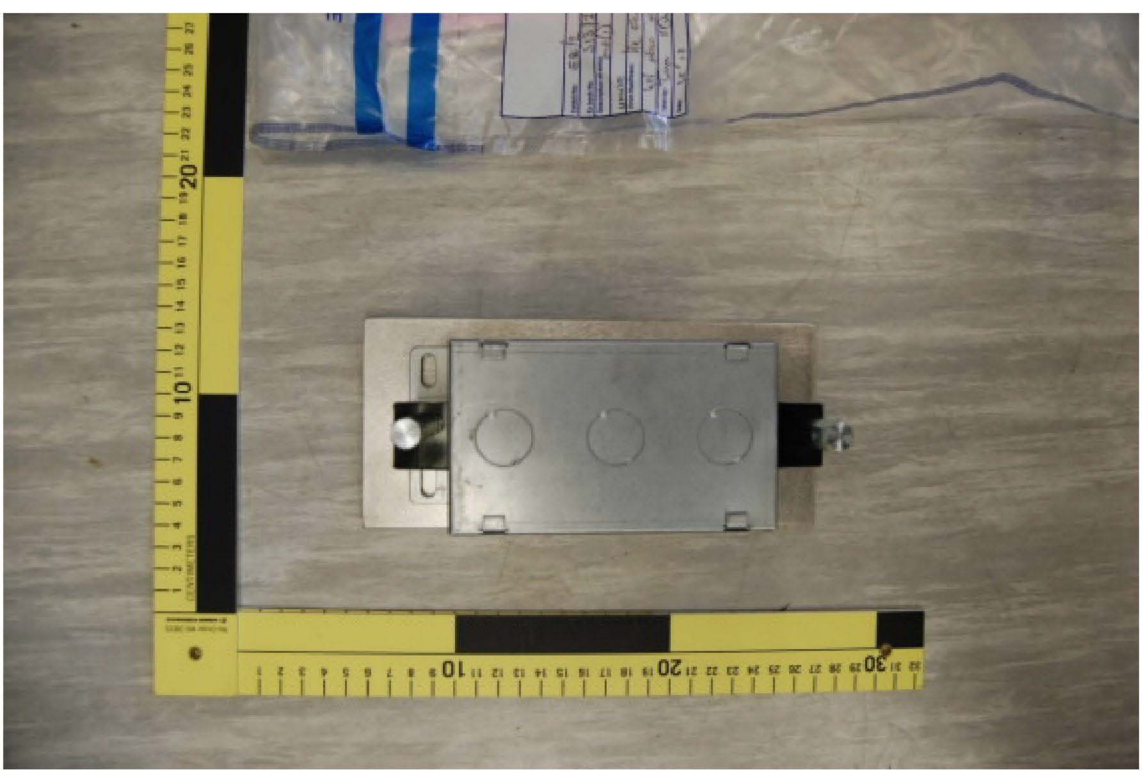

Photo 7 Fire control switch – ER/2 (rear view)

Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

Photo 8 Fire control switch – ER/2 (side view)

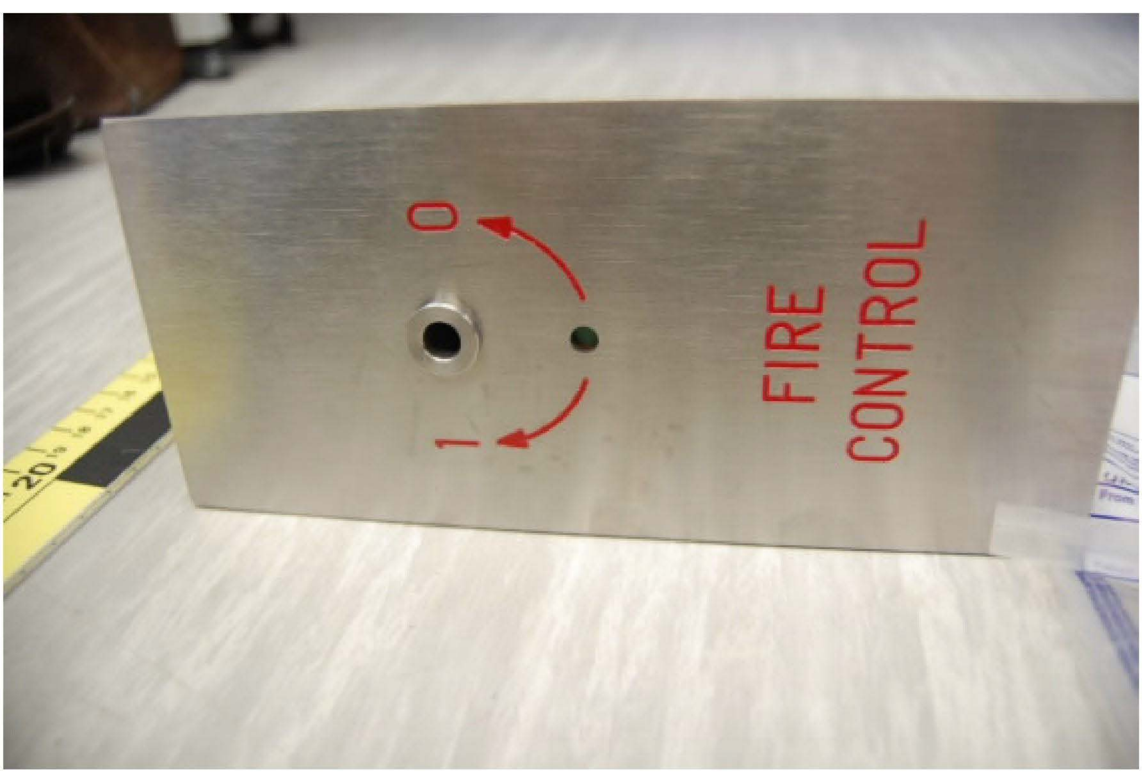

Photo 9 Fire control switch – ER/2 (front view – switch on side)

Subject Briefing Note

Date 1 March 2019 **Job No/Ref** 258294

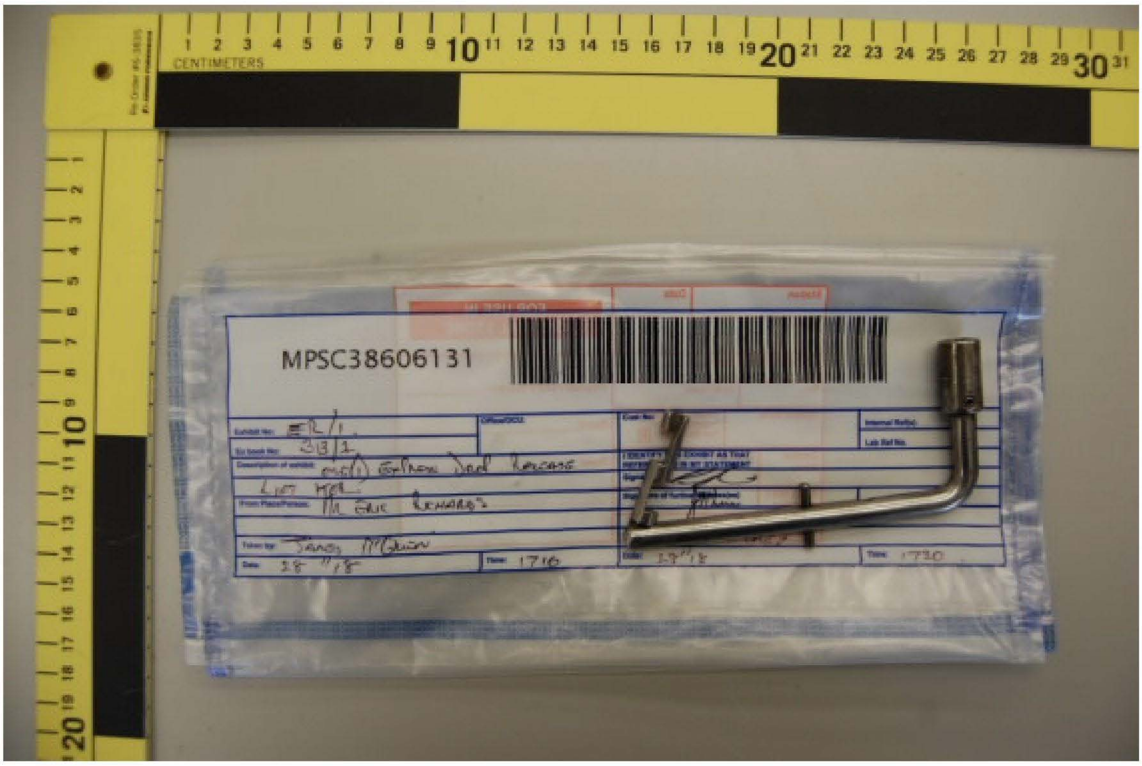

Photo 10 Evidence bag and 'Express' drop release key ER/1 this key was provided to the MPS by WSP and was not the key used on the night of the fire

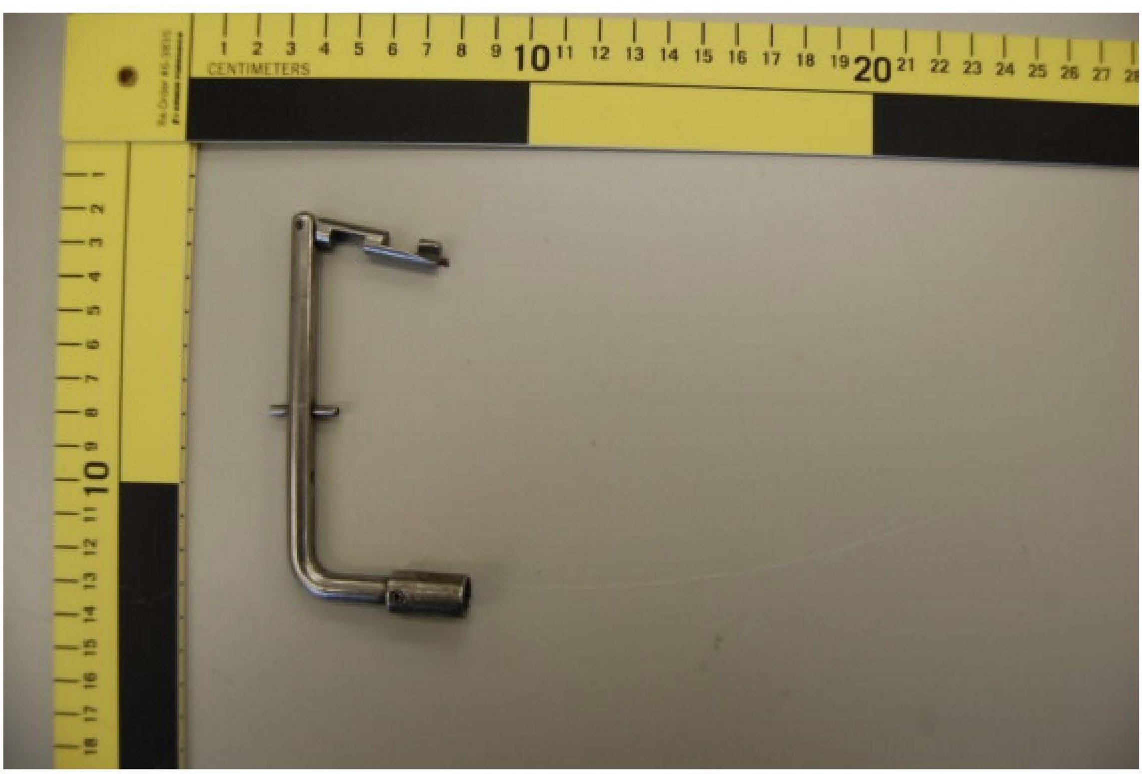

Photo 11 'Express' drop release key provided to the MPS by WSP

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Comparison of BJG/74 and ER/2

A physical examination of the two switches was undertaken.
One switch was installed at Grenfell Tower on the night of the fire (BJG/74) and the other switch which was the exemplar switch (ER/2) was also examined.
There is no manufacturing data on either switch, therefore it is not known the age or installation date of BJG/74.

It is not known how the BJG/74 fixing lugs were installed into the building fabric.
It is not known how this switch was removed from Grenfell Tower or who removed it.
It is not known if there is photographic evidence of this extraction procedure.

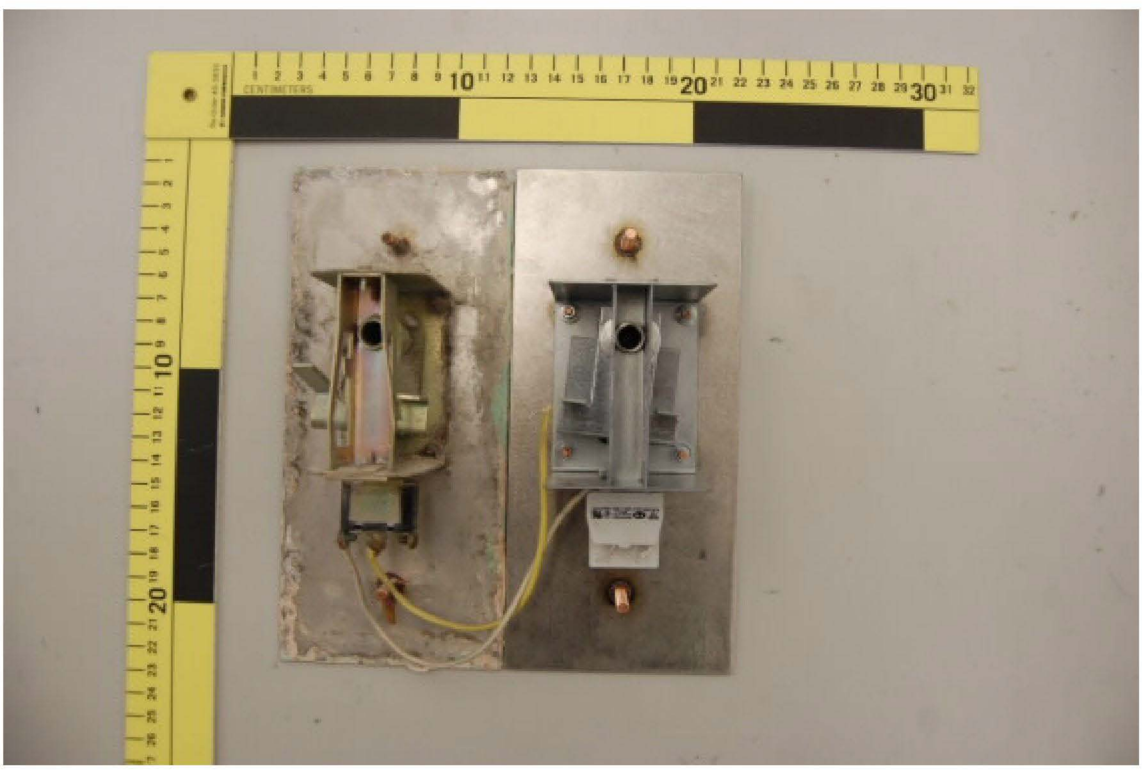

Photo 12 Comparison of fire switch BJG/74 (left) and ER/2 (right)

The examination of BJG/74 indicates deformation of the 'side wards' when compared with ER/2.
In my opinion, this deformation could not have occurred during removal.
It is not known if the removal procedure was photographed.

<u>Note</u>: the 'yellow' and 'white' field wiring on BJG/74 has been cut during the removal of the fire control switch from Grenfell Tower. It is not known the specification of the field wiring fitted the fire control micro switch or the age of the field wiring.

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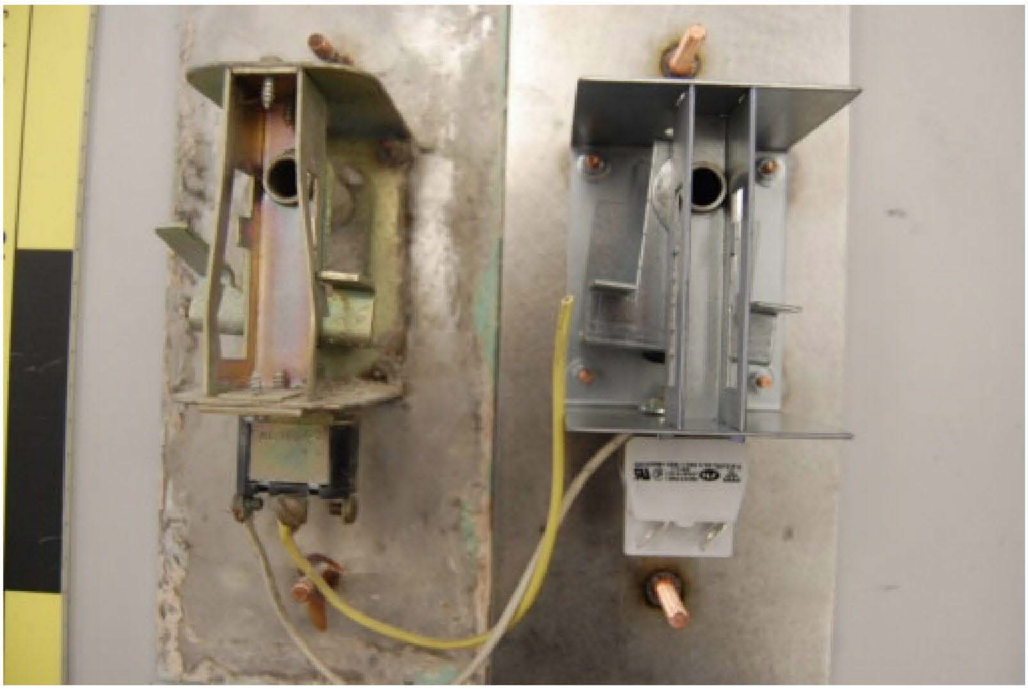

Photo 13 Deformation of 'side wards' to fire switch BJG/74 (left) compared with ER/2 (right)

Observation: there is 'green' wall paint visible on the side and on the bottom of the fire control switch. It is not known the age of the paint.

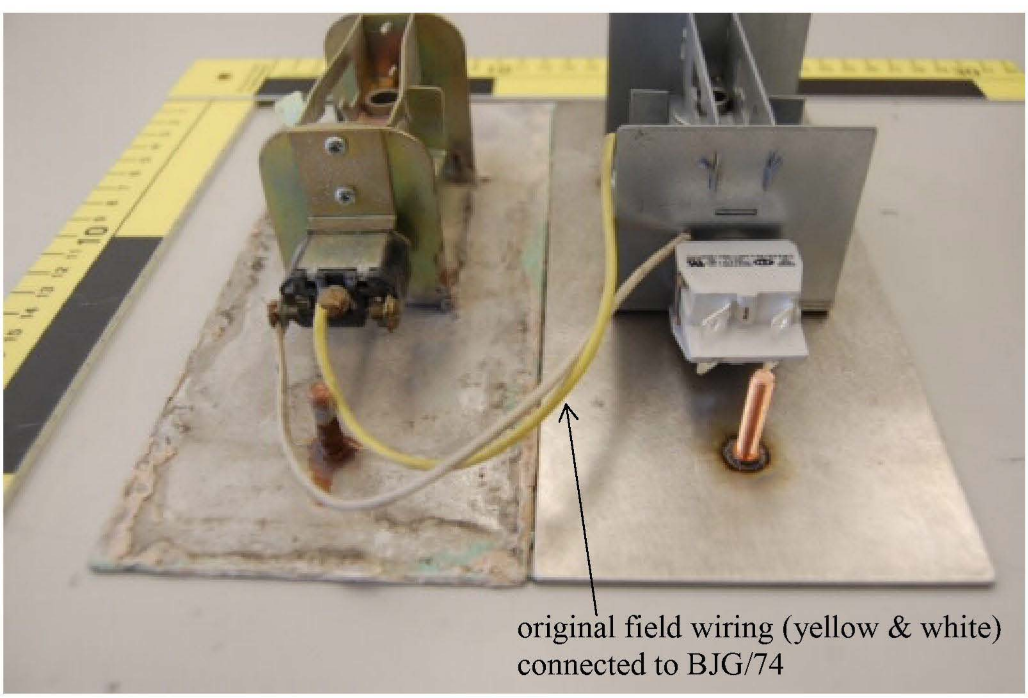

Photo 14 BJG/74 (left) and ER/2 (right) – View from bottom showing electric micro switch

Note: the 'yellow' and 'white' field wiring was connected onto BJG/74.

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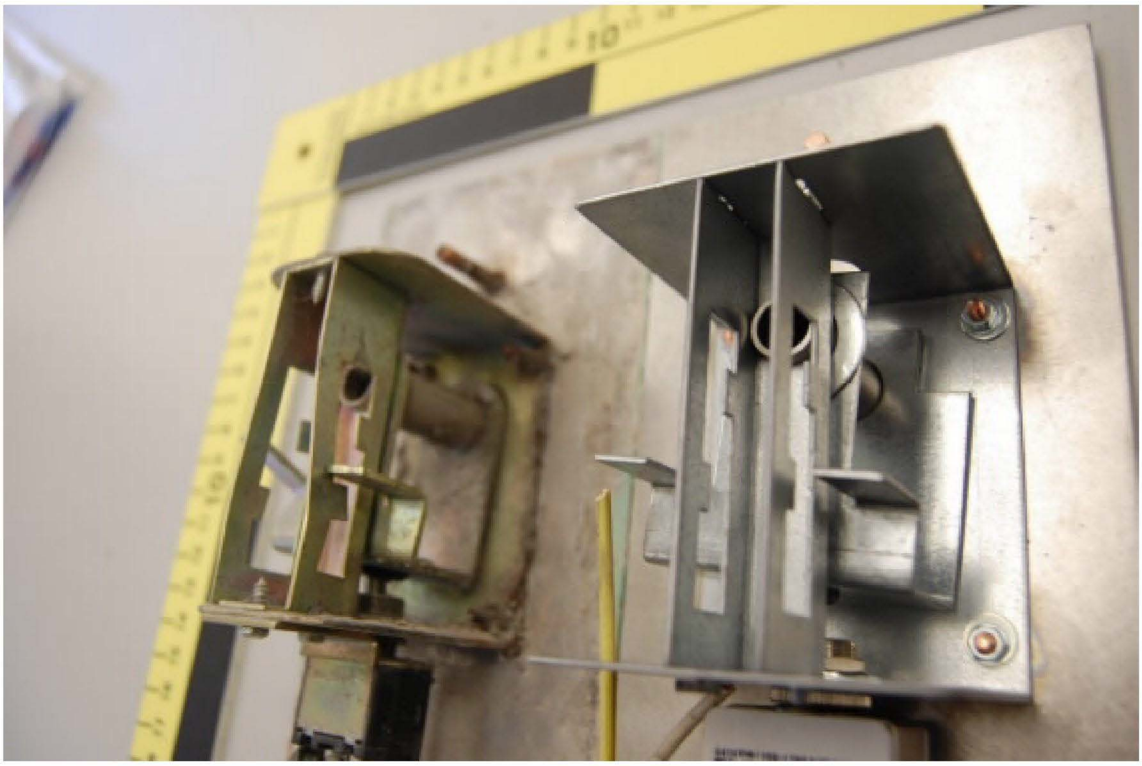

Photo 15 BJG/74 (left) and ER/2 (right) – Side view detailing deformer 'side wards'

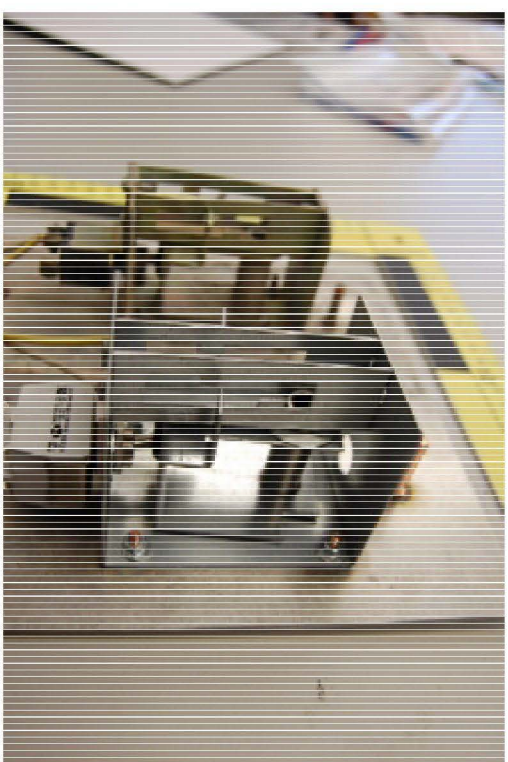

Photo 16 ER/2 'side wards'

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Photo 17 Comparison of 'side wards' BJG/74 (left) and ER/2 (right)

Corrosion

* The MPS visual examination of BJG/74 indicate a build up of builders' material on the switch casing and also the micro switch (**Photo 14**) was jammed. It appeared to be a wall plaster used during the works.
* During the examination the micro switch became free and the microswitch operated. It is not known what caused the micro switch to jam, but there were plaster grains on the work bench.
* It is considered that the build up of builders' material on the top of the switch was from the original works and not caused by the extraction of the switch. This is also my opinion.
* The micro switches installed on BJG/74 and ER/2 operated correctly when the jam was cleared. This was proved by using a digital multimeter provided by BRE.

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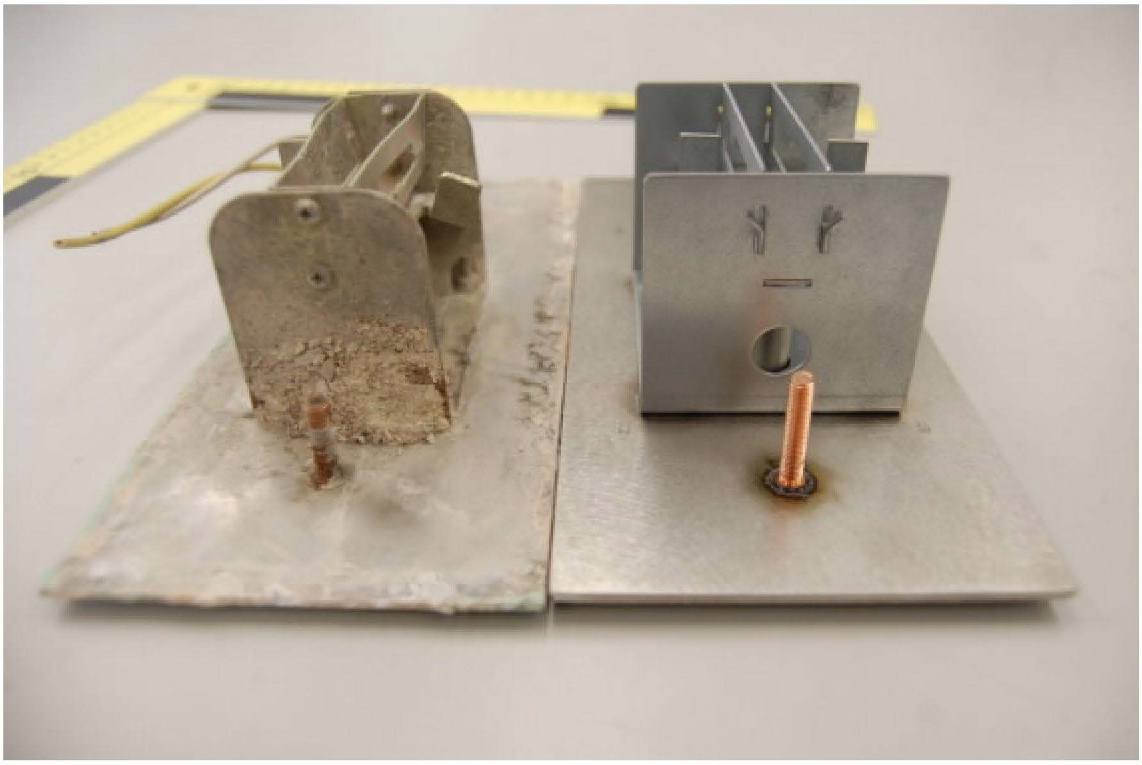

Photo 18 Builders' material on top of fire control switch BJG/74 (left) and new fire control switch ER/2 (right)

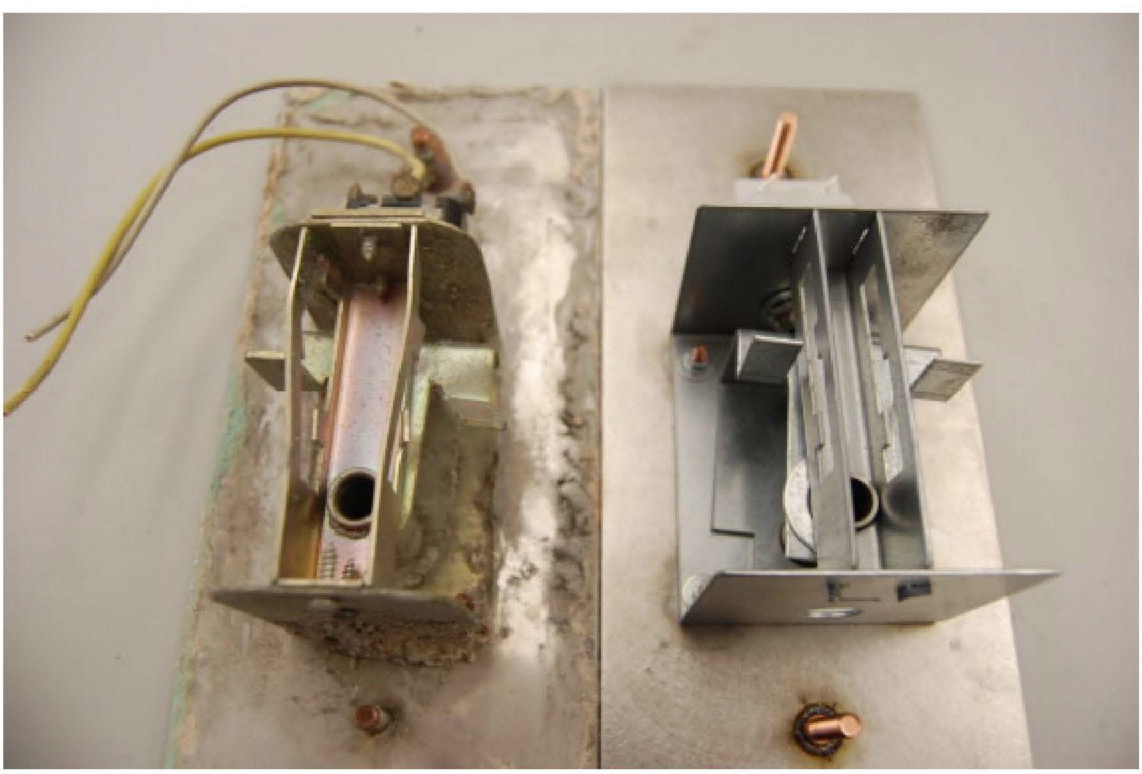

Photo 19 Comparison of BJG/74 (left) and ER/2 (right) - Detailing builders' material build up on BJG/74

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Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

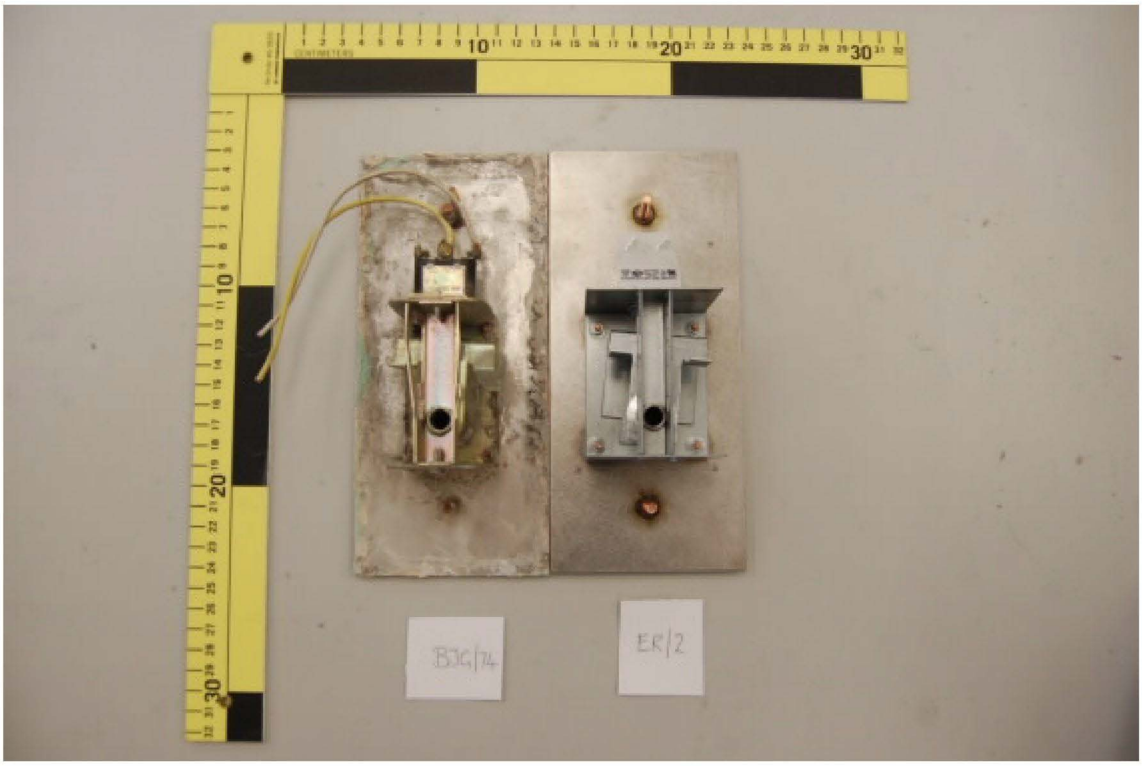

Photo 20 Comparison of BJG/74 (left) and ER/2 (right)

Internal examination

The barrel of BJG/74 was internally examined together with the 'side wards' by RH, AM, AH and JT and shared their observations.
It was agreed that there was no evidence of mis-use, vandalism or foreign objects (super glue) in the key barrel or 'side wards'.
The micro switch to BJG/74 initially was jammed and did not operate. During the examination this switch became free and operated correctly. It is not known what caused this micro switch to jam.
It is not known if the micro switch was jammed on the night of the fire.

It is not established if the damage to the 'side wards' was due to an incorrect 'drop' key being used or was damaged during installation.
In my opinion, the damage to the 'side wards' was caused by an incorrect drop key being used, which subsequently deformed the 'side wards', or by an 'express' drop key being inserted too far in the barrel and a high twisting force damaged the 'side wards'.

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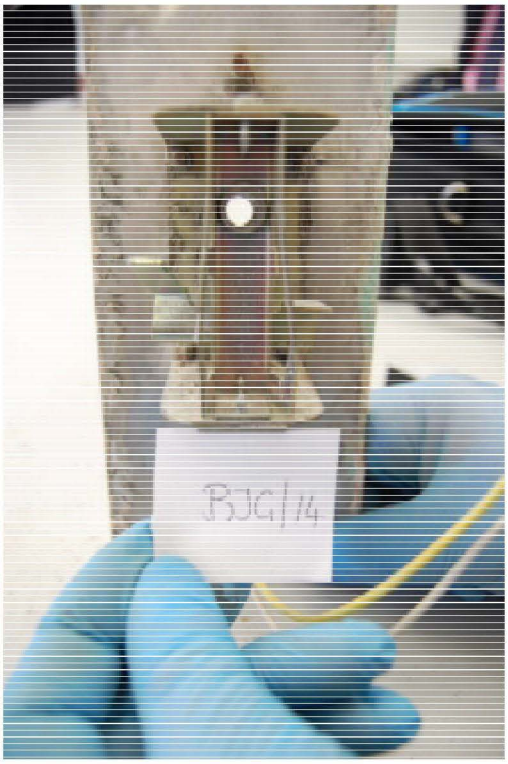

Photo 35 Drop key barrel BJG/74 – Where the 'express' drop key would be inserted

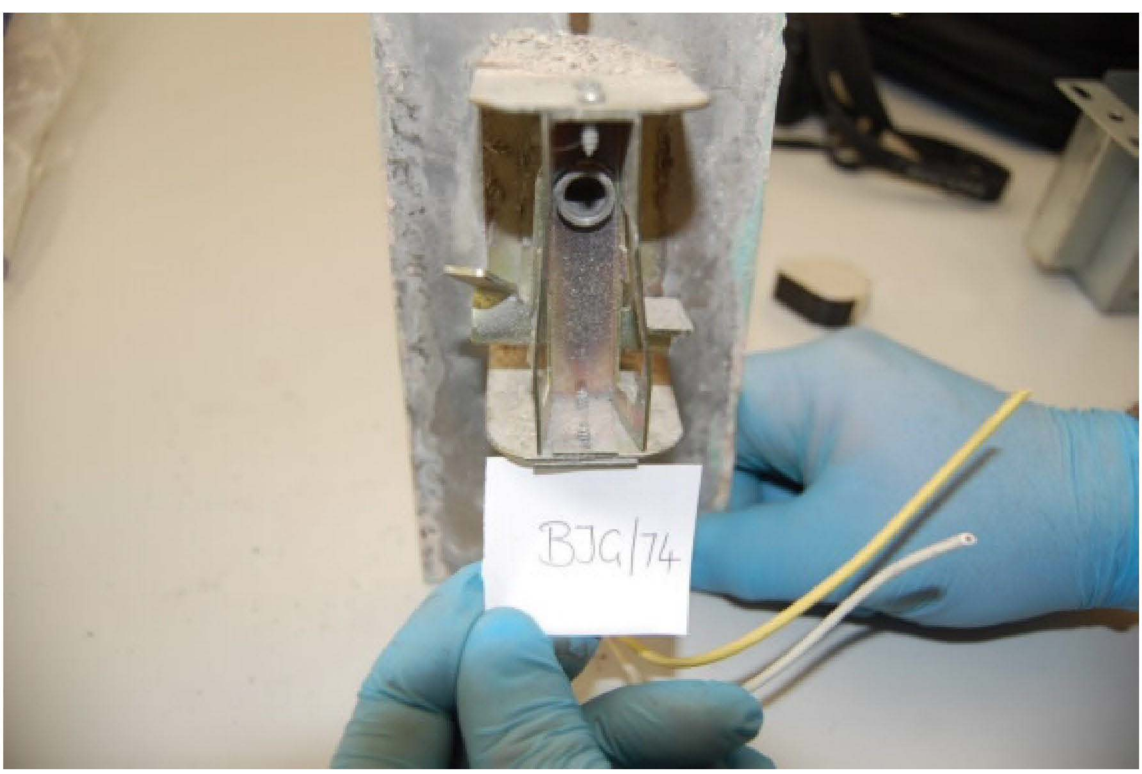

Photo 36 Drop key barrel BJG/74 – Where the 'express' drop key would be inserted

Subject Briefing Note

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Operation of fire control switches

BJG/74 and ER/2 were tested with 'express' drop keys.

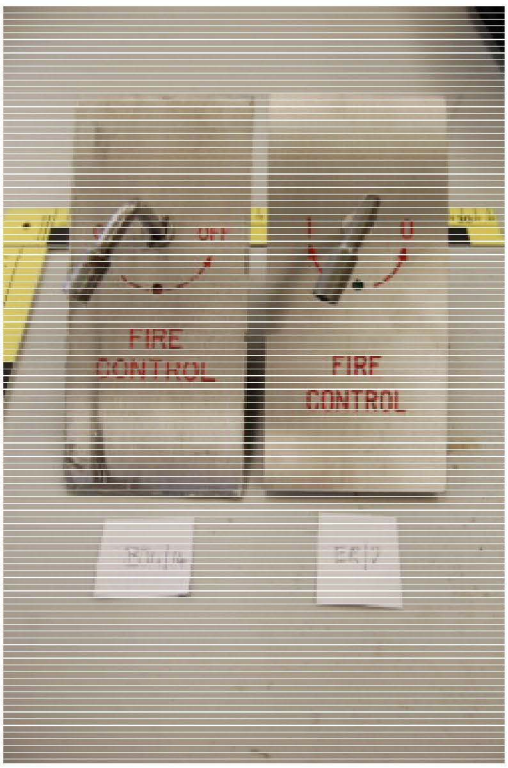

Photo 21 BJG/74 (left) and ER/2 (right) with 'express' drop keys

It was noted that fire switches BJG/74 and ER/2 have different engraving (ON/OFF – 1/0) and status colours (red and green) when in same position.
In my opinion, this could cause confusion to the Emergency Service on the night of the fire.

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Photo 22 Different engraving (ON/OFF–1/0) and status colours BJG/74 (left) is green and ER/2 (right) is red

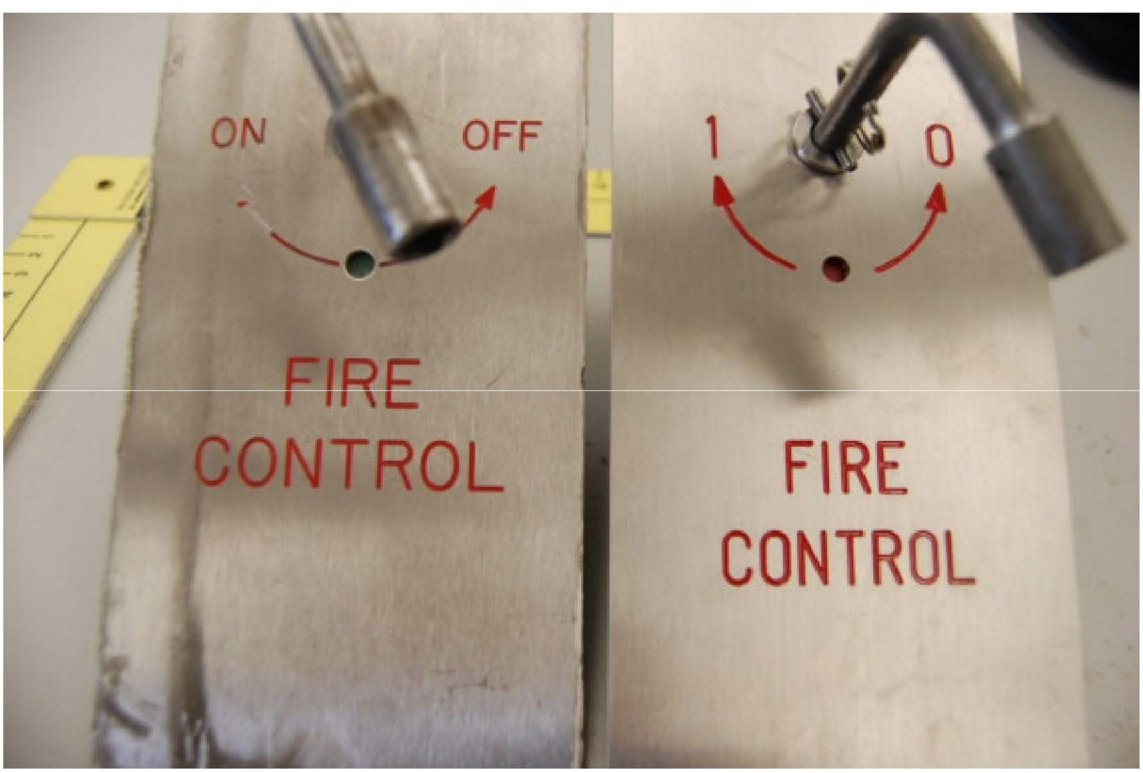

Photo 23 Different engraving (ON/OFF–1/0) and status colours BJG/74 (left) is green and ER/2 (right) is red

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BJG/74 the mechanical switch during the examination was found to be stuck in the 'OFF' position, indicating the electrical circuit was open.
The coloured indicator was showing 'GREEN', indicating the electrical circuit was open. This is the opposite of ER/2.
In my opinion, this could cause confusion on the night of the fire.

Damage to 'side wards' BJG/74

The 'side wards' to BJG/74 deformed due to most, probably, by an incorrect drop key being used or an 'express' drop key being inserted too far in the barrel and a high twisted force damaged the 'side wards'.
This deformation was not due to vandalism or mis-use. It is not known when the 'side wards' were deformed.
It was noted that the 'express' drop key ER/1 and the drop key used by Jeff Turner (JT) have slightly differing dimensions and one would operate the fire control switch and the other 'express' drop key would not operate the fire control switch. In my opinion, this indicates a lack of constancy in manufacturing tolerances of the switch or drop key.
It was recommended by the MPS that the Fire Service 'express' drop key used on the night of the fire is to be obtained for comparison purposes with the 'express' drop key used during this witnessing inspection.

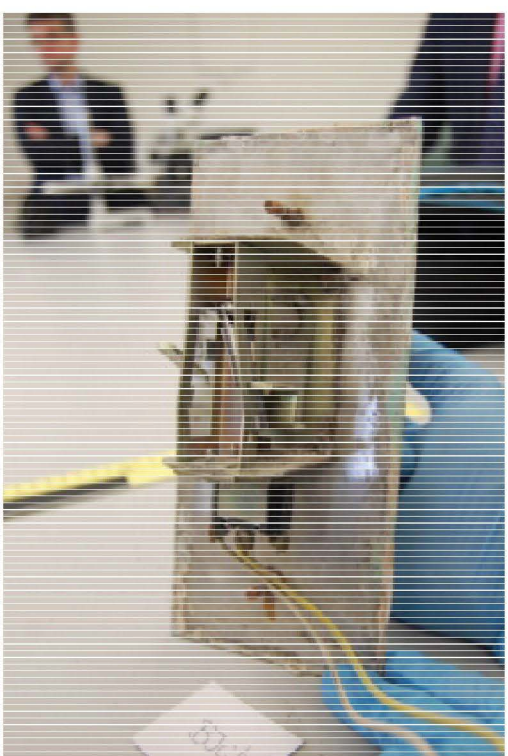

Photo 24 'Express' drop key inserted into BJG/74 barrel

Subject Briefing Note

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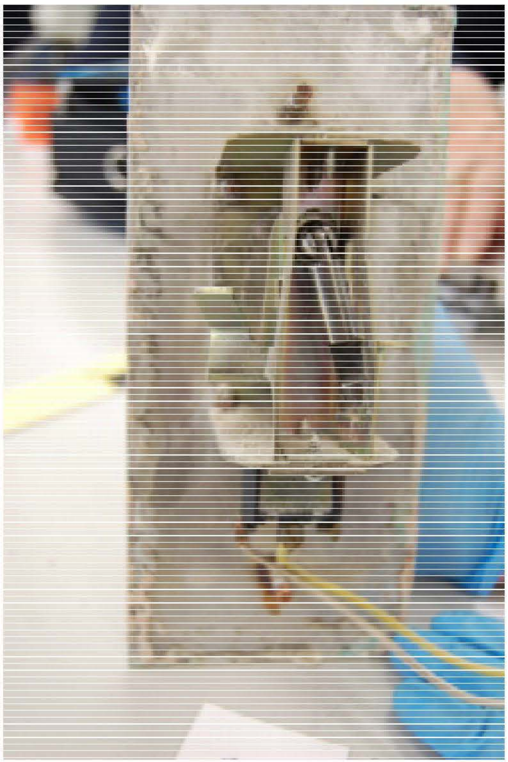

Photo 25 'Express' drop key in barrel and micro switch BJG/74

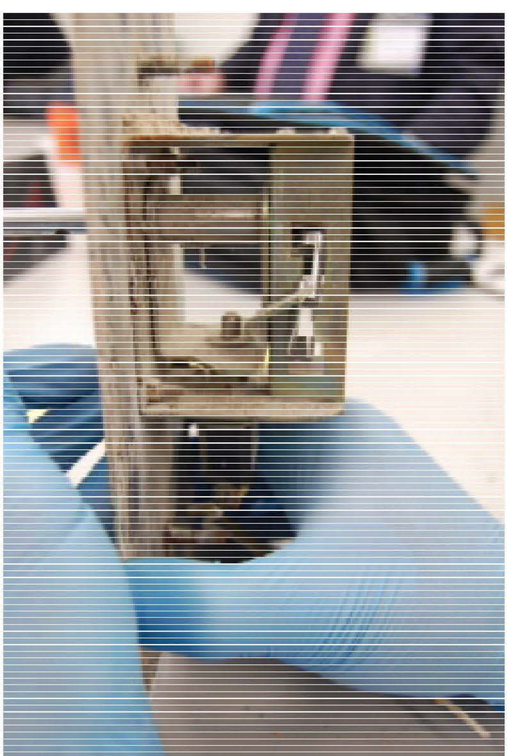

Photo 26 'Express' drop key inserted into the BJG/74

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Subject	Briefing Note		
Date	1 March 2019	**Job No/Ref**	258294

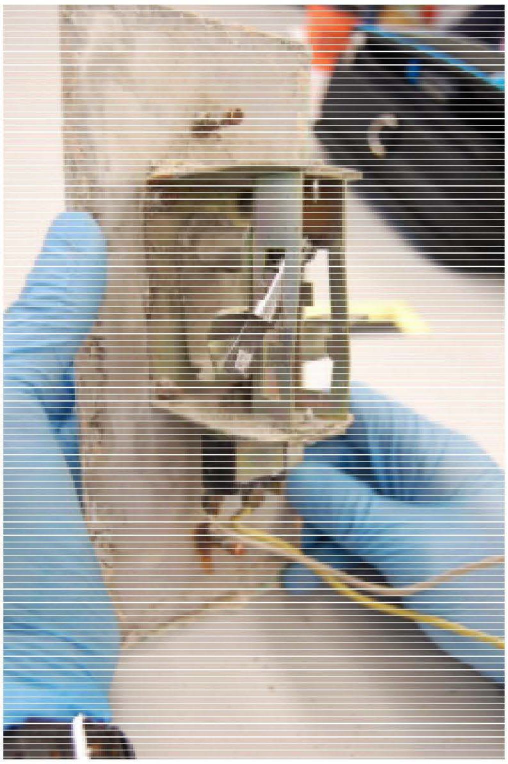

Photo 27 Comparison of 'express' drop release key in barrel of BJG/74 (key to left)

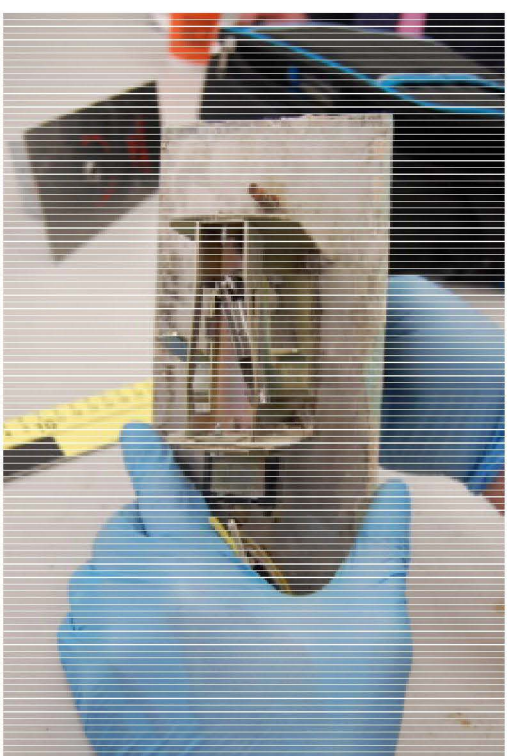

Photo 28 Comparison of 'express' drop release key. BJG/74 (key to right)

Subject Briefing Note

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Exhibit BJG/75

It was verbally agreed by all parties during the inspection that this fire control switch was not electrically connected and therefore would not be examined.
There was no photographic evidence that the switch was exactly connected when it was removed.

Note: good workmanship would have removed this fire control switch before the fire occurs to save any confusion.

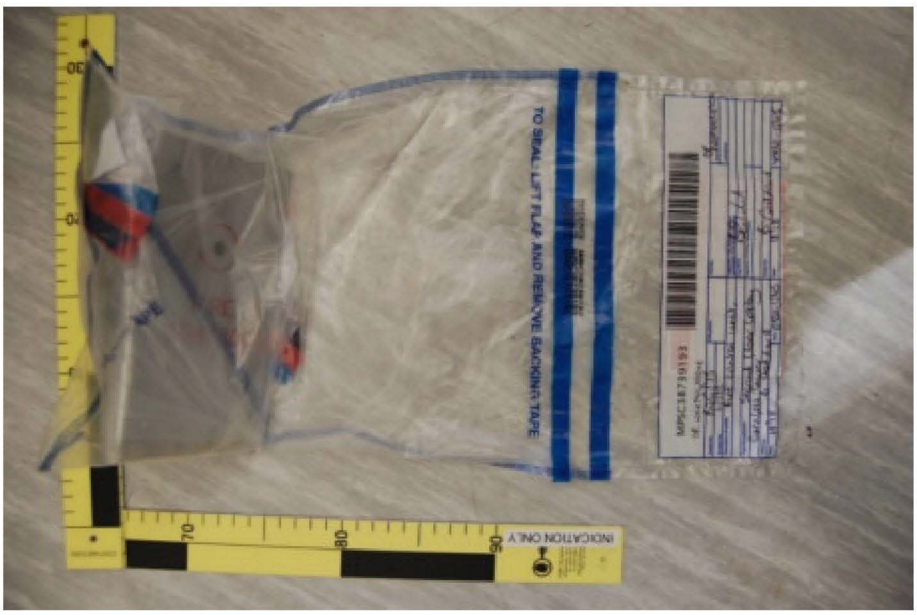


Photo 29 Evidence bag BJG/75

Photo 30 Evidence bag BJG/75

RHO00000004_0242

Subject Briefing Note

Date 1 March 2019 **Job No/Ref** 258294

Recommendations

MPS are to obtain the 'express' drop key used on the night of the fire by the Fire Service.
Those attending the examination on the 15th February 2019 would be invited back to BRE for an examination of the original 'express' drop key which was used on the night of the fire to confirm it would operate the switch with damaged 'side wards'.

The major reasons for the fire control switch malfunction are factory fault, components fatigue and misuse. Arup shall investigate all the possibilities:

1. An identical fire control switch and 'express' drop key will be obtained for testing and examination purposes.
    - The minimum twisting force required to damage the switch needs to be determined. The twisting force tests need to be carried out in laboratory conditions with specialised measuring equipment.
    - The minimum bending force required to permanently deform the pressed steel 'side wards' needs to be determined. The force tests need to be carried out in laboratory conditions with specialised measuring equipment.
    - The operation of micro switch needs to be analysed to evaluate any probabilities of its malfunction.
    - Different designs of drop keys will be used to test if they can be inserted into the fire control switch barrel and damage the 'side wards' or micro switch.

2. The components specification needs to be analysed to evaluate any probabilities of components design issues. Study will be focused on materials used, dimensions and the fabrication of the fire control switches.

3. The original factory drawing of the fire control switch shall be analysed to evaluate any probabilities of components design issues.

4. The 'express' drop key used to operate the fire control switch will be analysed to evaluate if the type of key is as per fire control switch manufacturer recommendation.

5. Fire Control switch design life and fatigue subject need to be analysed.

Appendix 6

RHO00000002

University of Northampton

Project Report

Testing of Fire Control Switch

Date: 27 October 2019

University of Northampton
Faculty of Arts, Science & Technology

PROJECT REPORT:

Testing of Fire Control Switch

BACKGROUND

When a fire alarm is activated all the lifts installed in the building are supposed to go down to the ground floor and remain there the entire time the fire alarm is active. Firefighters can then use the 'fire control' switch located at the fire service access level, outside of the well (and optionally in the car) to initiate firefighters service [1].

For this project ARUP (UK) commissioned work to test a standard "Fire Control" ('firefighter's) lift switch (see Figure 1 [2]).

Figure 1. "Fire Control" (firefighter's) switch [2].

THE AIM AND OBJECTIVES

The aim of this project is to test a standard "Fire Control" switch design. The investigation is to determine the load/ force range required to deform the switch frame structural elements.

The objectives are to determine:

- the force required to operate the switch (open/close),
- the force to bend the switch frames,
- the force to bend the Express drop key or break the hinge.

The loading conditions to be considered are when the switch is operated by a standard unlocking key (the Express "drop key") which fits the unlocking "drop key" mechanism. An example of the switch damaged during a fire event is shown in Figure 2 [2].

University of Northampton
Faculty of Arts, Science & Technology

A new "Fire Control" switch and the Express "drop key" was provided by ARUP (UK) for testing purposes.

The control switch case ('back box') structure has two steel frame plates ('cheeks' on either side of the entered key). The plates have a "labyrinth" (see Figure 3) designed to ensure that only the proper key could be turned, i.e. any improper/ vandal generated tool would hit the 'cheeks' and fail to turn.

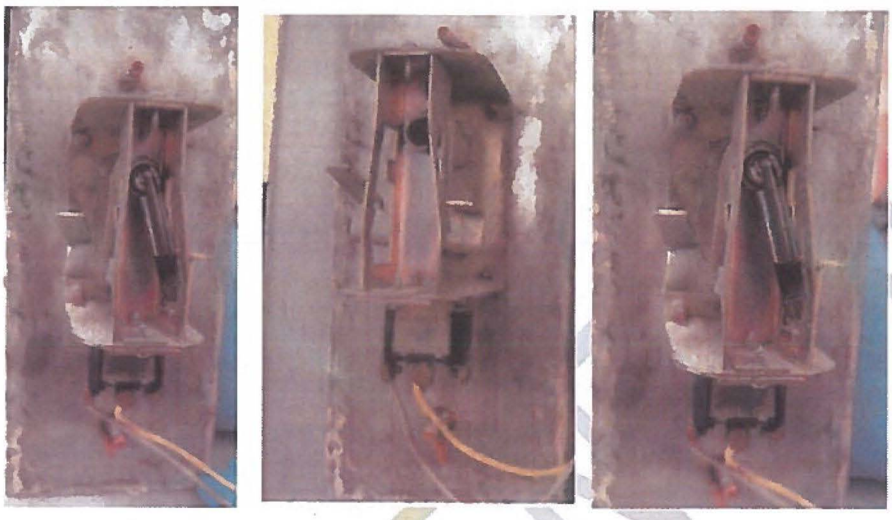
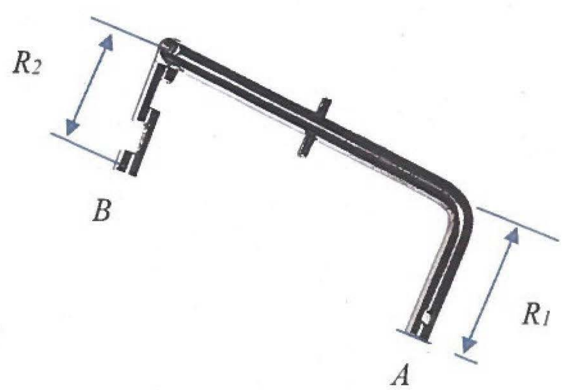


Figure 2. 'Fire Control' switch with deformed frame elements [2].



(a) **(b)**

Figure 3. Control switch: (a) case and (b) 'drop key'.

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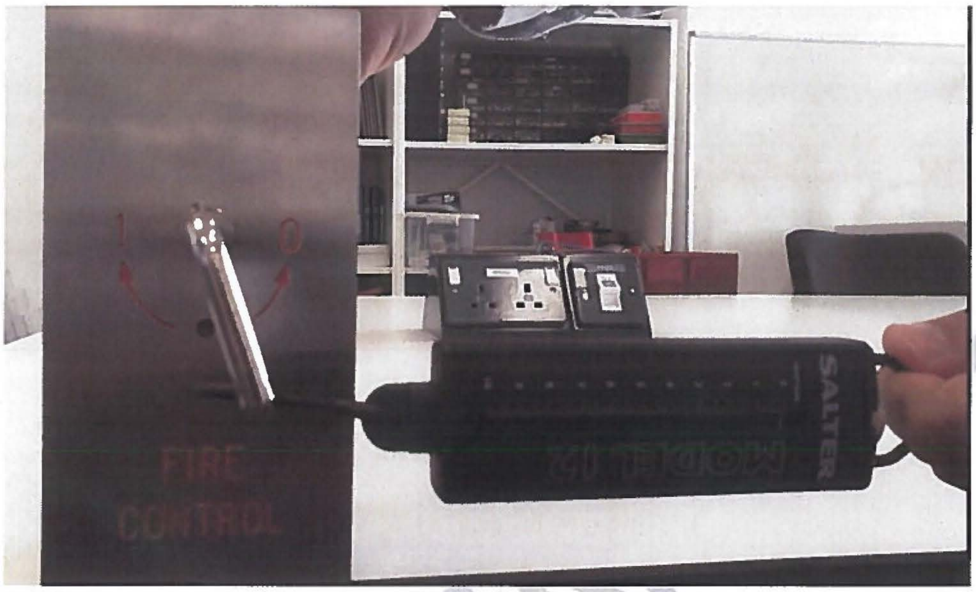
UON University of Northampton Faculty of Arts, Science & Technology

EXPERIMENTAL TESTS

1. Experimental procedure to determine the force required to operate the switch



(a)

(b)

Figure 4. Experimental setup used to determine the force required to operate the switch

Salter Brecknell (Model 12) Spring Balance was used to determine the force required to operate the switch. Figure 4 (a) (b) illustrates the measurement setup.

In addition, the measurement was repeat by a 'dead weight' experiment (see Figure 5).

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Figure 5. Experiment with dead weights.

The force used to operate the switch was measured to be 10.5 N.

2. **Experimental procedure to determine the force required to bend the back box frame plate and bend / break the Express drop key.**

The second test involved the setup illustrated in Figure 6. In this setup the switch was clamped in a workshop vice with the drop key operated by a torque wrench (Kennedy 3/8" SQ Torque Wrench [3]). With the drop key bottom end point engaged with the plate the torque was recorded and the bending displacements measured (see Figure 6,7). The torque values were then transposed to calculate the forces involved.

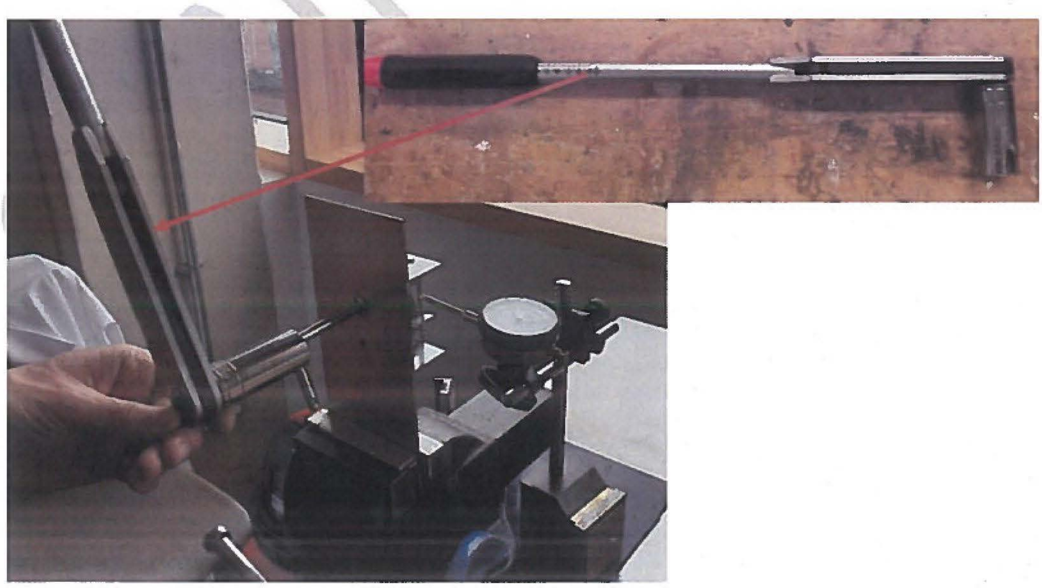

Figure 6. Torque wrench test setup.

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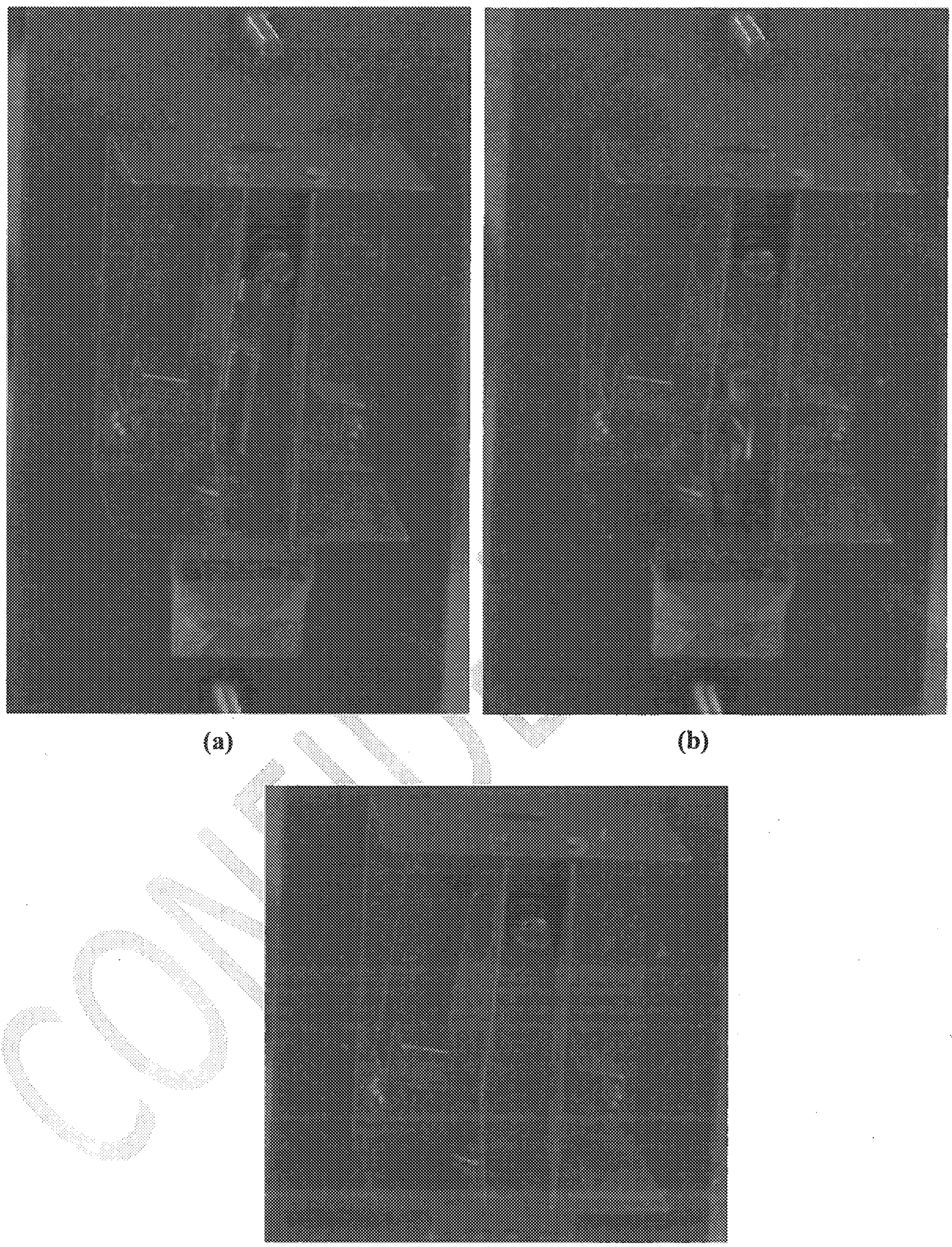

(a) (b)

(c)

Figure 7. Test procedure: (a) the drop key bent at the hinge end; (b) breaking point; (c) with the drop key broken at the hinge.

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The torques measured were 12 Nm and 14 NM, corresponding to the force values of 266.7 N and 311.1 N, respectively. The maximum displacements of the plate recorded were 1.76 mm and 2.08 mm respectively (see Table 1). Video evidence is available to confirm and illustrate the test procedures applied.

Table 1.

Torque measured T [Nm]	Corresponding force calculated as $F = T/R_1$ [N] $R_1 = 0.045$ [m]	Displacement [mm]
12	266.7	1.76
14	311.1	2.08

FINITE ELEMENT SIMULATION TESTS

A simplified CAD model and Finite Element Analysis (FEA) were developed to calculate the bending displacements of the the steel frame element under the loads measured. The results are summarised in Table 2 and the model is illustrated in Figure 8.

In the simulations a point force F_c corresponding to the torque of 12 Nm (determined as $F_c = T/R_2$ 12 Nm/0.035 m = 342.857 N) has been applied at various locations near the area where the drop key may get in contact with the 'cheeks' on either side of the entered key (see the images provided in the Appendix). Neither material properties nor the exact CAD models of the control switch structure were available. Therefore, the simulations were carried out for typical steel material parameter values (Young's modulus E and Poisson ratio ν).

Table 2

E [GPa]	200 GPa			215 GPa		
ν	0.3			0.3		
Load location	1	2	3	1	2	3
Deflection [mm]	1.009	1.528	1.616	1.022	1.422	1.502

The results demonstrate that the bending deflections calculated from the FEM model are close to the measured values.

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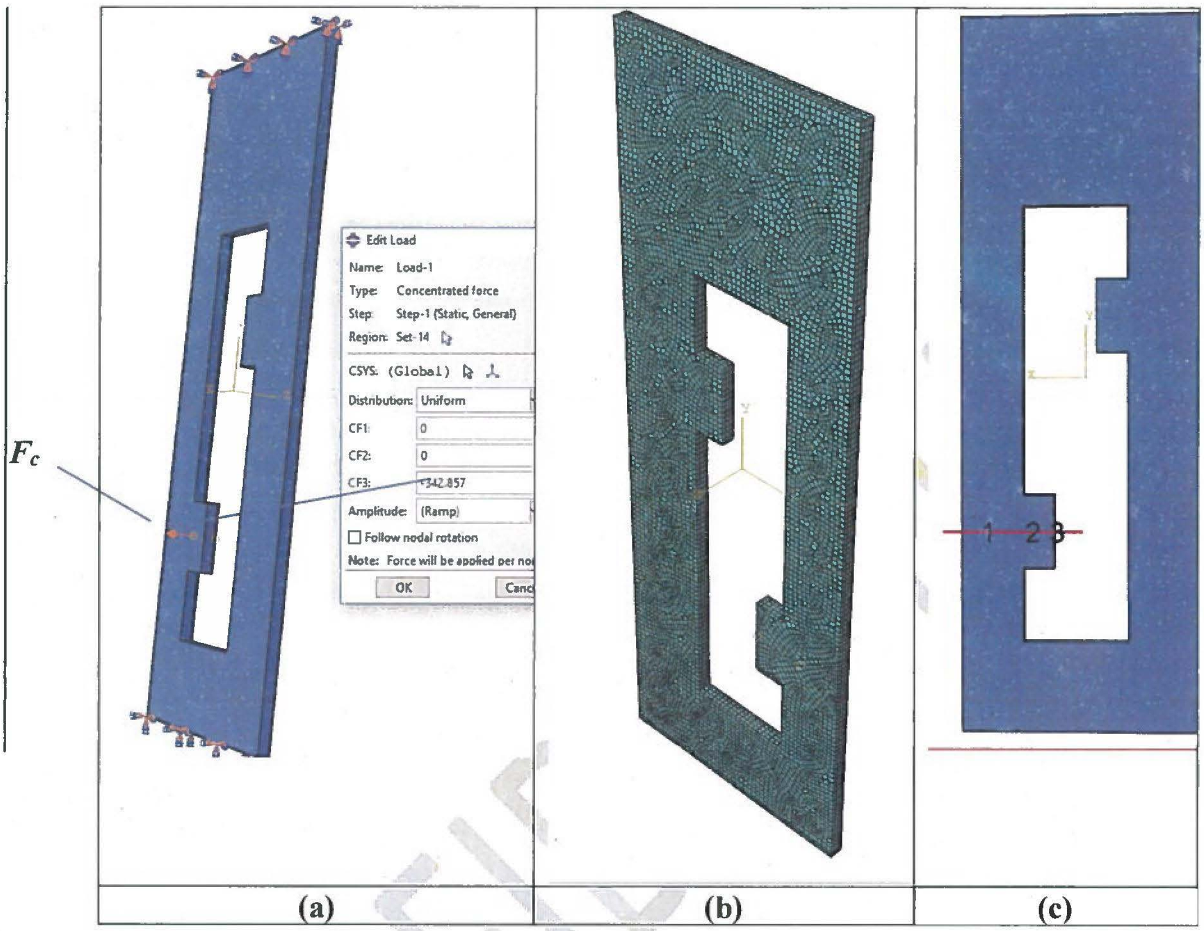

Figure 8. FEM model: (a) boundary and load conditions; (b) FEM mesh applied; (c) load locations.

SUMMARY AND CONCLUSION

The investigation carried out has led to the results summarized as follows:

- The force used to operate the switch was measured to be 10.5 N.
- The force to bend the switch frames depends on where the drop key hits the 'cheeks'.
- The maximum deflection will occur at the point of application of the load.
- The maximum deflection measured was approx. 1.76 mm. This value corresponds to the key turning torque of 12 Nm. This torque when transposed to a point force acting at point A of the key (see Figure 3(b)) gives the force of 266.7 N.
- The torque applied to bend the drop key and to break the key near the hinge was 14 Nm. When this value is transposed to a point force acting at point A of the key the result is 311.1 N.
- The FEM simulation tests were carried out to verify the measured values. An approximate/ simplified FEM model was applied.
- In this model the frame structure at one side of the drop key was represented by a constrained steel plate with a "labyrinth".

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- The results obtained from the computer simulation tests are within the range of the measured values.

Professor Stefan Kaczmarczyk

Dr Mohammad Ghaleeh

27/10/2019

ACKNOWLEDGEMENTS

Assistance of Dr Shafqat Rasool and Mr Mateusz Gizicki provided to set up and to carry out the tests is gratefully acknowledged.

REFERENCES

[1] British Standards Institution, *Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts Part 72: Firefighters lifts.* BSI Standards Publication. BS EN 81-72:2015.

[2] R. Howkins, *Project Blue 2 - Testing of fire control Switch – Confidential.* ARUP Consultant/Vertical Transportation, e-mail communication dated 21 May 2019.

[3] https://www.bukalapak.com/p/industrial/tools/1ayyrri-jual-kennedy-3-per-8-inc-sq-dr-mechanics-torque-wrench-12-68nm-code-ken5570440k (accessed 24 October 2019)

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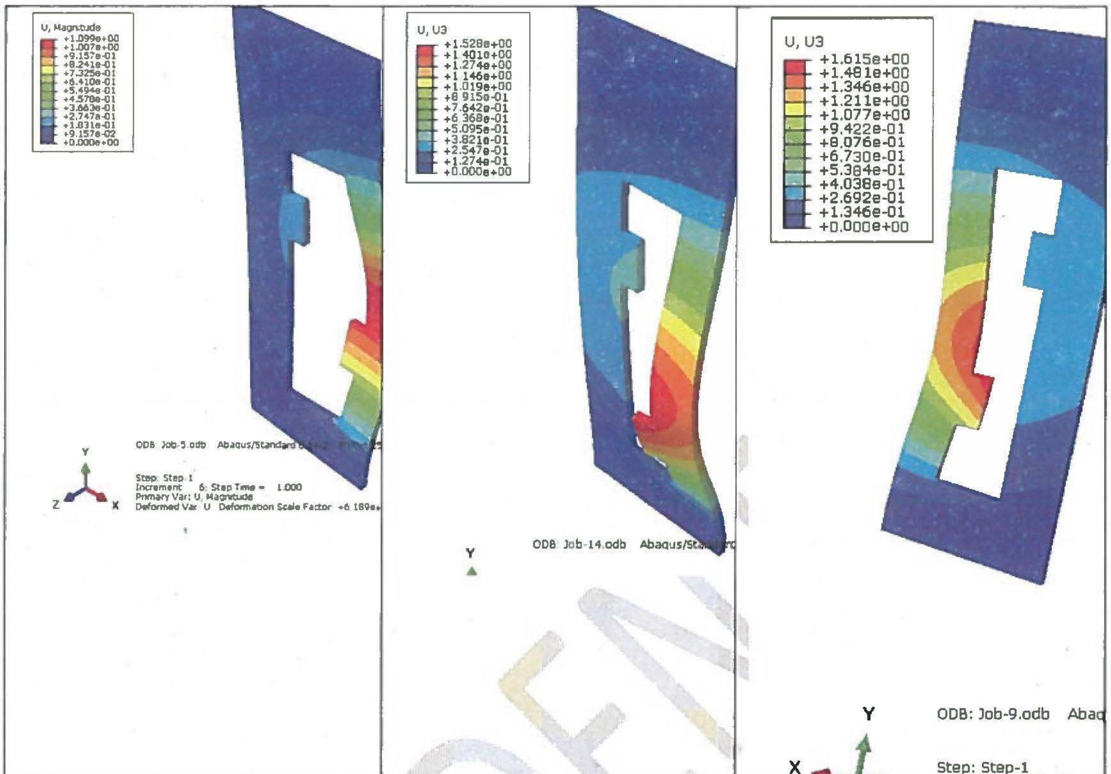
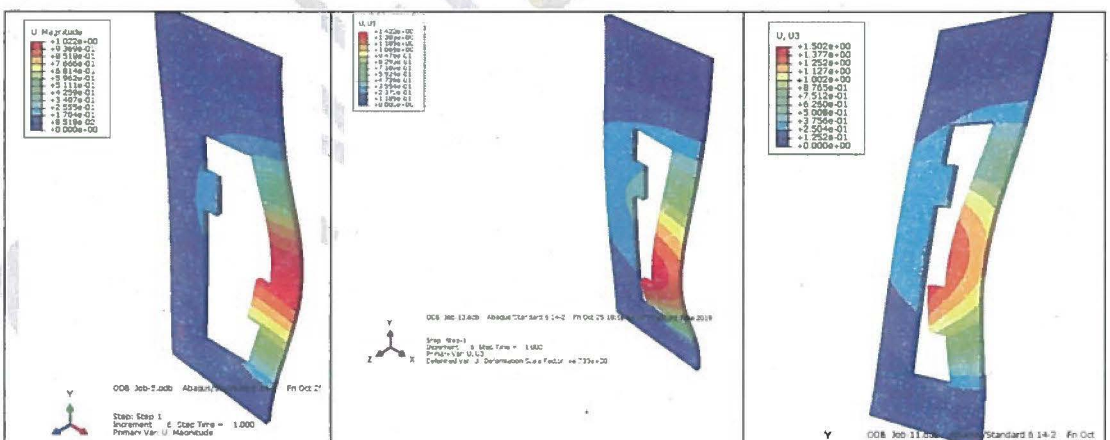
APPENDIX



Location1	Location2	Location3
E=200GPa		



Location1	Location2	Location3
E=215GPa		

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Appendix 7

MET00056700

Forensic Report by Scientist Andre Horne (Eurofins Forensics) Concerning the Examinations of the Fire Control Panel and Drop Keys from Grenfell Tower

Date of report: 12 November 2019

OFFICIAL
DOCUMENT RECORD PRINT

Other Document

		URN	D26735
Priority:	Low	Class:	L96 CONSTRUCTION - EXPERT REPORTS AND TESTING
Title:	FORENSIC REPORT - EXAMINATION OF THE FIRE CONTROL PANEL AND DROP KEYS		

FORENSIC REPORT BY SCIENTIST ANDRE HORNE (EUROFINS FORENSICS) CONCERNING THE EXAMINATIONS OF THE FIRE CONTROL PANEL AND DROP KEYS FROM GRENFELL TOWER

page 1 of 12

Official Sensitive

Forensic Report

This report provides only a summary of the scientific findings, interpretation and conclusions in this case. It is not intended for court use and therefore does not comply with the Criminal Procedure Rules parts 16 and 19. If the information in this report is required for court purposes then a Full Statement must be requested in advance of any court date.

Date of Report:	12 November 2019
Customer References:	Operation Northleigh
LGC Forensics Reference:	LGC-17132109
Police Force:	Metropolitan Police Service
Officer in the case:	Sarah WILD
Offence:	Investigation into the fire at Grenfell Tower
Date of offence:	NA
Suspects:	NA
Victim/Complainant:	NA
Offence Location:	Grenfell Tower

Request:
To examine the Fire Control Panel, Item BJG/74, recovered from the ground floor of Grenfell Tower following the fire on 14 June 2017.
Purpose:
To determine if the mechanism of the Fire Control Panel, Item BJG/74, was in working order and if it had been damaged, tampered with or vandalised.
Examination
On 15 February 2019 I attended at BRE Watford at the request of the Metropolitan Police Service to examine the fireman's lock recovered from Grenfell Towers following the fire on 14 June 2017. Other experts and members of the MPS were also present.
We were presented with the following exhibits to examine in the presence of officers from the Metropolitan Police Service:
BJG/74 Fire control panel unit, ground floor (recovered 18/7/18)
ER/1 One (1) Exprox Drop release lift key
ER/2 One (1) Exprox firemans switch
Examination and results

ER/2 One (1) Exprox Firemans Switch
This was a fire control panel, usually mounted in the wall adjacent to a lift, with a switch to take control of a lift and summon it to the location of the panel. The control panel consists of a wall mounted plate with a circular aperture through which to insert a specialized fireman's drop key. When the key is inserted into the circular aperture, it is pushed along a tube, at the end of which the lower part of the key hinges and drops down (as a result of gravity) and dangles freely rom the key shaft. The free dangling part of the key is shaped to fit and pass through slots in the metal side wards in order to press against and move a metal switch frame arm attached to an electronic toggle switch. If the kay is turned one way, the contacts on the electronic switch are closed and if it is turned the other way, the contacts are opened.
The panel was marked Fire Control on the outside in red with arrows pointing to the number 1 (On) and 0 (Off). The arrows indicated the direction to turn the key to achieve the On or Off condition. On the panel (ER/2) the key had to be turned clockwise for the On condition and it had to be turned counter-clockwise for the Off condition. Directly under the key aperture was a colour indicator for a visual indication of the condition of the panel. The indicator can be red or green. On this panel, when it was in the Off condition, the red indicator was visible and the electronic switch circuit was found to be closed when tested with a multi-meter. When it was in the On condition, the green indicator was visible.

(Please see original document for image)

(Please see original document for image)
Rear of panel

(Please see original document for image)

ER/1 One (1) Exprox Drop Release Lift Key
This was a fireman's drop key with no brand markings or other identifying markings. There was slight corrosion and damage on the key from normal use. The key is cylindrical, bent at a right angle at the rear and hinged at the front. The hinged front part of the key is cut to fit the slots in the side wards of fire control panels. The key has a stop bar in approximately the middle to prevent it from being inserted too far into the rube of the panel. The key was tried on the fire control panel, Item ER/2, and it functions correctly.

(Please see original document for image) (Please see original document for image)
Key Key inserted into panel

BJG/74 Fire Control Panel Unit, Ground Floor (Recovered 18/7/18)
This was a fire control panel marked Fire Control on the outside in red with arrows pointing to the words On and Off. The arrows indicated the direction to turn the key to achieve the On or Off condition. On this panel (BJG/74), to achieve the On condition, the key had to be turned clockwise and it had to be turned counter-clockwise for the Off condition. Directly under the key hole was a colour indicator for a visual indication of the condition of the panel. The indicator can be red or green. The metal frame and switch arms were ferrous and coated with a corrosion resistant material.
The aperture and tube was inspected to determine if it had been damaged by vandalism or attempts to operate it with something other than a fireman's key. No damage was observed to the aperture or the tube to indicated vandalism or misuse.
There was some surface corrosion visible on the metal parts of the switch. The corrosion was not sufficient to affect the operation of the switch.
The panel was received in the Off condition and the visual indicator was on green. The electronic switch circuit was tested with a multi meter and found to be open.

When an attempt was made to toggle the switch to the On condition, the switch frame arms were found to be jammed. They did not move freely. Inspection as to the cause revealed that there was some debris evident on the frame which appeared to be dirt/mortar/sand possibly from the construction of the building. It could not be determined if some of this debris had become dislodged during the removal, transportation and storage of the panel to cause the jam or if it had been jammed prior to removal from the building. After some gentle manipulation by hand it moved freely. In our opinion, forceful manipulation of a fitting key would have moved the switch frame arms.
The side wards with the slots for the key to pass through were damaged and bulged outwards. It was evident that some force had been applied to the inside of the side wards on either side. There were marks on the metal where something had pressed against the side wards.
The switch frame arm on the off side was also bent, apparently from excessive force applied to it.
The fireman's drop key of Jeff TURNER (attending Forensic locksmith) was inserted into the lock and turned. They key fitted the slots correctly and was able to pass through the slots and engage the switch frame arms. The key Item ER/1 supplied as an exemplar key was subsequently tried on the lock. The key however fouled on the interior of the side ward on the On side and did not pass through the slot to engage the switch frame arm. The side ward on the Off side was found to be bent more and the key passed through the slot to engage with the switch frame arm.
The two keys were compared side by side and it was evident that there was a slight difference in dimensions. The difference in dimensions was sufficient for the exemplar key to foul on the side wards. If sufficient force was applied, the side wards would bend and the key would be able to be forced through the slots.
My conclusion at this stage was that the side wards and switch frame arm on the Off side were bent due to the use of an ill-fitting key and the use of excessive force. The bent side wards and switch frame arm did not cause the jam experienced at the start of the examination. I was able to turn a key with the correct dimensions in either direction to turn the electronic switch On or Off.
At this stage the examination was suspended in order to source the fireman's drop key alleged to have been used on the night of the fire.

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(Please see original document for image) (Please see original document for image)
Keys in On and Off positions to show the difference in colour indicators

On 29 July 2019 I attended at BRE Watford at the request of the Metropolitan Police Service to examine the recovered fireman's drop key alleged to have been used on 14 June 2017. Other experts and members of the MPS were also present.
The items examined on 15 February 2019 were present in addition to the following exhibit
LJH/67 Lift Key
This was a fireman's drop key, similar to the other keys examined on 15 February 2019. It appeared new and there was no apparent damage from normal use. It did not have any brand markings or other identifying markings.
It was visually compared to the ill-fitting key, Item ER/1, examined on 15 February. The differences in key dimensions were immediately apparent. The hinged part of the key, Item LJH/67 that had to pass though the slots in the side wards, was longer by several millimeters and the slots in the key were several millimetres displaced compared to the key, ER/1.

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The key was tried on the fire control panel, Item BJG/74 and the dimensions were found to be so grossly different that the key was un-useable on the fire control panel (in its current as well as undamaged condition). It was capable of being inserted in the aperture but could not be turned. It fouled completely on the side wards and even if excessive force had been applied, it would not be able to bend the side wards sufficiently to pass through the slots to engage with the switch frame arm and toggle the electronic switch. Due to misalignment, we concluded that the key could not have caused the damage observed on the side wards and on the switch frame arm on the fire control panel, Item BJG/74.
The key was also tried on the exemplar panel, Item ER/2, with the same results.

(Please see original document for image) Key LJH/67 at the top and KEY ER/1 at the bottom

(Please see original document for image) Key ER/1 at the top and Key LJH/67 at the bottom

(Please see original document for image) LJH/67 fouling completely on the side ward of panel PJG/74

Conclusions:
In my opinion:
No vandalism or tampering with the fire panel, Item BJG/74 was observed. The metal side wards and the switch frame arm on the Off side were bent out of shape and there were visible scuff marks on the side wards where a drop key had been forced against them. The damage we observed on the lock mechanism was caused by someone forcing a slightly ill-fitting key in both directions, to such an extent that the side wards were bent. The side ward on the Off side appears to have been bent sufficiently for the key to pass through the slot and engage with metal switch frame arm which was bent from apparently forcefully trying to get the switch to work. I am unable to determine when this took place. It may have been before, during or after the fire.
If this had happened prior to the fire incident, the fire fighter would have been able to turn a fitting key in the damaged lock in either direction. One direction would have had more movement than the other.
When I first examined the fire control panel, the switch frame arm was jammed by apparent building debris caught between the arm and the frame. Gentle manipulation by hand freed it. I am unable to determine when this occurred. In my opinion, forceful manipulation of a fitting key would have moved the mechanism.
Observations which may affect public safety
I observed differences in the labelling and visual colour indicators on the fire control panels I examined. On one panel, green indicated Off and on the other panel red indicated Off. On one panel the electronic switch circuit was open in the Off position and on the other panel it was closed in the Off position. On one panel the terms On and Off were used and on the other panel the letters 0 and 1 were used.

There are drop keys available for purchase on the internet which do not fit the fire control panels installed in buildings. This can have serious implications for firefighting operations during a fire.

Report provided by: Andre HORNE BMedSci
Signature:
Address Royal Armouries, Armouries Drive, Leeds, LS10 1LT
Telephone number: [redacted]
Declaration
All the information I have given in the following certificate is true to the best of my knowledge and belief. I will notify those instructing me of any change in this information. I am aware that

any false or misleading information I have given in this document, or any deliberate omission of relevant information may lead to disciplinary or criminal proceedings.
Expert Witness Declaration Form
I am an expert in the subject matters discussed and I have been requested to provide a report. I confirm that I have read guidance contained in a booklet known as Disclosure: Expert's evidence and unused material which details my role and documents my responsibilities, in relation to revelation as an expert witness. I have followed the guidance and recognise the continuing nature of my responsibilities of revelation. In accordance with my duties of revelation, as documented in the guidance booklet, I
(a) confirm that I have complied with my duties to record, retain and reveal material in accordance with the Criminal Procedure and Investigations Act 1996, as amended.
(b) have compiled an Index of all material. I will ensure that the Index is updated in the event I am provided with or generate additional material;
(c) that in the event my opinion changes on any material issue, I will inform the investigating officer, as soon as reasonably practicable and give reasons.
Expert Witnesses Self-Certificate
Revelation of information (Criminal Procedure and Investigations Act 1996)
Name of Expert Witness: Andre HORNE
Date of birth: [redacted]
Signature:
Defendant Name(s):
Address: Royal Armouries Drive, Leeds, LS10 1LT
I have been instructed to provide expert evidence in relation to the prosecution of the above-named, or an investigation into the following criminal offence: Simple supply (up to 3 items)
I confirm that I have read the booklet known as Disclosure: Experts evidence and unused material, that has been given to me with the form, and that I am aware of my responsibilities as an expert witness to reveal to the Prosecution Team any information that might undermine my evidence.
Personal Information
1. Have you ever been convicted of, cautioned for, or received a penalty notice for, any criminal offence (other than minor traffic offences)? [redacted]
2. Are there any proceedings pending against you in any criminal or civil court? [redacted]
3. Are you aware of any adverse finding by a judge, magistrate or coroner about your professional competence or credibility as a witness? [redacted]
4. Have you ever been the subject of any adverse findings by a professional or regulatory body? [redacted]
5. Are there any proceedings, referrals or investigations pending against you that have been brought by a professional or regulatory body? [redacted]
6. Are you aware of any other information that you think may adversely affect your professional competence and credibility as an expert witness? [redacted]

Name of Expert Witness: Andre HORNE
Signature:

Page 12 of 12

Appendix 8

MET00065879

BRE Client Report

GT Site Report

Report Number: P116337-1001

Issue: 1

Dated 10 February 2020

www.bre.co.uk

BRE Client Report

GT site report

Prepared for: Martin Tucker

Date: 10 February 2020

Report Number: P116337-1001 Issue: 1

BRE

Watford, Herts

WD25 9XX

Customer Services [redacted]

From outside the UK:

Prepared for:
Martin Tucker
Forensic Manager
Operation Northleigh (Grenfell Tower Fire)
Metropolitan Police
Unit 25, Deer Park Road
Wimbledon
SW19 3TL

www.bre.co.uk

Prepared by

Name Eman Mattie-Suleiman and David Butler

Position Technical Development Director and Principal HVAC Consultant

Date 10 February 2020

Signature

Authorised by

Name Julie Bregulla

Position Director, Fire and Building Technology Group

Date 10 February 2020

Signature

bre

Executive Summary

The Metropolitan Police Service (MPS) requested BRE to investigate the operation of the smoke detection system. This led to the work program which included the review of various documentation and visits to Grenfell Tower by the BRE team during December and February 2019.

The aim of the visit was to determine the as-built installation of the smoke detection system, locating the various control panels and devices and tracing the connections between them before labelling and removing key items from site.

The ultimate objective was to gain a greater awareness of the operation of the smoke detection system and answer specific questions raised by the MPS.

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Table of Contents

1 Introduction

This report summarises the work done, and observations made on site by BRE in February 2019 in relation to the fire detection system installed in Grenfell Tower.

The work was undertaken at the request of Mr Martin Tucker, Forensic Manager, Operation Northleigh (Grenfell Tower Fire), Metropolitan Police Service (MPS).

The overall objective of this work was to gain a greater awareness of the operation of the smoke detection system; determine why the lift did not return to the ground floor upon activation of the smoke detection system; and determine why the smoke vent opened on the 11th floor.

This report summarises the work undertaken by BRE on site during February 2019 to identify relevant components and wiring associated with the Master Panel and Outstations of the smoke detection system in the building, and the labelling of these components before their removal by MPS officers.

The report is not intended to provide any expert opinion on the possible operation of the system or provide any wiring diagrams. All photographs shown in this report were taken by BRE staff.

BRE's site inspection undertaken in February 2019 was led by Eman Mattie-Suleiman (Technical Development Director) and David Butler (Principal HVAC Consultant).

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2 Identification of smoke detection system components

2.1 Overview of smoke detection system components

The smoke detection system was manufactured by PSB-UK Ltd. A schematic of the system is shown in PSB Drawing 800 and the accompanying PSB Wiring Tables (not reproduced in this report).

BRE visually inspected the system panels, and where accessible the interconnection between the panels and their wiring to the other system components including fans, dampers, detectors, fireman's override switches and pressure transducers.

The system panels comprise:

- Master Panel containing PLC (PLC was removed) and one Modbus I/O board, located in ground floor Hub Room
- Inverter Panel 1 containing one Modbus I/O board and inverters for ground floor fans, located in ground floor Hub Room
- HMI Panel incorporating a touch screen and Fireman's Override Switch, located on wall in ground floor lobby
- Inverter Panel 2 containing one Modbus I/O board and inverters for roof level smoke extract fans, located in Roof Plant Room
- 9 Battery Back-up Panels (located on approximately every other floor)
- 22 Outstation panels located on floors 2 to 23, each containing one Modbus I/O board with exception of Outstation O/S 1 contained three Modbus I/O boards.

All of the panels, except the Battery Back-up Panels, were connected to the PLC within the Master Panel by RS-485 MODBUS™ digital communication.

The Modbus I/O boards in the Master Panel and Outstation Panels provided digital inputs and outputs to the smoke dampers, smoke detectors, detector relay, pressure switches and Fireman's Override Switches. The Inverter Panels provided speed control of the smoke extract and environmental supply and extract fans and control of the fan dampers.

A list of the system panels and connected devices, confirmed by BRE visual inspection, is shown in **Table 1**.

Note that the Boxing Club smoke detector (underside of ceiling in Boxing Club lobby) was covered with a red plastic cover (usually used to prevent false alarms during building maintenance related works).

Table 1: List of system panels and connected devices confirmed by BRE visual inspection

System Panel	Location	Connected devices (external to panel)
Master Panel	Hub room on ground floor	MODBUS link to Inverter Panel 1 MODBUS link to HMI Panel Fireman's switch at HMI Panel

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		24 volt supply to HMI MODBUS to all Outstations Multi-core cable to BMS in basement providing: • Outputs (volt-free relay contacts) to signal critical fault, system fault, battery fault and fire detected • Input from BMS for environmental temperature Ground floor lift lobby smoke dampers (24volt outputs) Ground floor lift lobby smoke detector, Fireman's switch and pressure switch (inputs) 1st floor lift lobby smoke dampers (24volt outputs) 1st floor lift lobby smoke detector, Fireman's switch and pressure switch (inputs) Note: smoke detector cables include 24 volt supply to the detector
Inverter Panel 1	Hub room on ground floor	MODBUS to Master Panel 3-phase power input 3-phase power output from inverter to main smoke extract fan 3-phase power output from inverter to back-up smoke extract fan 3-phase power output to environmental fan Ground floor entrance lobby smoke extract fan inlet and outlet dampers (single 24 volt output) Ground floor entrance lobby environmental fan inlet and outlet dampers (single 24 volt output)
HMI	Ground floor lobby	MODBUS to Master Panel* *same cable Fireman's override switch to Master Panel* 24volt supply from Master Panel
Outstation Panel (O/S) 1	Service riser on 2nd floor lift lobby	MODBUS input from Master Panel MODBUS output to O/S 2 24volt supply input from battery backup panel 24volt supply output

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		2nd floor lift lobby smoke dampers (24 volt outputs) 2nd floor lift lobby smoke detector, Fireman's switch and pressure switch (inputs) Ground floor Community Room AOV (window opening actuator) (24volt output) Ground floor Community Room smoke detector and Fireman's switch 2nd floor lift lobby smoke dampers (24volt outputs) 2nd floor lift lobby smoke detector, Fireman's switch and pressure switch (inputs) 2nd floor boxing club lobby AOV (window opening actuator) (24volt output) 2nd floor boxing club lobby smoke detector and Fireman's switch Note: smoke detector cables include 24 volt supply to the detector
Outstation Panels (O/S) 2 to 22	In lift lobby pipe riser cupboard (O/S2 in dry riser behind MDF wall panel)	MODBUS input MODBUS output 24volt supply input 24volt supply output Lift lobby smoke dampers (24 volt outputs) Lift lobby smoke detector, Fireman's switch and pressure switch (inputs) Notes: 1. Lift lobby smoke dampers are connected to same O/S terminals and therefore operate simultaneously 2. Smoke detector cable includes 24 volt supply to the detector
Inverter Panel 2	Roof plant room	MODBUS output 24volt supply output 3-phase power input 3-phase power output from inverter to main extract fan 3-phase power output from inverter to backup extract fan Note: The PSB Wiring Table for Inverter Panel 2 showed wiring connections to several external devices that BRE

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		visual inspection showed had not been installed. These were: 3-wire Changeover Damper, 2-wire Changeover Damper and Environmental Fan.

2.2 PSB Modbus I/O board addresses (slave nos.)

Each of the smoke extract system panels (Master Panel, Outstations, Inverter Panels) had one PSB MODBUS™ I/0 board which provided digital inputs and outputs and RS-485 MODBUS™ communications with other boards in the Smoke Detection System.

Outstation 1 (2^{nd} floor) was the exception in that it had three individually addressed Modbus I/O boards, stacked on top of each other.

Each PSB MODBUS™ I/O board had a unique address determined by the switch settings on an 8-way DIP switch on the board. The board address was also handwritten on most boards. The DIP switches are binary coded such that when an individual switch way is ON it represents a numeric value and the sum of these values is the address setting of the board, see

Table 22.

The majority of the PSB Modbus I/O boards were MK1 versions although there were three MK2 boards, see

Table 2.

The PSB Wiring Tables refer to the Modbus I/O board address as "Slave No."

Table 2: I/O board address code

SW way	1	2	3	4	5	6	7	8
Value when ON	1	2	4	8	16	32	64	128

In the following example the address is 46:

SW way	1	2	3	4	5	6	7	8
SW setting	OFF	ON	ON	ON	OFF	ON	OFF	OFF
Value	0	2	4	8	0	32	0	0

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Table 3: Modbus I/O board addresses visually confirmed by BRE

Floor	System Panel	MK of board	Handwritten address	DIP SW
Roof	Inverter Panel 2	2	11	11
23	O/S 22	1	94	94
22	O/S 21	1	91	91
21	O/S 20	1	88	88
20	O/S 19	1	85	85
19	O/S 18	1	82	82
18	O/S 17	1	79	79
17	O/S 16	2	Blank	76
16	O/S 15	2	Blank	73
15	O/S 14	1	70	70
14	O/S 13	1	67	67
13	O/S 12	1	64	64
12	O/S 11	1	61	61
11	O/S 10	1	58	58
10	O/S 9	1	55	55
9	O/S 8	1	52	52
8	O/S 7	1	49	49
7	O/S 6	1	46	46
6	O/S 5	1	43	43
5	O/S 4	1	40	40
4	O/S 3	1	37	37
3	O/S 2	1	34	34
2	O/S 1	1	33*	33*
2	O/S 1	1	32*	32*
2	O/S 1	1	31*	31*
Ground	Master Panel	1	1	1
Ground	Inverter Panel 1	1	6	6

* Outstation O/S 1 has three stacked Modbus I/O boards. Addresses of the lower two boards were not confirmed visually since it would have required some dismantling. Board addresses have been assumed to be as indicated in the PSB Wiring Tables that accompany PSB Drawing 800.

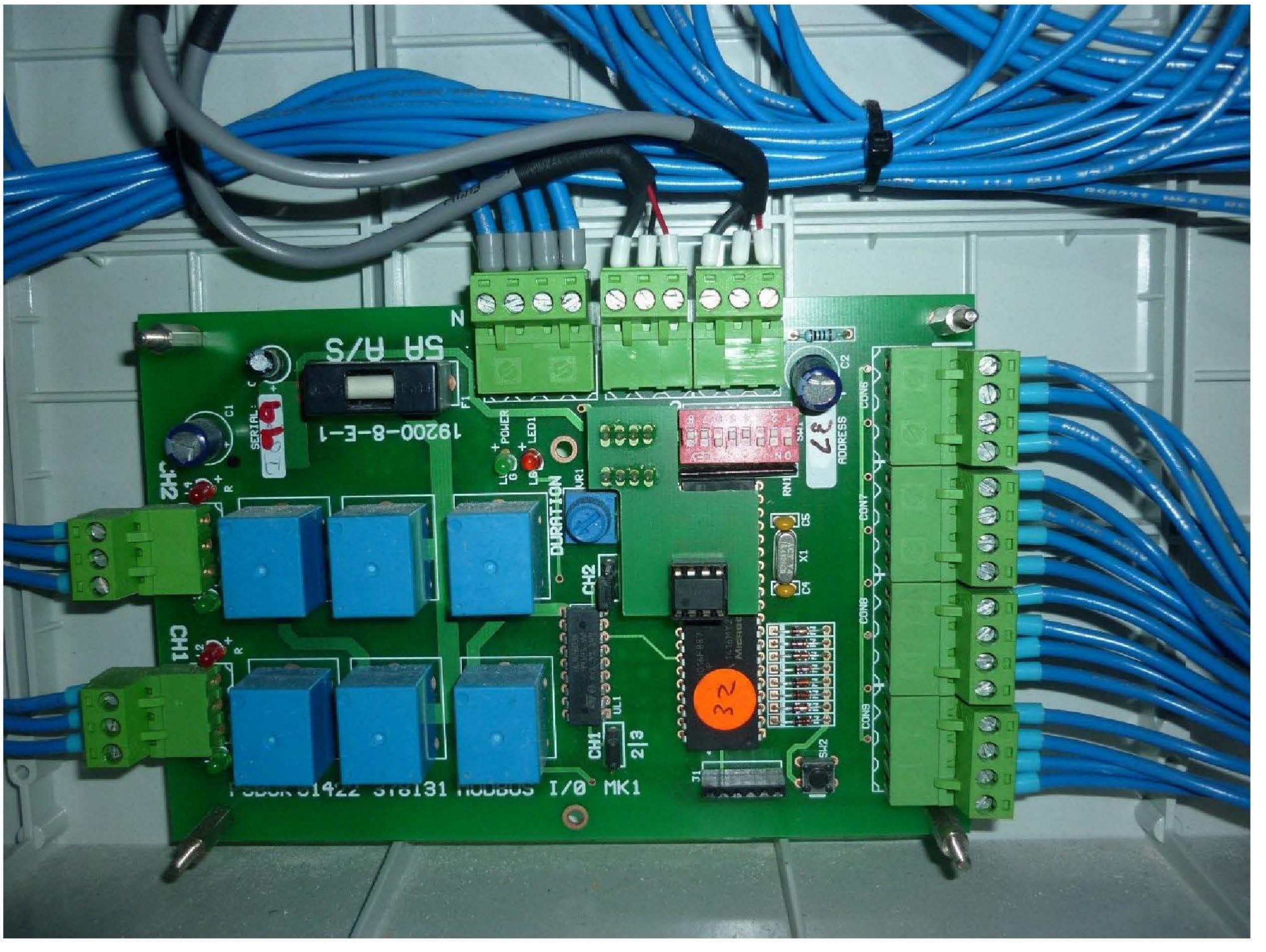

Figure 1: Example MK1 Modbus I/O board in Outstation O/S 3, 4th floor (address = 37)

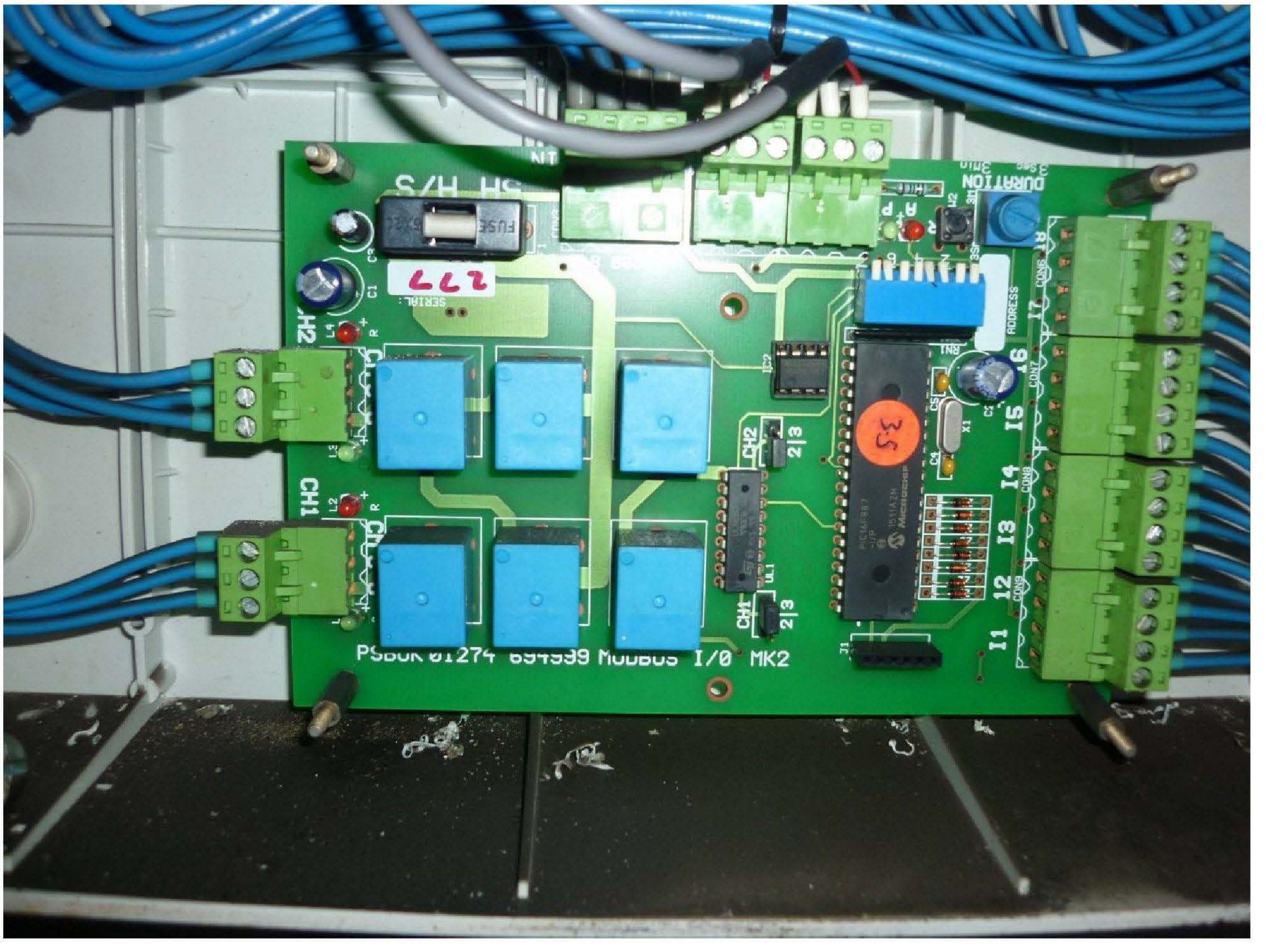

Figure 2: Example MK2 Modbus I/O board in Outstation O/S 16, 17th floor (address = 76)

Note: No handwritten address on this particular board

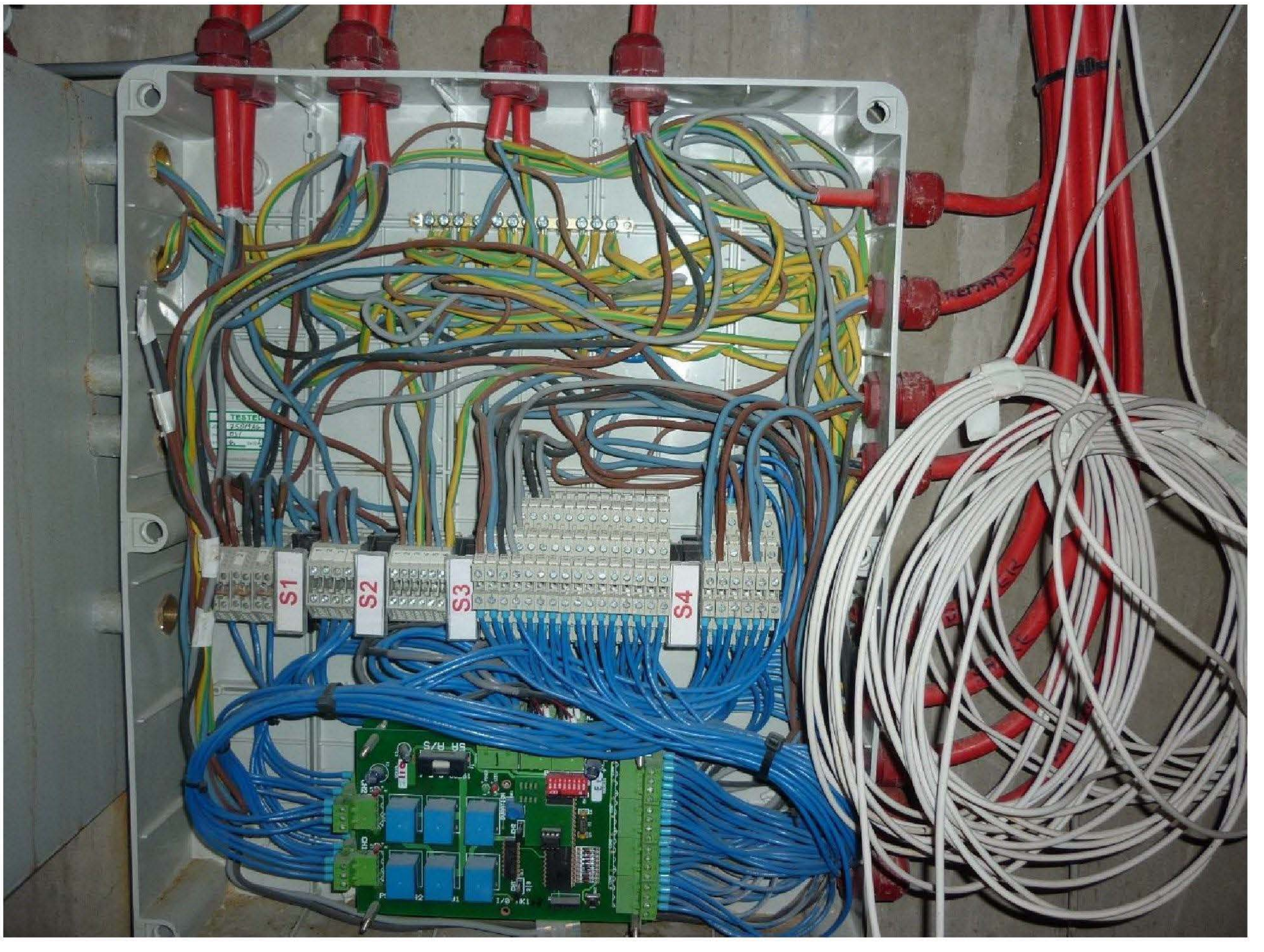

Figure 3: Outstation O/S 1 (2nd floor), exceptionally had three stacked Modbus I/O boards

2.3 Preparation and labelling of System Panels

Prior to removal of the System Panels BRE visually identified and confirmed the presence of all external devices connected to the panels by external cables. The cables wherever possible were labelled by writing on the them and then a coloured cable tie was attached to the cable either side of where the cable was subsequently cut.

The cable tie colours followed a colour scheme according to the type of device connected to the cable, as shown in **Table 4**. If there was more than one device of the same type then additional cable ties were attached, for example, the first damper cable had one cable tie either side of the cut, the second damper cable had two cables ties either side of the cut, and so on.

Each panel was photographed as-found and after cable ties had been attached, and finally the space left was photographed to show the remaining cables.

Table 4: Colours of cable ties used to identify the function of external cables to the System Panels

Cable tie colour	Device connected to cable
White	MODBUS Output
Black	MODBUS Input
Yellow	Smoke detector
Green	Pressure switch
Purple	Fireman's override switch
Blue	Damper north
Red	Damper south
Grey	24volt power
Light orange	used for other cables as required
Dark orange	used for other cables as required

2.4 Master Panel external wiring connections

The connections from the master panel were checked and each cable was tagged according to the cable tie colour code in **Table 4**. Each external cable from the Master Panel was traced visually, and when possible confirmed using an electrical continuity test, to identify the Master Panel cable connections, as detailed in Table 5**.**

Table 5 is based on the PSB Wiring Tables but with confirmation and additional information from BRE's visual inspection.

Several photographs were taken in relation with the Master controller to demonstrate the overall cabinet with cable ties, detail of the cable ties, lower section cables, and when the Master controller was removed. (see Figure 5, Figure 6, Figure 7and Figure 8).

It should be noted that while checking the connection from Terminal X3/7 to the 1st floor lift lobby pressure switch continuity testing showed no electrical continuity. Inspection showed that the wire was lose in the terminal due to the terminal screw not having been tightened, as shown by the exposed copper core having no marks, see Figure 9.

NOTE: An error was made when reinstating two cables after an electrical continuity test by BRE. Brown wire in X8/4 should go to X8/7, and blue wire in X8/5 should go to X8/8, see **Figure 10*.***

bre

Table 5: Cable connections to Master Panel

Terminal	Function	Comments
X3/1 X3/2	Ground floor lift lobby pressure SW	
X3/3 X3/4	Ground floor lift lobby Fireman's SW	
X3/5 X3/6	Ground floor lift lobby smoke detector	
X3/7 X3/8	1st floor lift lobby pressure SW	
X3/9 X3/10	1st floor lift lobby Fireman's SW	
X3/11 X3/12	1st floor lift lobby smoke detector	
X3/13 X3/14	Temperature signal from BMS	Part of multi-core core cable to BMS (see below)
X3/15 to X3/22	nc	
X4/1 X4/2 X4/3	Ground floor lift lobby lower smoke damper in wall	
X4/4 X4/5 X4/6	Ground floor lift lobby upper smoke damper in riser ceiling	
X4/7 X4/8 X4/9	1st floor lift lobby upper smoke damper	
X4/10 X4/11 X4/12	1st floor lift lobby lower smoke damper	
X4/13 to X4/20	nc	
X5/1 X5/2 X5/3 X5/4 X5/5 X5/6	Outputs to BMS	Multi-core cable to the BMS

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Terminal	Function	Comments
X5/7		
X5/8		
X5/9		
X5/10		
X5/11		
X5/12		
X7/1	Ground	
X7/2	24v to HMI	
X7/3		
X7/4	COMMS to HMI	1 cable
X7/5		
X7/6	SG	
X7/7	Fireman's Override Switch at HMI	
X7/8		
X8/1	Inverter Panel1 X8/1	
X8/2	Inverter Panel1 X8/2	
X8/3	Inverter Panel1 X8/3	
X8/4	nc	
X8/5	nc	
X8/6	nc	
X8/7	O/S 1 S2/1	MODBUS to O/S 1
X8/8	O/S 1 S2/2	
X8/9	O/S 1 S2/3	
X8/10	Internally linked to X8/7	MODBUS to Inverter Panel1
X8/11	Internally linked to X8/8	
X8/12		
S4/1	Ground floor lift lobby smoke detector 24V supply	Same 4-core cable as detector
S4/2		
S4/3	nc	
S4/4	1st floor lift lobby smoke detector 24V supply	Same 4-core cable as detector
S4/5		
S4/6	nc	
Note: The fireman's override switch is labelled Auto / ON on the front panel of the HMI unit to the right of the touch screen. The HMI unit had been removed from its panel prior to BRE's site visit but a photograph of the unit before it was removed is shown in Figure 4.		

nc = no wire connected

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Figure 4: HMI panel, incorporating touch screen and Fireman's Override Switch

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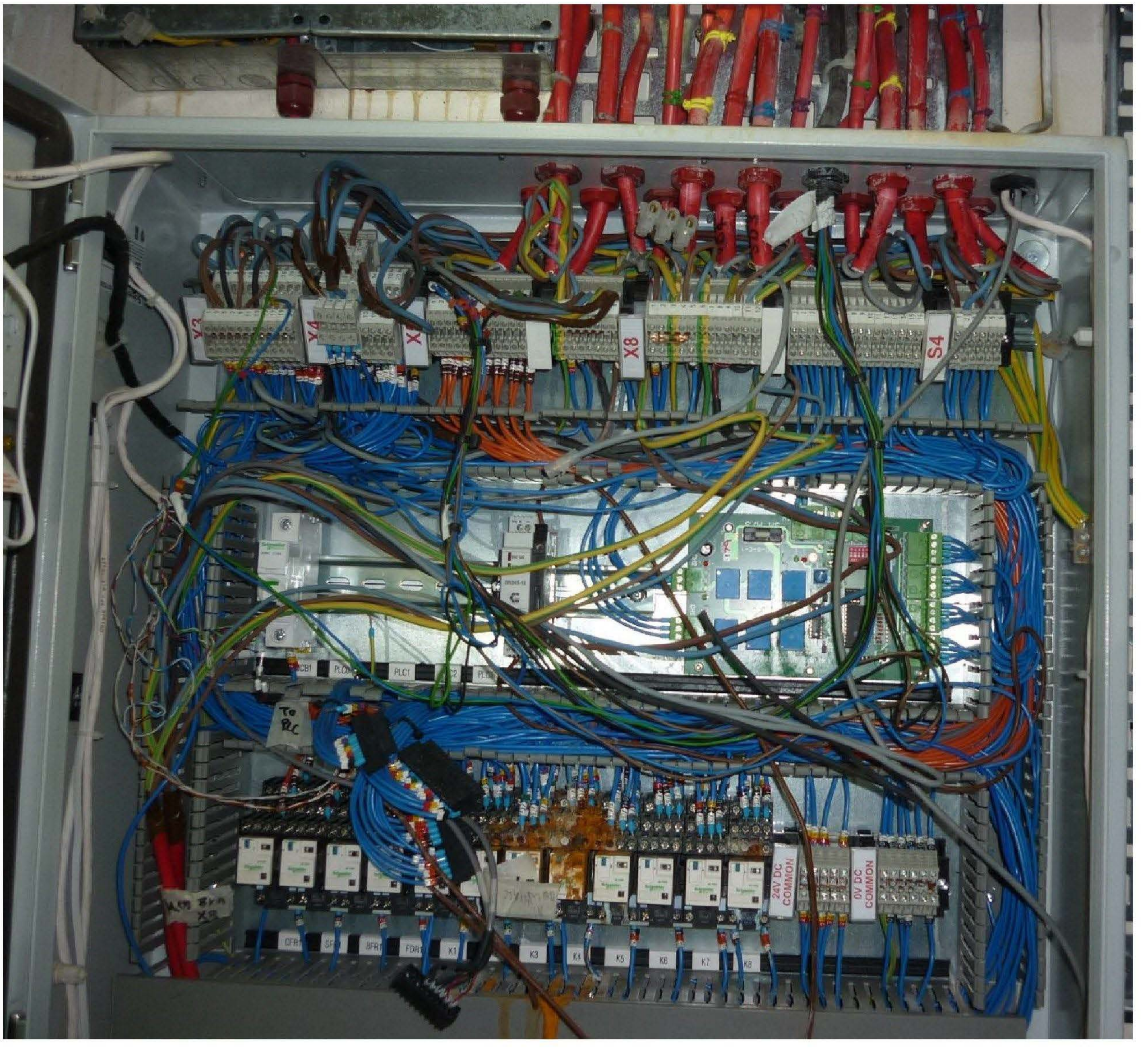

Figure 5: Master Panel with cable ties attached with PLC removed

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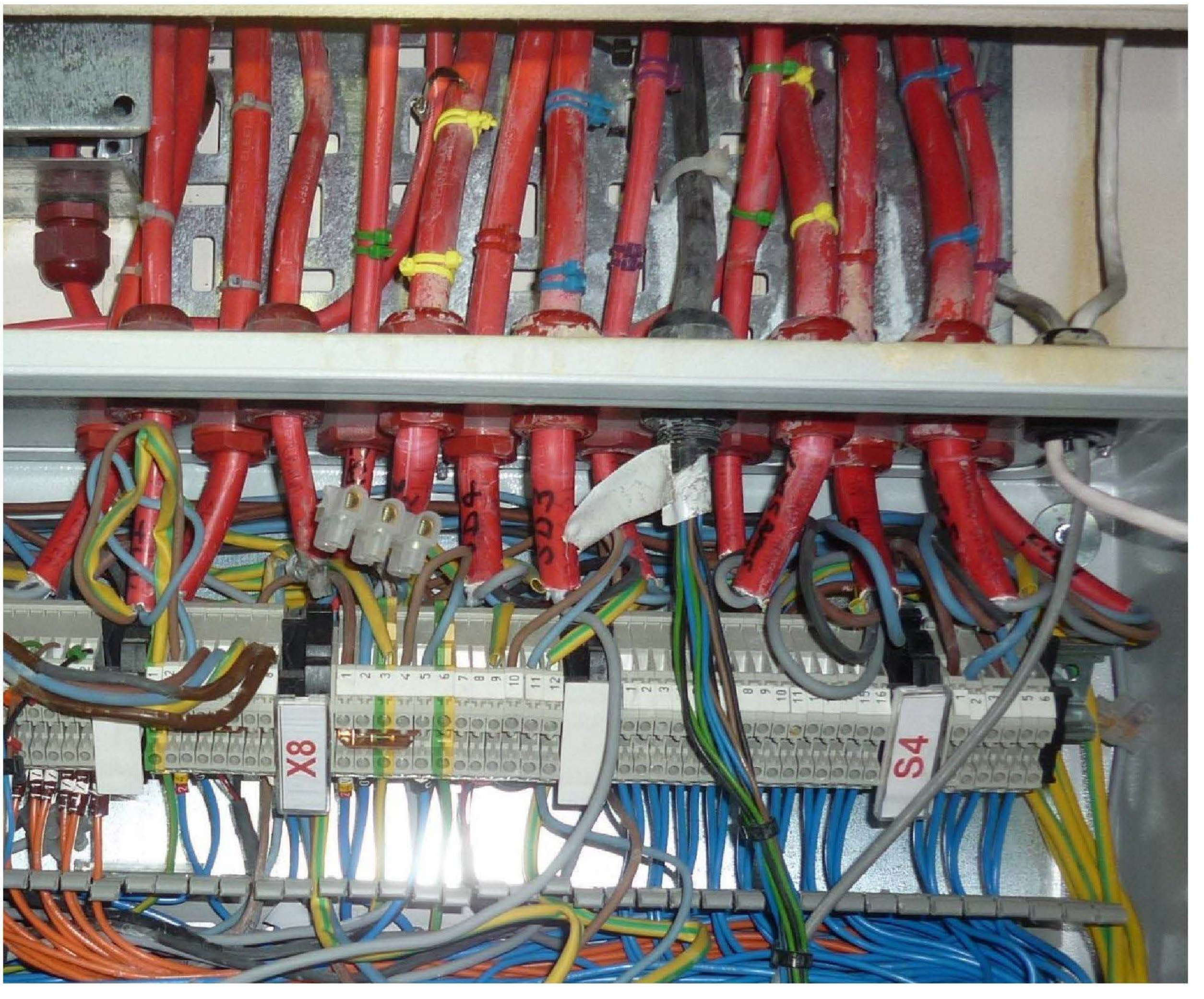

Figure 6: Master Panel – detail of top right cables

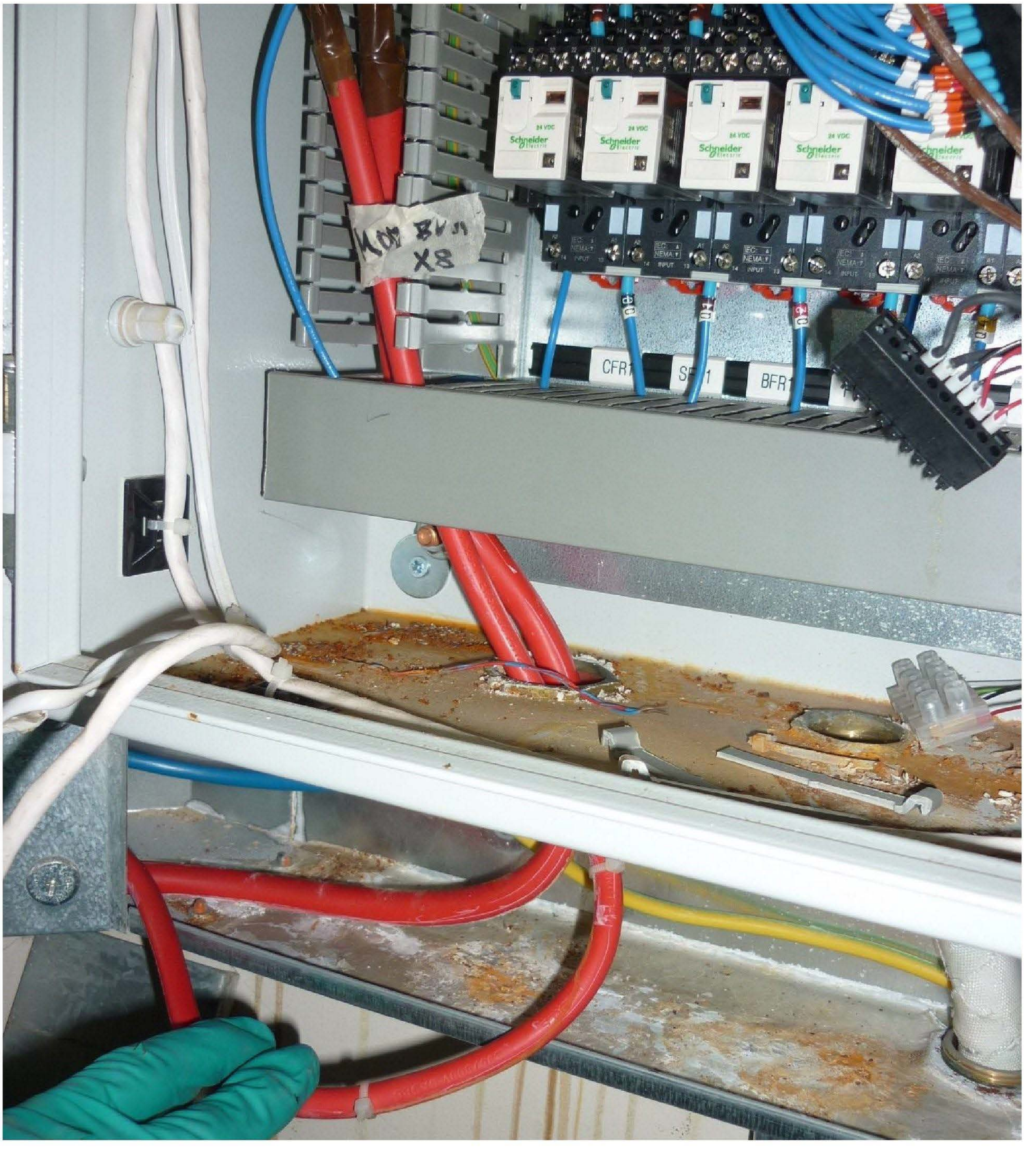

Figure 7: Master Panel – detail of bottom left cables

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Figure 8: Master Panel cables after panel removed

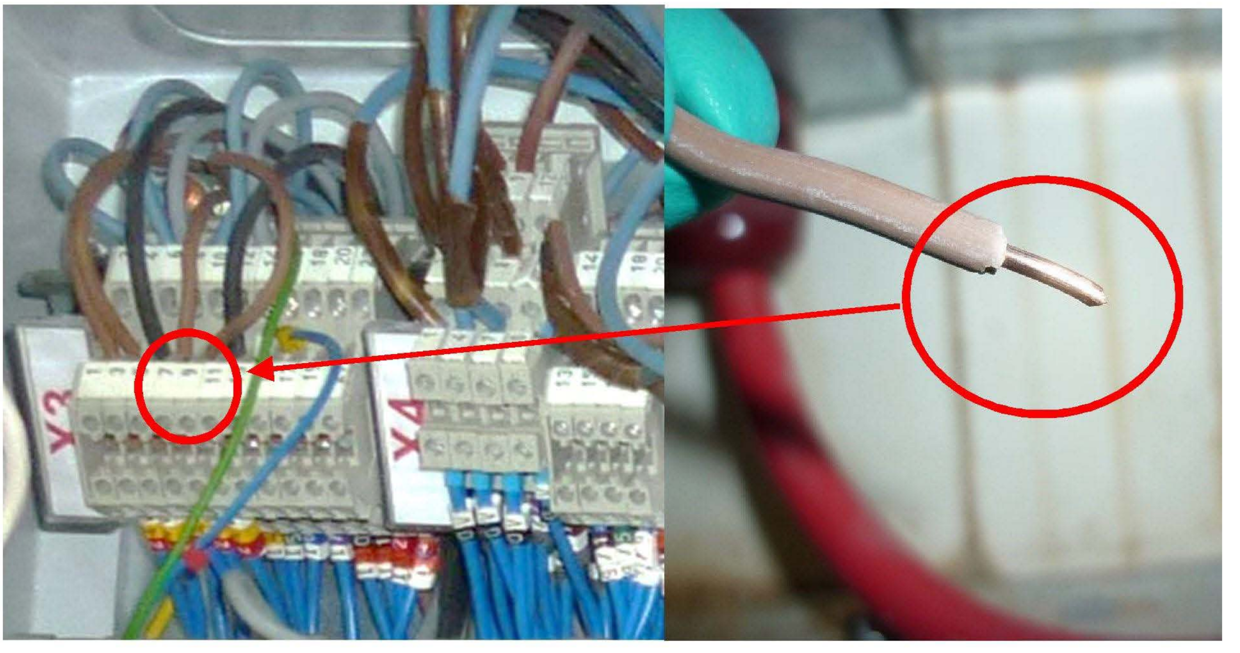

Figure 9: Master Panel - Unsecured wire in Terminal X3/7 failed continuity test

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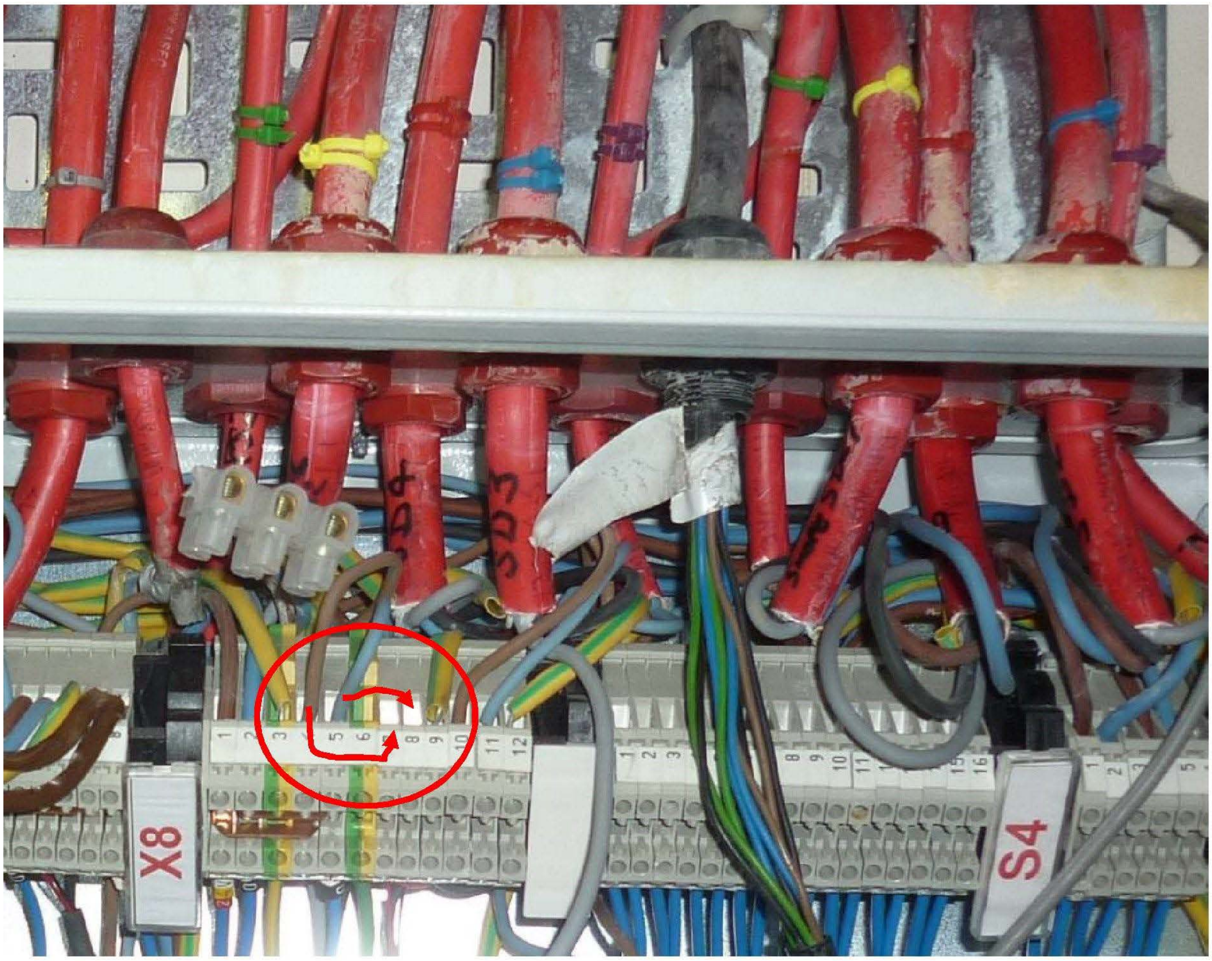

Figure 10: Master Panel - Details of error made when reinstating wires after continuity test

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2.5 Outstation external wiring connections

The external cables from each outstation (O/S) were tagged according to the cable tie colour code in **Table 4**.

Outstation 1 (O/S 1) has more connected devices than all of the other outstations since it also controls the window smoke vents (AOVs) in the Boxing Club and Community Room as well as the 2nd floor lift lobby smoke extract dampers. Table 6 shows the function of the devices connected to the wiring terminals in Outstation O/S 1. A photograph of Outstation O/S 1 is also shown in Figure 11. Note that the lift lobby smoke dampers are 3-wire devices whereas the window smoke AOVs in the Community Room and Boxing Club are 2-wire devices. Table 6 is based on the PSB Wiring Tables but with confirmation and additional information from BRE's visual inspection.

Table 7 shows the function of the devices connected to the wiring terminals in Outstation O/S 8 which is similar to all outstations O/S 2 to O/S 22. Basically, each outstation is connected to components within its floor such as detector, fireman's switch, pressure switch, etc. The Modbus RS-485 is connected to the outstation of the floor below and the outstation at the floor above. Table 7 is based on the PSB Wiring Tables but with confirmation and additional information from BRE's visual inspection.

The wires to the two sets of lift lobby smoke extract dampers are connected to the same O/S terminals (S4/1, S4/2 and S4/3) and therefore both dampers (north and south) operate simultaneously.

The cable to each detector is a 4 core cable, 2 cores supply 24Volts to the detector, and the other 2 cores are for the signal from the detector relay base when the detector is activated, see Figure 12.

The following photos (Figure 13, Figure 14 and Figure 15) show the sequence of steps in the removal of O/S 8 on the 7th floor and its accompanying battery backup panel.

bre

Table 6: Cable connections to Outstation O/S 1

Terminal	Function of connected devices	Comments
S1/1	24v from Battery backup	
S1/2		
S1/3	'Network Output' cable	
S1/4		
S2/1	MODBUS from Master panel	
S2/2		
S2/3		
S2/4	MODBUS to OS2	
S2/5		
S2/6		
S3/1	2nd floor lobby PS	
S3/2		
S3/3	2nd floor lobby Fireman's SW	
S3/4		
S3/5	2nd floor lobby smoke detector	Same cable as detector 24V supply at S4/4, 5
S3/6		
S3/7 to S3/16	nc	
S3/17	Community lobby Firemans SW	
S3/18		
S3/19	Community lobby smoke detector	Same cable as detector 24V supply at S4/10, 11
S3/20		
S3/21 to S3/32	nc	
S3/33	Boxing club Fireman's SW	
S3/34		
S3/35	Boxing club smoke detector	Same cable as detector 24V supply at S4/16, 17
S3/36		
S3/37 to S3/48	nc	
S4/1	2nd floor lobby dampers	3 wire cable Both dampers operate simultaneously
S4/2		
S4/3		
S4/4	2nd floor lobby smoke detector	Same cable as detector to S3/5, 6

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Terminal	Function of connected devices	Comments
S4/5		
S4/6	nc	
S4/7	Community room window AOV	
S4/8		
S4/9	nc	
S4/10	Community room smoke detector	Same cable as detector to S3/19, 20
S4/11		
S4/12	nc	
S4/13	Boxing club lobby window AOV	
S4/14		
S4/15	nc	
S4/16	Boxing lobby smoke detector	Same cable as detector to S3/35, 36
S4/17		
S4/18	nc	

nc = no wire connected to terminal

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Table 7: Cable connections to Outstation O/S 8 (similar to Outstations O/S 2 to O/S 22)

Terminal	Function	Comments
S1/1	24v from Battery backup	
S1/2		
S1/3	'Network Output' cable	
S1/4		
S2/1	MODBUS from O/S 7	
S2/2		
S2/3		
S2/4	MODBUS to O/S 9	
S2/5		
S2/6		
S3/1	Lift lobby PS	
S3/2		
S3/3	Lift lobby Fireman's SW	
S3/4		
S3/5	Lift lobby smoke detector	Same cable as detector 24V supply at S4/4, 5
S3/6		
S3/7	Signal from Battery Backup Panel	Only used in O/S panels with adjacent Battery Backup Panel
S3/8		
S3/9 to S3/16	nc	
S4/1	2nd floor lobby dampers	3 wire cable Both dampers operate simultaneously
S4/2		
S4/3		
S4/4	2nd floor lobby smoke detector	Same cable as detector to S3/5, 6
S4/5		
S4/6	nc	

nc = no wire connected

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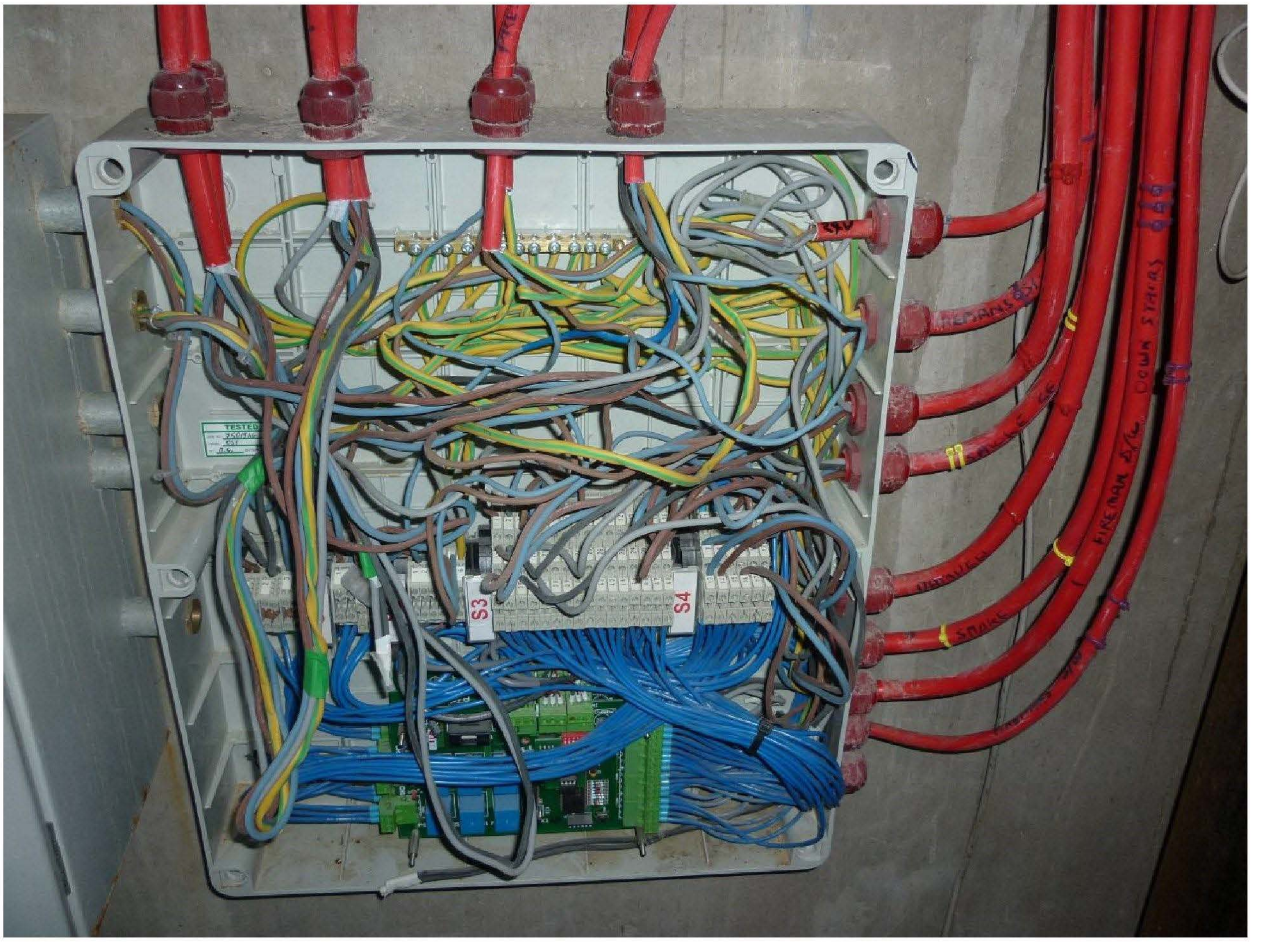

Figure 11: Outstation O/S 1

Figure 12: Typical smoke detector and relay base

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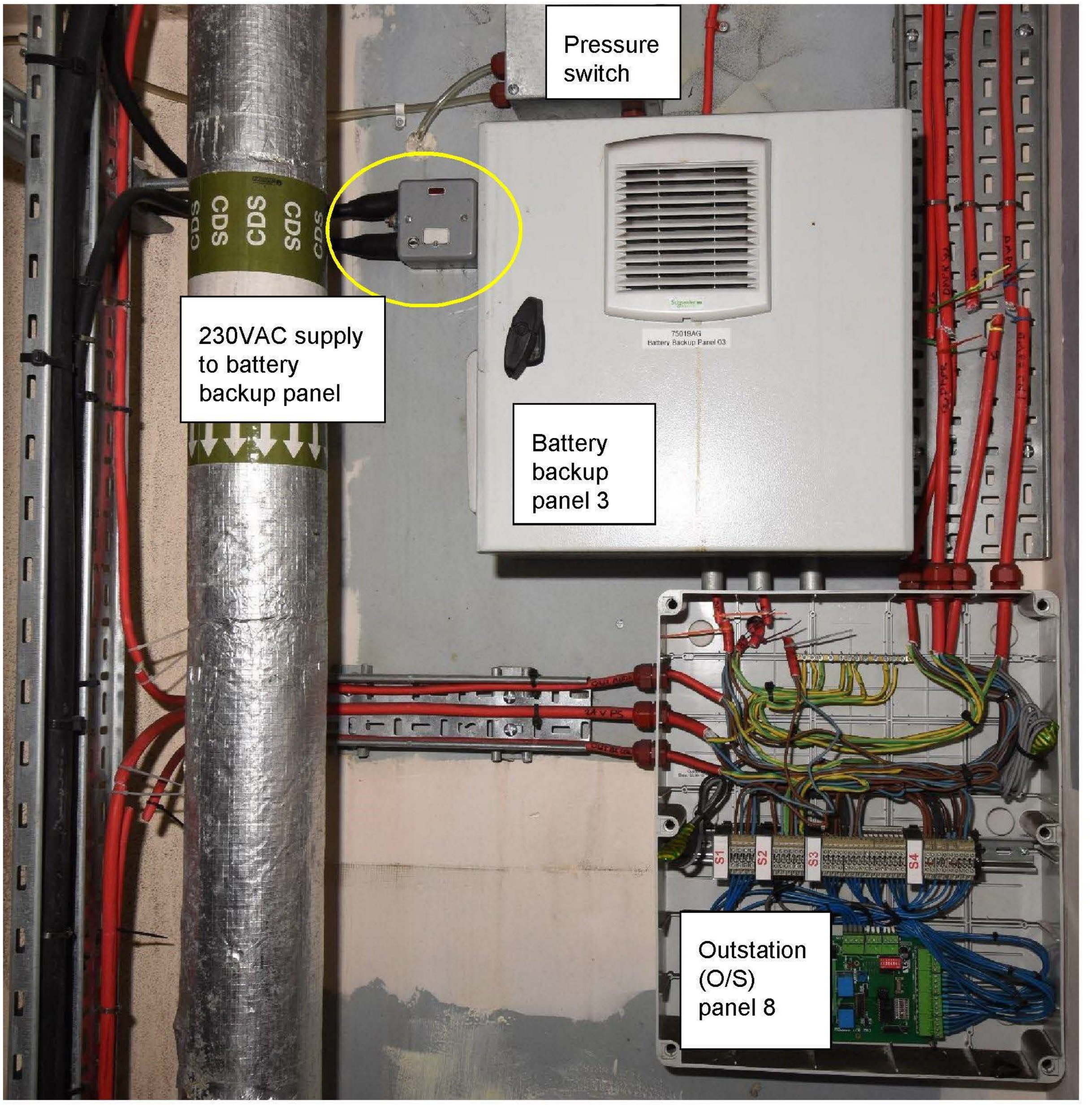

Figure 13: Cables to external devices from Outstation O/S 8 tagged and cut prior to removal of Outstation O/S panel

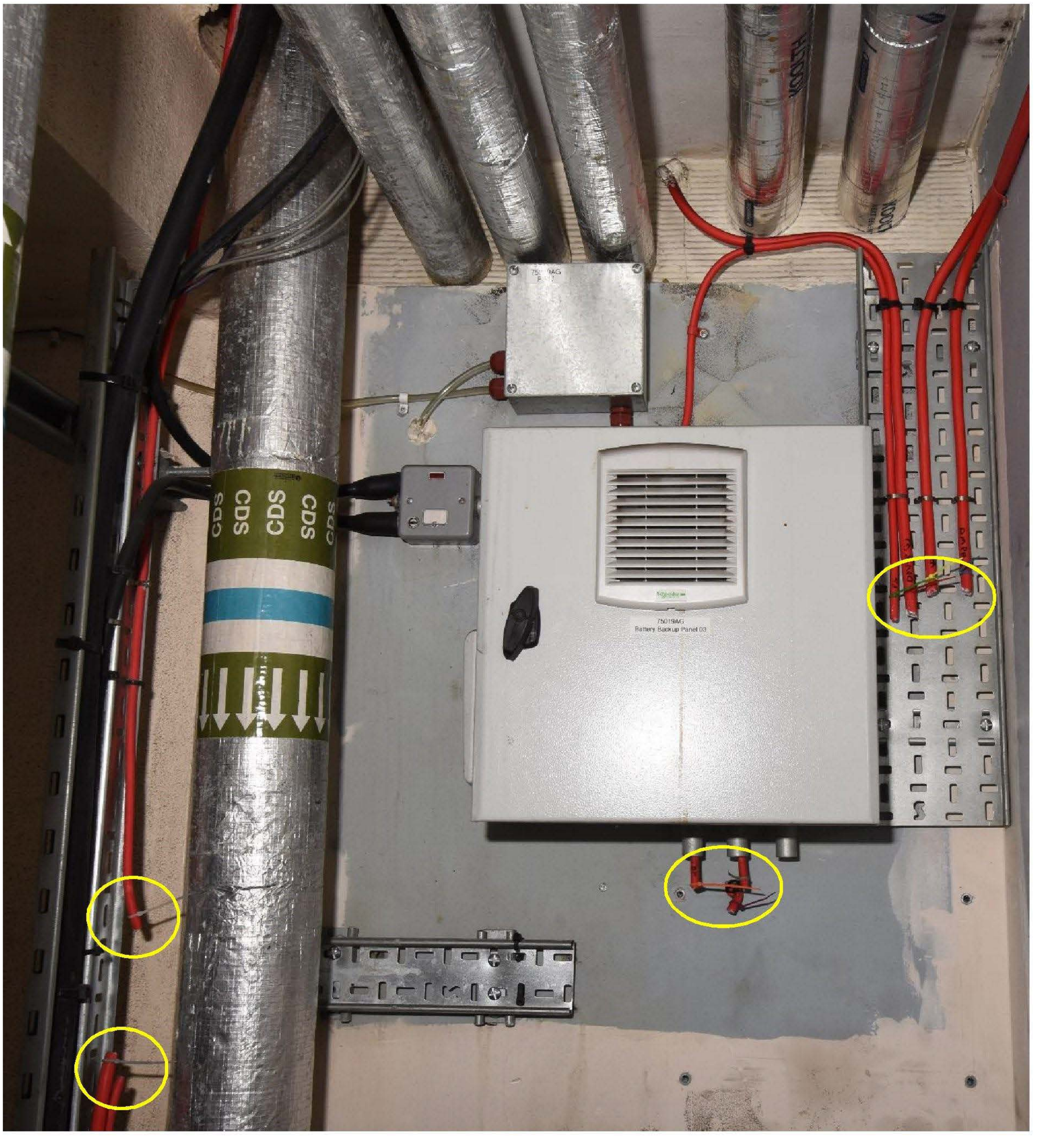

Figure 14: Outstation O/S 8 removed leaving behind cut cables to external devices

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Figure 15: Outstation O/S 8 panel and Battery Backup Panel 03 removed

2.6 Connection between lift controller and smoke detection system

BRE was specifically requested to investigate whether there was a connection between the smoke detection system and the lift controller.

The lift controller had been installed in the lift motor room and had been removed prior to BRE's site inspections in February 2019. However, the metal trunking that contained cables and individual wires to this controller was still in place.

The lift motor room had a fire detector attached to the ceiling, a manual call point close to the entrance door and a sounder/beacon on the wall close to the location of an 'Auxillary Relay Unit' mounting back box (see Figure 16 and Figure 17). The Auxillary Relay Unit had been removed as a Police Exhibit but its

mounting back box and fixed wiring was still in place. A photograph of the Auxillary Relay Unit (inspected by BRE at MPS Wimbledon) is shown in Figure 18.

Figure 18 shows a black wire and a brown wire connected to the 1NO and 1C relay contacts. These wires were traced visually and by an electrical continuity tester from the auxiliary relay mounting back box (auxiliary unit removed) to the black and brown wires in the metal trunking cut close to where the trunking would have met the lift controller panel (See Figure 19).

Figure 18 shows 2 pairs of wires (24V DC+ brown and grey / 24V DC - black and blue) connected to the 24V coil of the Auxillary Relay Unit. These wires were part of a 4 core cable which was traced from the Auxillary Relay Unit mounting back box to the sounder/beacon located on the same section of wall. The connections at the base to the sounder/beacon are shown in Figure 20. The brown and blue wires from the Auxillary Relay Unit mounting back box are seen to pass into and out of the sounder / beacon. The brown and blue wires coming out of the sounder / beacon are part of a second 4 core cable that passes through the wall from the lift motor room to the next-door plant room (containing large water tanks). The black and grey wires bypass the sounder / beacon and are joined to the second cable that carries the brown and blue wires from the sounder / beacon. Electrical continuity testing confirmed that the sounder / beacon was connected to the to the Auxillary Relay Unit coil (brown and blue wires). Therefore, energisation of the Auxillary Relay Unit would also cause the sounder / beacon to operate.

The 3 cables from the lift motor room sounder / beacon, detector and manual call point passed through the wall to the next-door plant room containing large water tanks (see Figure 21). Tracing these cables to the adjoining plant room showed one cable descended down the wall and 2 of 2-core cables entered a wiring junction box mounted on the wall. A 2-core cable exited the bottom of the wiring junction box and ran down the wall alongside a second cable that ran directly from the lift motor room. Electrical continuity testing confirmed that the cable running directly from the lift motor room was the 4-core cable that was connected to the Auxillary Relay Unit and the sounder / beacon in the lift motor room.

The two cables (one 2-core cable from the junction box, one 4-core cable from Auxillary Relay Unit via sounder/beacon) (See Figure 21 and Figure 22) were traced visually and appeared to pass through the floor to the 23rd floor below. The cables were traced visually from the 23rd floor down each floor until the ground floor riser (see Figure 23). These cables were traced physically from the ground floor riser to the plant room by physically pulling them upwards and removing in sections on a floor by floor basis.

Both these cables terminated unconnected inside the ground floor riser, with straight cut ends (no protection from unintended electrical connection), see SOCO photographs. There was also a third unconnected cable. None of these cables were labelled.

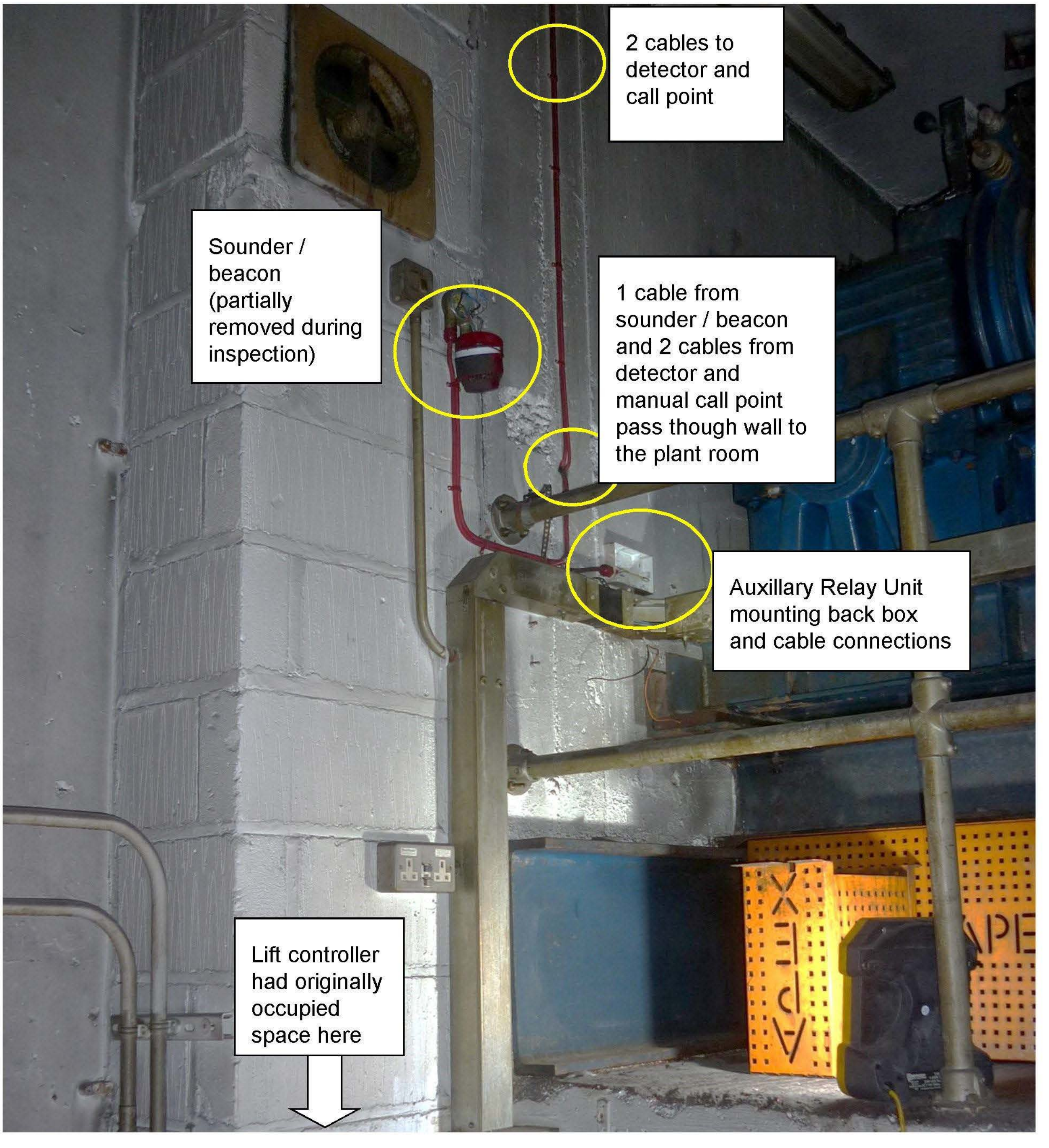

Figure 16: Cables, sounder / beacon and Auxillary Relay Unit mounting back box adjacent to position of lift controller

Figure 17: Manual call point and smoke detector in lift motor room

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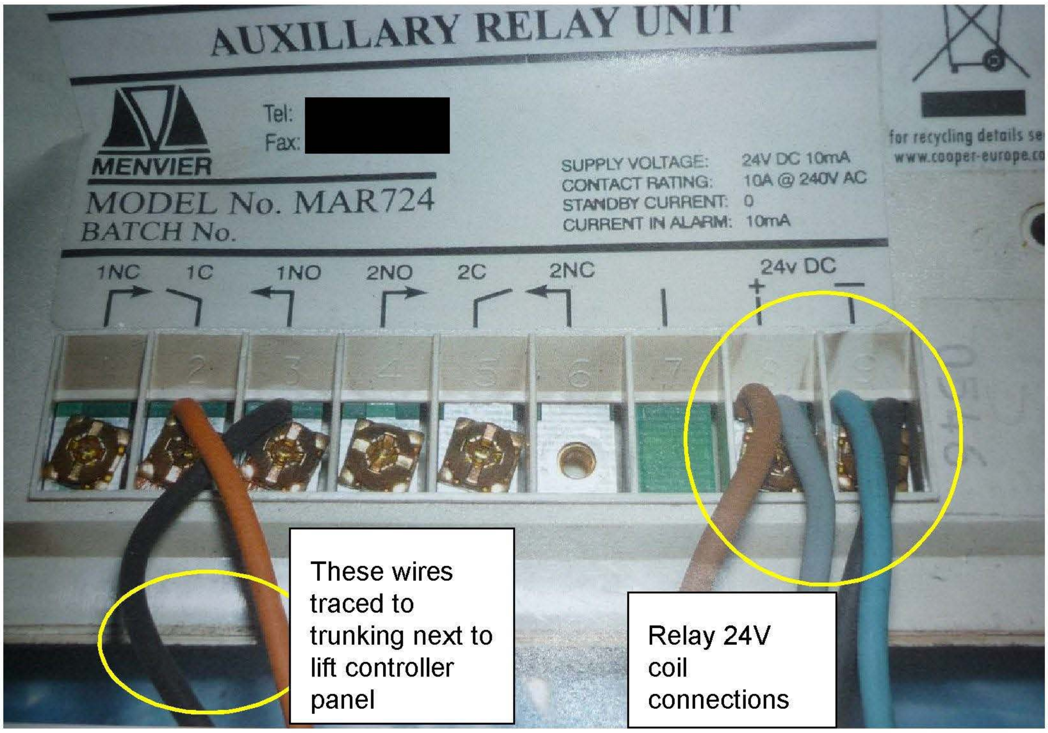

Figure 18: Auxillary Relay Unit

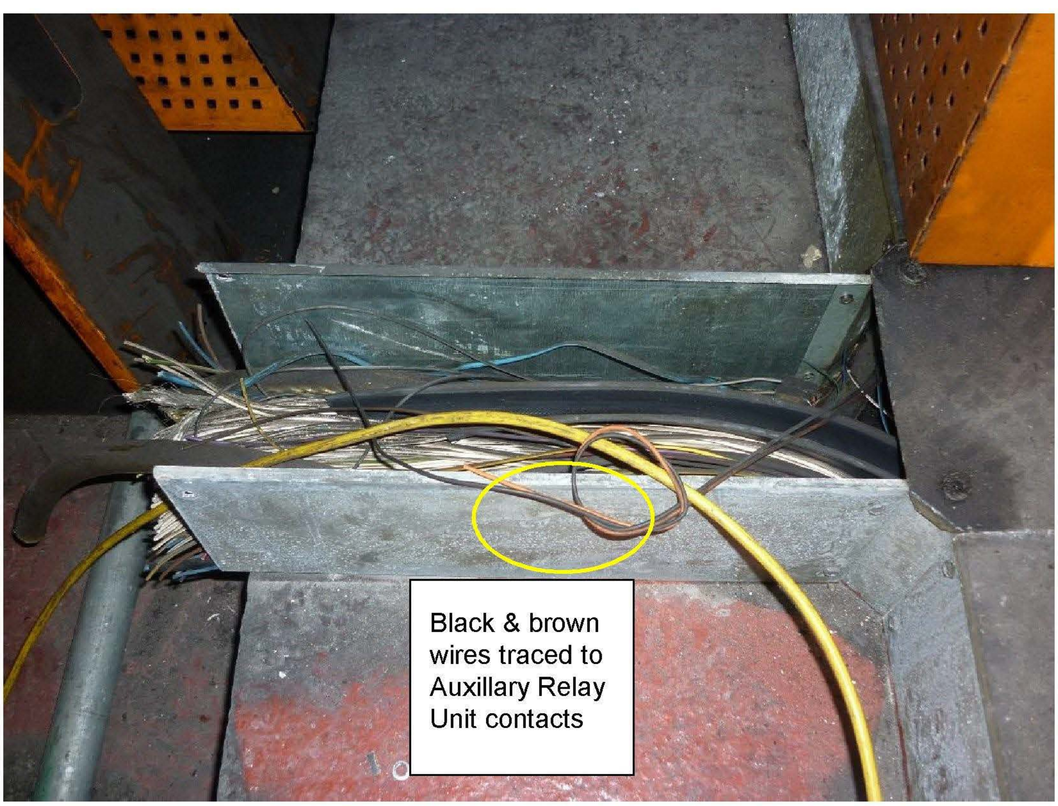

Figure 19: Metal trunking containing cables and wires to lift controller

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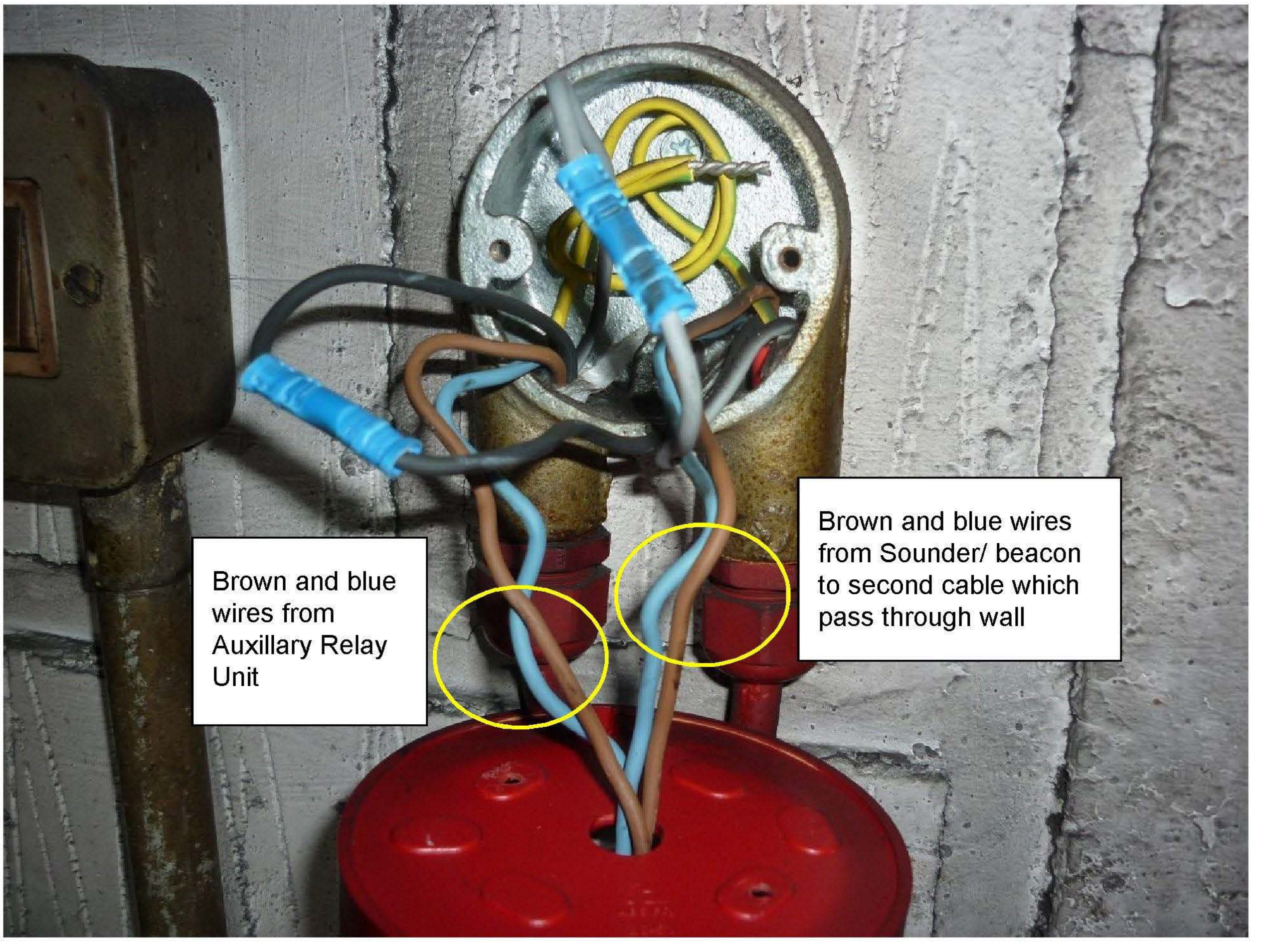
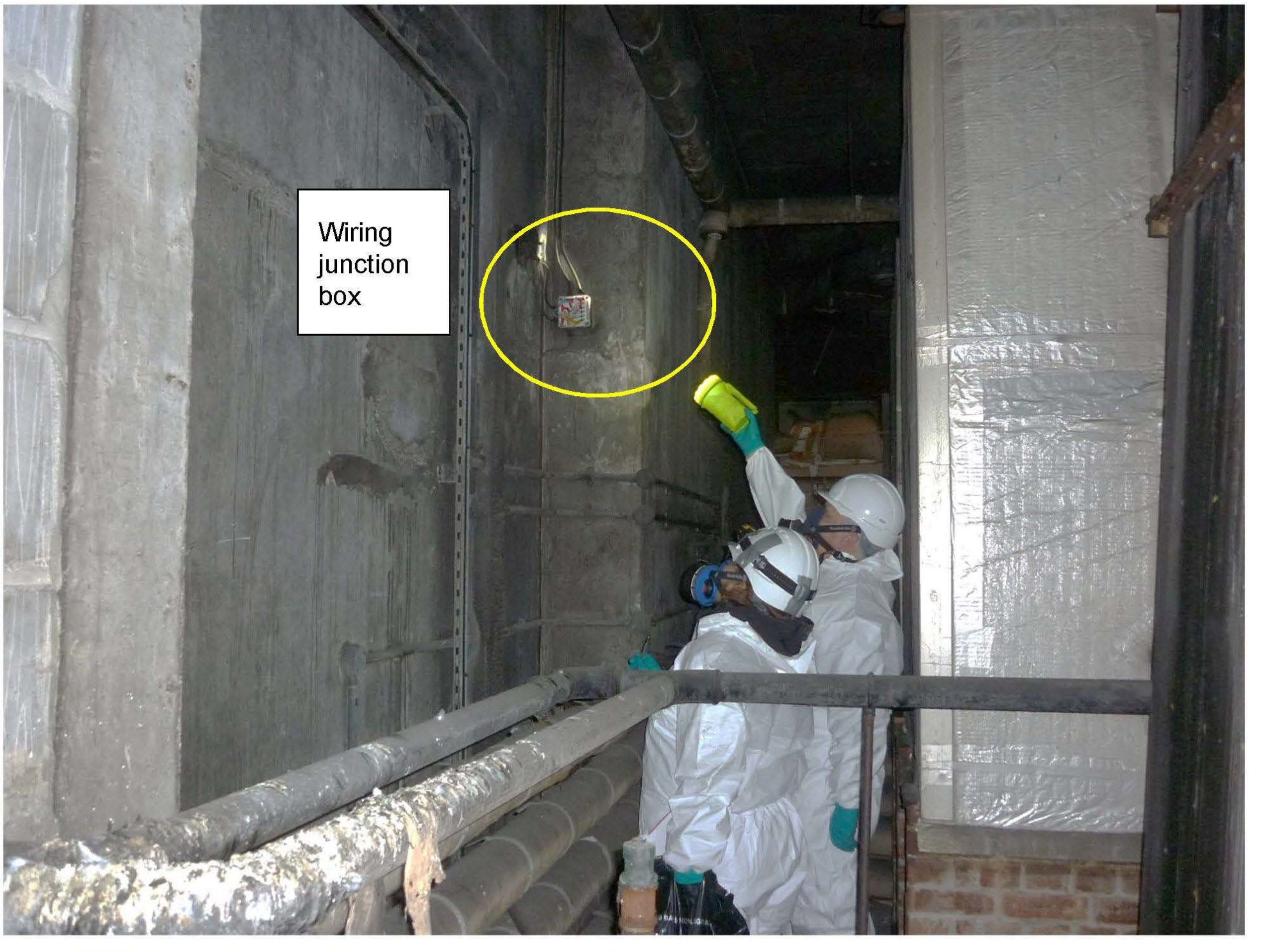


Figure 20: Cable connections at base of sounder / beacon in lift motor room

Note: Left hand side, 4-core cable from Auxillary Relay Unit. Right hand side, 4-core cable passes through wall to next-door plant room



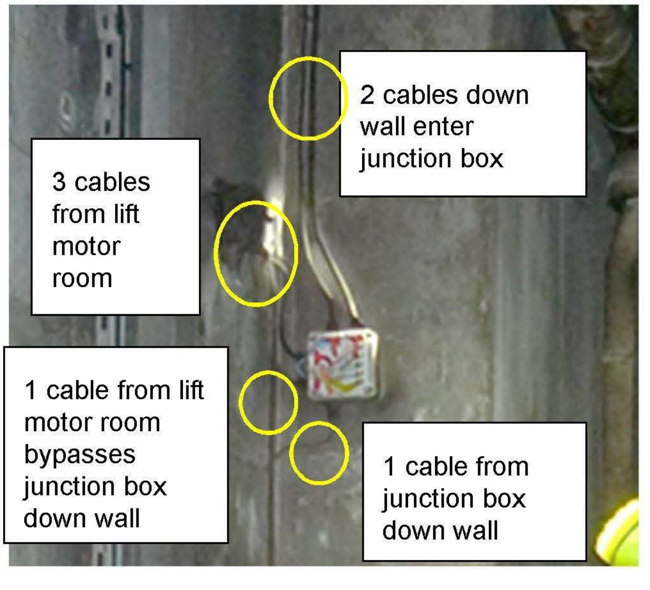


Figure 21: Wiring junction box on wall in water tank room next to lift motor room, showing 3 cables from lift motor room

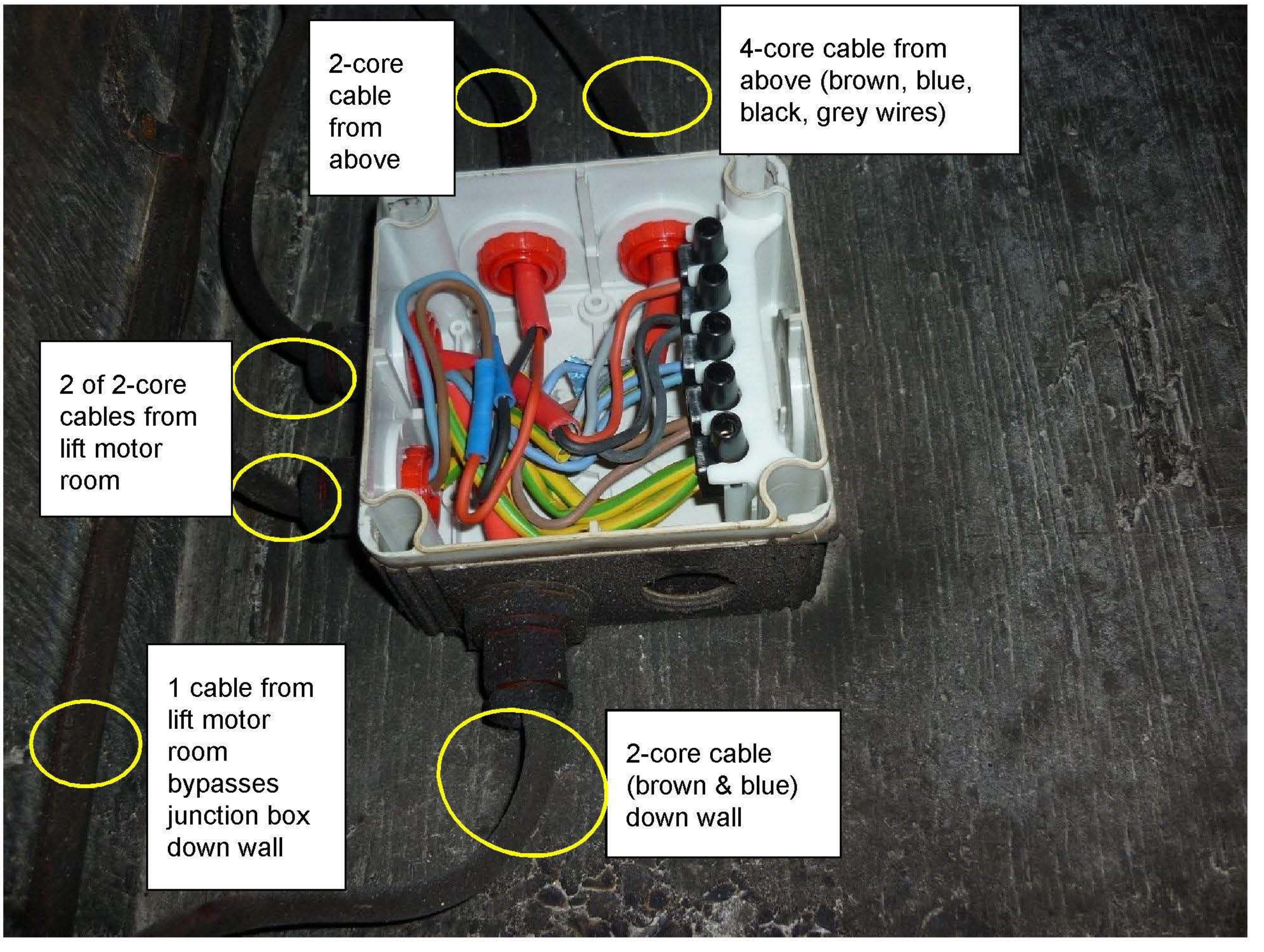


Figure 22: Wiring junction box

Figure 23: Cables from Lift Motor Room descended the building floor, labelled Relay Coil and Detector

2.7 Smoke extract and environmental fan dampers above entrance lobby

There were four dampers in the smoke extract and environmental supply ductwork in the ceiling above the entrance lobby as listed below and shown in **Figure 24**. All of the dampers were three wire devices. 24Volts powered to open and 24Volts powered to close.

- Ground floor entrance lobby smoke extract fan inlet and outlet dampers (one 3-wire 24volt output)
- Ground floor entrance lobby environmental fan inlet and outlet dampers (one 3-wire 24volt output)

The 24volt damper control cables from Inverter Panel 1 to the smoke extract and environmental fresh air supply fan dampers were traced.

It was confirmed that the Environmental Fan inlet and outlet dampers were both connected by cable to a single set of terminals in a wiring junction box to a cable from Inverter Panel 1. This confirms that the intended operation was for both dampers to operate simultaneously.

The Smoke Extract Fan inlet damper was confirmed to be connected to a cable from Inverter Panel 1 but the Smoke Extract Fan outlet damper was NOT connected inside the wiring junction box (see SOCO photographs). It was therefore presumed that it was intended for the Smoke Extract Fan outlet damper to be permanently open. Note that the Smoke Extract Fan outlet damper was open but the other three dampers were closed, when inspected by BRE in July 2017

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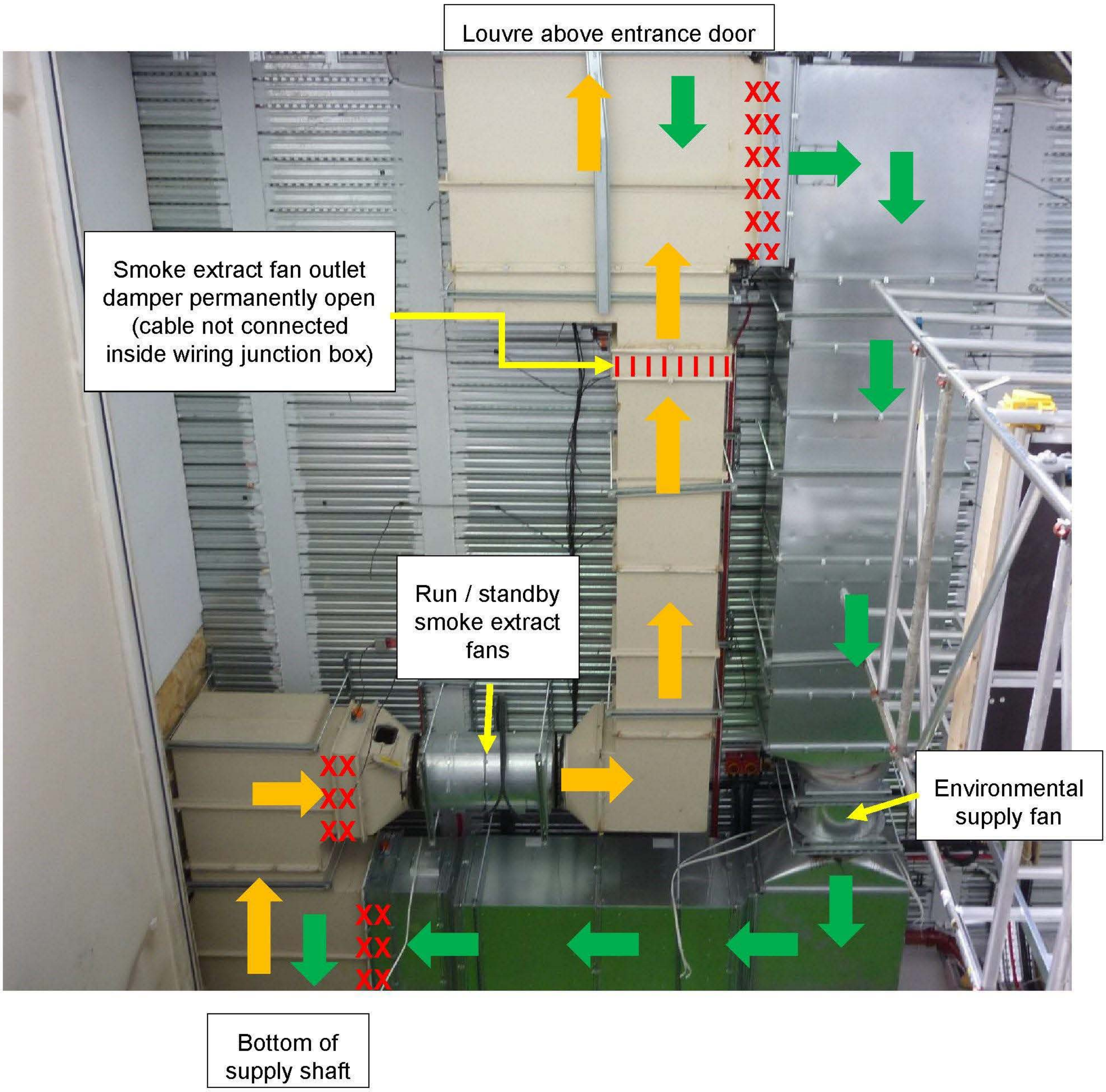


= smoke extract airflow direction   = fresh air ventilation airflow direction

XXXXX = motorised damper (found closed)   IIIIIIII = motorised damper (found open)

Figure 24: Smoke extract and environmental supply ductwork above entrance lobby

(As found damper (July 2017) open/close status indicated)

Conclusion and recommendations

The work to meet the Metropolitan police objectives was stopped, therefore no results or conclusion can be reported. However, this report could assist in the reconstruction of the smoke detection system in order to meet the Metropolitan police objectives.

RHO00000004_0306

References

Documents referred to the report

‘75019AG Boards Assignment rev02.pdf’ (file dated 12/2/16) – this file contains the PSB Wiring Tables

PSB Smoke Ventilation System Electric Schematic, Contract 75015, Drawing 800, Revision E

Glossary of Terms used in report

AOV – Automatic Opening Vent

BMS – Building Management System

I/O _ Input/Output

MPS – Metropolitan Police Services

SOCO – Scenes Of Crime Officer

SW – Switch

Appendix 9

MET00070846

Forensic Report by Scientist Andre Horne (Eurofins Forensics) to Examine a Fire Control Panel Key supplied by the Fire Services

Date of report: 15 May 2020

This report provides only a summary of the scientific findings, interpretation and conclusions in this case. It is not intended for court use and therefore **does not** comply with the Criminal Procedure Rules parts 16 and 19. If the information in this report is required for court purposes then a Full Statement must be requested in advance of any court date.

Date of Report:	15 May 2020
Customer References:	Operation Northleigh
LGC Forensics Reference:	LGC-17132109
Police Force:	Metropolitan Police Service
Officer in the case:	Sarah WILD
Offence:	Investigation into the fire at Grenfell Tower
Date of offence:	NA
Suspects:	NA
Victim/Complainant:	NA
Offence Location:	Grenfell Tower

Request:

To examine a Fire Control Panel Key supplied by the Fire Services.

Purpose:

To determine if the dimensions of the key correspond to other keys previously examined.

Examination

On 7 February 2020 I attended at the CSI offices at Deer Park, London at the request of the Metropolitan Police Service to examine the keys.

I was presented with the following exhibits to examine in the presence of officers from the Metropolitan Police Service:

DER/22	15 LIFT KEYS – ON D100
SJG/01	ONE (1) FIRE BRIGADE DROP KEY PURCHASED FROM EBAY + INVOICE

The following exhibits were also present for comparison purposes. They had been previously examined and reported in my report dated 12 November 2019.

ER/1	ONE (1) EXPRESS DROP RELEASE LIFT KEY

ER/2 ONE (1) EXPRESS FIREMANS SWITCH UN-USED

LJH/67 LIFT KEY

BJG/74 FIRE CONTROL PANEL UNIT, GROUND FLOOR (RECOVERED 18/7/18)

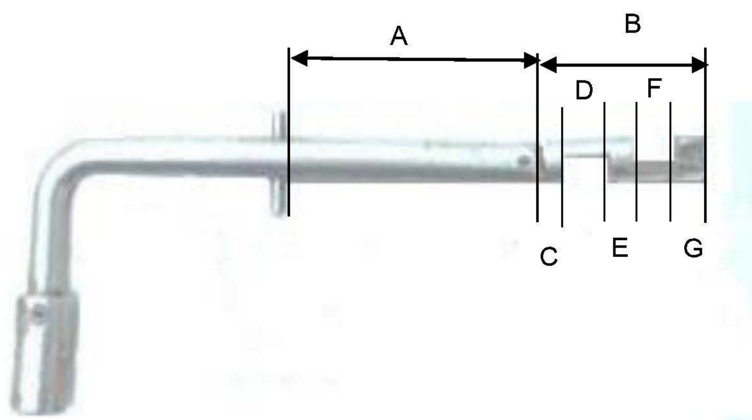
Examination and results

DER/22 15 LIFT KEYS – ON D100

This was 15 keys of different types but included one drop key of the same type that would fit the fire control panel, Item BJG/74, the subject of this investigation.

The drop key was measured to obtain the dimensions and it was visually compared to other drop keys, Items SJG/01, ER/1 and LJH/67, which were also measured.

The drop key was found to be similar in all dimensions to the drop keys, Items ER/1 and SJG/01. There was however a significant difference in dimension C between the other drop keys and the drop key, Item LJH/67. The drop key dimensions are provided in the table below.



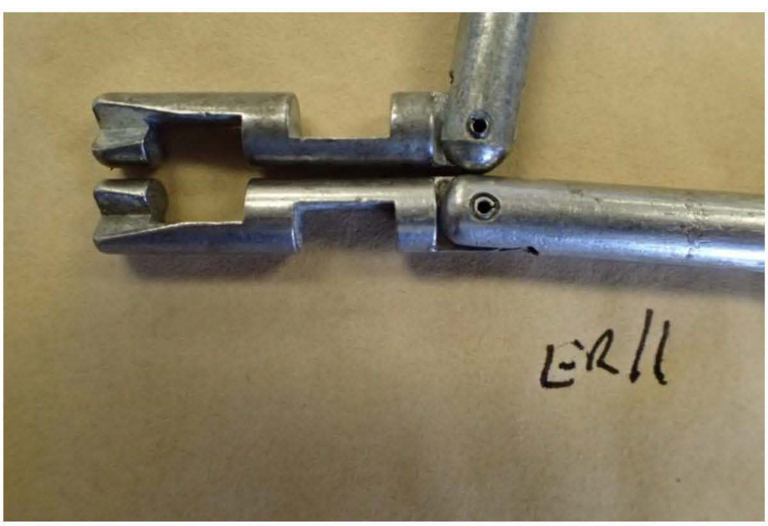
	A	B	C	D	E	F	G
DER/22	57.5	35.26	4.5	10.24	5.24	9.94	5.90
SJG/01	55.79	35.55	4.54	10.13	4.63	10.00	6.76
ER/1	58.72	35.29	4.00	10.29	5.04	10.12	6.0
LJH/67	55.15	36.41	7.69	10.06	4.28	10.08	4.53

The difference in dimension C is the dimension that results in drop key, Item LJH/67, being un-useable in fire control panels such as Items BJG/74 and ER/2.

The drop key in Item DER/22, was inserted into the fire control panel, Item BJG/74, recovered from Grenfell Tower to determine the fit. The side wards of the panel had been bent as described in my report dated 12 November 2019. The key passed through the bent side ward on the "OFF" side without touching the edges of the slots. The key fouled on the bent side ward on the "ON" side, but was able to pass through with slight force. The observation that the key was fouling on the bent side ward on the "ON" side, indicates that it would also have fouled on the side wards in their original unbent state (This can be confirmed if the bent side wards were to be straightened and the key tried again).

The drop key in Item DER/22 was also inserted into the exemplar fire control panel, Item ER/22, to determine the fit. They key functioned normally in the panel without fouling on the side wards.

In my opinion the key, Item DER/22, could also be considered as a slightly ill-fitting key for the Fire Control panel, Item BJG/74 (as described in my report dated 12 November 2019), and had such a key been used it could have been responsible for the damage observed on the Fire Control panel side wards of Item BJG/74.



Key DER/22 at the top and Key ER/1 at the bottom

Key LJH/67 at the top and Key ER/1 at the bottom

Conclusions:

In my opinion:-

The drop key in Item DER/22 can be described as slightly ill-fitting. Had such a drop key been used it could have been responsible for the damage observed on the fire control panel side wards of Item BJG/74. If a fire control panel with the same dimensions as Item BJG/74 is encountered and a drop key such as the one in Item DER/22 is used, it may cause the same problems encountered during the response to the fire in Grenfell Tower.

The drop key, Item DER/22 was similar in all dimensions to the drop keys, Item ER/1 and SJG/01.

There was several millimetres difference in dimension C between the drop keys, Items DER/22, ER/1 and JG/01 and the drop key Item LJH/67.

The drop key, Item LJH/67, is not suitable for use in fire control panels such as Items ER/2 and BJG/74.

Report provided by: *Andre HORNE BMedSci*

Signature:

Address *Royal Armouries, Armouries Drive, Leeds, LS10 1LT*

Telephone number: [redacted]

RHO00000004_0312

DECLARATION
All the information I have given in the following certificate is true to the best of my knowledge and belief. I will notify those instructing me of any change in this information. I am aware that any false or misleading information I have given in this document, or any deliberate omission of relevant information may lead to disciplinary or criminal proceedings.

EXPERT WITNESS DECLARATION FORM
I am an expert in the subject matters discussed and I have been requested to provide a report. I confirm that I have read guidance contained in a booklet known as *Disclosure: Expert's evidence and unused material* which details my role and documents my responsibilities, in relation to revelation as an expert witness. I have followed the guidance and recognise the continuing nature of my responsibilities of revelation. In accordance with my duties of revelation, as documented in the guidance booklet, I

(a) confirm that I have complied with my duties to record, retain and reveal material in accordance with the Criminal Procedure and Investigations Act 1996, as amended.
(b) have compiled an Index of all material. I will ensure that the Index is updated in the event I am provided with or generate additional material;
(c) that in the event my opinion changes on any material issue, I will inform the investigating officer, as soon as reasonably practicable and give reasons.

EXPERT WITNESSES SELF-CERTIFICATE
Revelation of information (Criminal Procedure and Investigations Act 1996)
Name of Expert Witness: Andre HORNE
Date of birth: [redacted]
Signature:
Defendant Name(s):

Address: Royal Armouries, Armouries Drive, Leeds, LS10 1LT

I have been instructed to provide expert evidence in relation to the prosecution of the above-named, or an investigation into the following : Grenfell Tower fire control panel.
I confirm that I have read the booklet known as *Disclosure: Experts evidence and unused material*, that has been given to me with this form, and that I am aware of my responsibilities as an expert witness to reveal to the Prosecution Team any information that might undermine my evidence.

PERSONAL INFORMATION

1. Have you ever been convicted of, cautioned for, or received a penalty notice for, any criminal offence (other than minor traffic offences)?

[redacted]

2. Are there any proceedings pending against you in any criminal or civil court?
3. Are you aware of any adverse finding by a judge, magistrate or coroner about your professional competence or credibility as a witness?
4. Have you ever been the subject of any adverse findings by a professional or regulatory body?
5. Are there any proceedings, referrals or investigations pending against you that have been brought by a professional or regulatory body?
6. Are you aware of any other information that you think may adversely affect your professional competence and credibility as an expert witness?

Name of Expert Witness: Andre HORNE
Signature:

Appendix 10

APX00008713

Apex

General Arrangement – Lifts H090 & H091

Drawing No. C5469/001

3 September 2004

Official Sensitive

Forensic Report

This report provides only a summary of the scientific findings, interpretation and conclusions in this case. It is not intended for court use and therefore **does not** comply with the Criminal Procedure Rules parts 16 and 19. If the information in this report is required for court purposes then a Full Statement must be requested in advance of any court date.

Date of Report:	28 August 2020
Customer References:	Operation Northleigh
LGC Forensics Reference:	LGC-17132109
Police Force:	Metropolitan Police Service
Officer in the case:	Sarah WILD
Offence:	Investigation into the fire at Grenfell Tower
Date of offence:	NA
Suspects:	NA
Victim/Complainant:	NA
Offence Location:	Grenfell Tower

Request:
To examine a Fire Control Panel Key supplied by the Fire Services. I have been asked to expand on my report dated 15 May 2020 to include the examination of exhibit SJG/01 and to produce a table of results.

Purpose:
To determine if the dimensions of the key correspond to other keys previously examined.

Examination
On 7 February 2020 I attended at the CSI offices at Deer Park, London at the request of the Metropolitan Police Service to examine the keys.

I was presented with the following exhibits to examine in the presence of officers from the Metropolitan Police Service:

DER/22	15 LIFT KEYS – ON D100
SJG/01	ONE (1) FIRE BRIGADE DROP KEY PURCHASED FROM EBAY + INVOICE

The following exhibits were also present for comparison purposes. They had been previously examined and reported in my report dated 12 November 2019.

ER/1	ONE (1) EXPRESS DROP RELEASE LIFT KEY
ER/2	ONE (1) EXPRESS FIREMANS SWITCH UN-USED
LJH/67	LIFT KEY
BJG/74	FIRE CONTROL PANEL UNIT, GROUND FLOOR (RECOVERED 18/7/18)

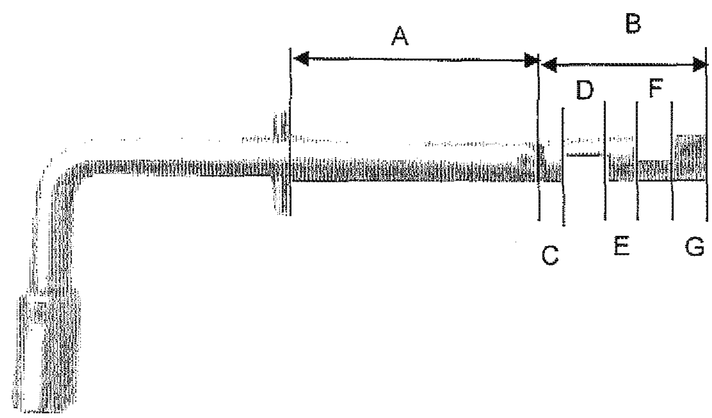
Examination and results

DER/22 15 LIFT KEYS – ON D100

This was 15 keys of different types but included one drop key of the same type that would fit the fire control panel, Item BJG/74, the subject of this investigation.

The drop key was measured to obtain the dimensions and it was visually compared to other drop keys, Items SJG/01, ER/1 and LJH/67, which were also measured.

The drop key was found to be similar in all dimensions (but not the same) to the drop keys, Items ER/1 and SJG/01. There was however a significant difference in dimension C between the other drop keys and the drop key, Item LJH/67. The drop key dimensions are provided in the table below.



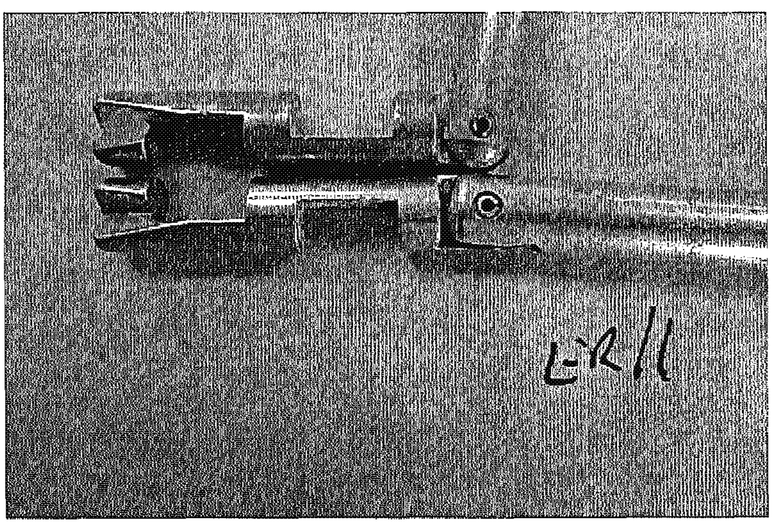
	A	B	C	D	E	F	G
DER/22	57.5	35.26	4.5	10.24	5.24	9.94	5.90
SJG/01	55.79	35.55	4.54	10.13	4.63	10.00	6.76
ER/1	58.72	35.29	4.00	10.29	5.04	10.12	6.0
LJH/67	55.15	36.41	7.69	10.06	4.28	10.08	4.53

The difference in dimension C is the dimension that results in drop key, Item LJH/67, being un-useable in fire control panels such as Items BJG/74 and ER/2.

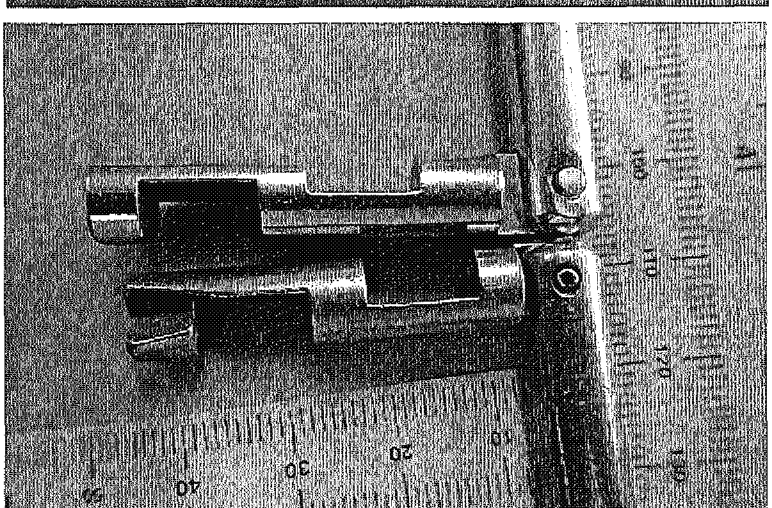
The drop key in Item DER/22, was inserted into the fire control panel, Item BJG/74, recovered from Grenfell Tower to determine the fit. The side wards of the panel had been bent as described in my report dated 12 November 2019. The key passed through the bent side ward on the "OFF" side without touching the edges of the slots. The key fouled on the bent side ward on the "ON" side, but was able to pass through with slight force. The observation that the key was fouling on the bent side ward on the "ON" side, indicates that it would also have fouled on the side wards in their original unbent state (This can be confirmed if the bent side wards were to be straightened and the key tried again). I cannot categorically state what the degree of fouling would have been and how much force would have been required to force the key through the side wards in their original unbent state in order to operate the electronic switch.

The drop key in Item DER/22 was also inserted into the exemplar fire control panel, Item ER/22, to determine the fit. They key functioned normally in the panel without fouling on the side wards.

In my opinion the key, Item DER/22, could also be considered as a slightly ill-fitting key for the Fire Control panel, Item BJG/74 (as described in my report dated 12 November 2019), and had such a key been used it could have been responsible for the damage observed on the Fire Control panel side wards of Item BJG/74.



Key DER/22 at the top and
Key ER/1 at the bottom



Key LJH/67 at the top and
Key ER/1 at the bottom

SJG/01 ONE (1) FIRE BRIGADE DROP KEY PURCHASED FROM EBAY + INVOICE

This was a commercially available drop key purchased by the Metropolitan Police Service. The drop key was measured to obtain the dimensions and it was visually compared to other drop keys, Items DER/22, ER/1 and LJH/67, which were also measured.

The drop key was found to be similar in all dimensions to the drop keys, Items ER/1 and DER/22. There was however a significant difference in dimension C between the other drop keys and the drop key, Item LJH/67. The drop key dimensions are provided in the table in the paragraph describing Item DER/22.

The drop key was inserted into the fire control panel, Item BJG/74, recovered from Grenfell Tower and the exemplar fire control panel, Item ER/2, to determine the fit. The key passed through the side wards on both sides without touching the edges of the slots of both panels.

Conclusions:

In my opinion:-

The drop key in Item DER/22 can be described as slightly ill-fitting. Had such a drop key been used it could have been responsible for the damage observed on the fire control panel side wards of Item BJG/74. If a fire control panel with the same dimensions as Item BJG/74 is encountered and a drop key such as the one in Item DER/22 is used, it may cause the same problems encountered during the response to the fire in Grenfell Tower. Because the panel BJG/74 is in a damaged state with bent side wards, I cannot categorically state what amount of force that would have been required to force it through the side wards in its undamaged state.

The drop key, Item SJG/01, functioned normally on the damaged panel BJG/74. My expectation is that it would also have functioned normally on the undamaged panel.

The drop key, Item DER/22 was similar in all dimensions to the drop keys, Item ER/1 and SJG/01. Although the dimensions of the three keys were similar, they were however not the same (as can be seen in the table with drop key dimensions in the paragraph describing Item DER/22).

There was several millimetres difference in dimension C between the drop keys, Items DER/22, ER/1 and SJG/01 and the drop key Item LJH/67.

The drop key, Item LJH/67, is not suitable for use in fire control panels such as Items ER/2 and BJG/74.

A summary of my conclusions for both panels can be found in the table below

	Control panel BJG/74 (Grenfell Tower)	Control panel ER/2 (unused control switch purchased as an example)
LJH/67	Grossly ill-fitting. If inserted into this control panel the key would not turn and would not be capable of switching the control panel on/off. Incapable of causing the side ward damage seen in this control panel.	Grossly ill-fitting. If inserted into this control panel the key would not turn and would not be capable of switching the control panel on/off.
ER/1	Slightly ill-fitting. With force * this key would be capable of being turned in this control panel and at the same time causing damage similar to that seen in this control panel side wards. In these circumstances this key could have operated the control panel electronic switch.	Functioned correctly
DER/22	Slightly ill-fitting. With force * this key would be capable of being turned in this control panel and at the same time causing damage similar to that seen in this control panel side wards. In these circumstances this key could have operated the control panel electronic switch.	Functioned normally without fouling on the side wards
SJG/01	Functioned normally without fouling on the side wards. Would not have caused any damage to the side wards and would have operated the control panel electronic switch	Functioned normally without fouling on the side wards

* Because the panel BJG/74 is in a damaged state with bent side wards, I cannot categorically state what amount of force that would have been required to force the key through the side wards in its undamaged state.

Report provided by: *Andre HORNE BMedSci*

Signature:

Address *Royal Armouries, Armouries Drive, Leeds, LS10 1LT*

Telephone number: [redacted]

DECLARATION
All the information I have given in the following certificate is true to the best of my knowledge and belief. I will notify those instructing me of any change in this information. I am aware that any false or misleading information I have given in this document, or any deliberate omission of relevant information may lead to disciplinary or criminal proceedings.

EXPERT WITNESS DECLARATION FORM
I am an expert in the subject matters discussed and I have been requested to provide a report. I confirm that I have read guidance contained in a booklet known as *Disclosure: Expert's evidence and unused material* which details my role and documents my responsibilities, in relation to revelation as an expert witness. I have followed the guidance and recognise the continuing nature of my responsibilities of revelation. In accordance with my duties of revelation, as documented in the guidance booklet, I

(a) confirm that I have complied with my duties to record, retain and reveal material in accordance with the Criminal Procedure and Investigations Act 1996, as amended.
(b) have compiled an Index of all material. I will ensure that the Index is updated in the event I am provided with or generate additional material;
(c) that in the event my opinion changes on any material issue, I will inform the investigating officer, as soon as reasonably practicable and give reasons.

EXPERT WITNESSES SELF-CERTIFICATE
Revelation of information (Criminal Procedure and Investigations Act 1996)
Name of Expert Witness: Andre HORNE
Date of birth: [redacted]
Signature:
Defendant Name(s):

Address: Royal Armouries, Armouries Drive, Leeds, LS10 1LT

I have been instructed to provide expert evidence in relation to the prosecution of the above-named, or an investigation into the following : Grenfell Tower fire control panel.
I confirm that I have read the booklet known as *Disclosure: Experts evidence and unused material*, that has been given to me with this form, and that I am aware of my responsibilities as an expert witness to reveal to the Prosecution Team any information that might undermine my evidence.

PERSONAL INFORMATION

1. Have you ever been convicted of, cautioned for, or received a penalty notice for, any criminal offence (other than minor traffic offences)? [redacted]
2. Are there any proceedings pending against you in any criminal or civil court?
3. Are you aware of any adverse finding by a judge, magistrate or coroner about your professional competence or credibility as a witness?
4. Have you ever been the subject of any adverse findings by a professional or regulatory body?
5. Are there any proceedings, referrals or investigations pending against you that have been brought by a professional or regulatory body?
6. Are you aware of any other information that you think may adversely affect your professional competence and credibility as an expert witness?

Name of Expert Witness: Andre HORNE
Signature:

Appendix 10

MET00071006

Forensic Report by Scientist Andre Horne

(Eurofins Forensics)

Date of report: 28 August 2020

Official Sensitive

Forensic Report

This report provides only a summary of the scientific findings, interpretation and conclusions in this case. It is not intended for court use and therefore **does not** comply with the Criminal Procedure Rules parts 16 and 19. If the information in this report is required for court purposes then a Full Statement must be requested in advance of any court date.

Date of Report:	28 August 2020
Customer References:	Operation Northleigh
LGC Forensics Reference:	LGC-17132109
Police Force:	Metropolitan Police Service
Officer in the case:	Sarah WILD
Offence:	Investigation into the fire at Grenfell Tower
Date of offence:	NA
Suspects:	NA
Victim/Complainant:	NA
Offence Location:	Grenfell Tower

Request:
To examine a Fire Control Panel Key supplied by the Fire Services. I have been asked to expand on my report dated 15 May 2020 to include the examination of exhibit SJG/01 and to produce a table of results.

Purpose:
To determine if the dimensions of the key correspond to other keys previously examined.

Examination
On 7 February 2020 I attended at the CSI offices at Deer Park, London at the request of the Metropolitan Police Service to examine the keys.

I was presented with the following exhibits to examine in the presence of officers from the Metropolitan Police Service:

DER/22	15 LIFT KEYS – ON D100
SJG/01	ONE (1) FIRE BRIGADE DROP KEY PURCHASED FROM EBAY + INVOICE

The following exhibits were also present for comparison purposes. They had been previously examined and reported in my report dated 12 November 2019.

ER/1 ONE (1) EXPRESS DROP RELEASE LIFT KEY

ER/2 ONE (1) EXPRESS FIREMANS SWITCH UN-USED

LJH/67 LIFT KEY

BJG/74 FIRE CONTROL PANEL UNIT, GROUND FLOOR (RECOVERED 18/7/18)

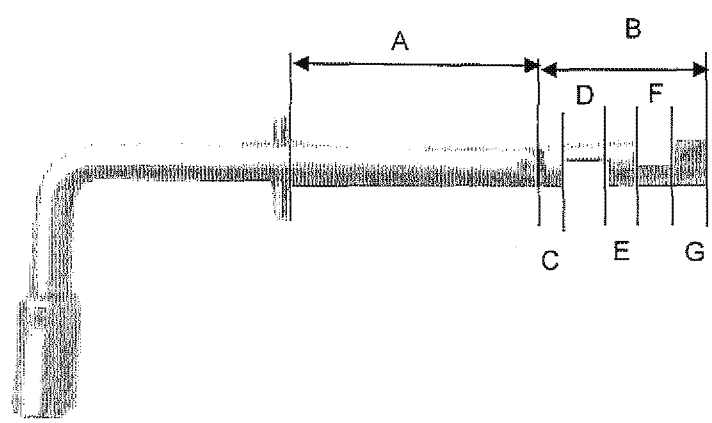
Examination and results

DER/22 15 LIFT KEYS – ON D100

This was 15 keys of different types but included one drop key of the same type that would fit the fire control panel, Item BJG/74, the subject of this investigation.

The drop key was measured to obtain the dimensions and it was visually compared to other drop keys, Items SJG/01, ER/1 and LJH/67, which were also measured.

The drop key was found to be similar in all dimensions (but not the same) to the drop keys, Items ER/1 and SJG/01. There was however a significant difference in dimension C between the other drop keys and the drop key, Item LJH/67. The drop key dimensions are provided in the table below.



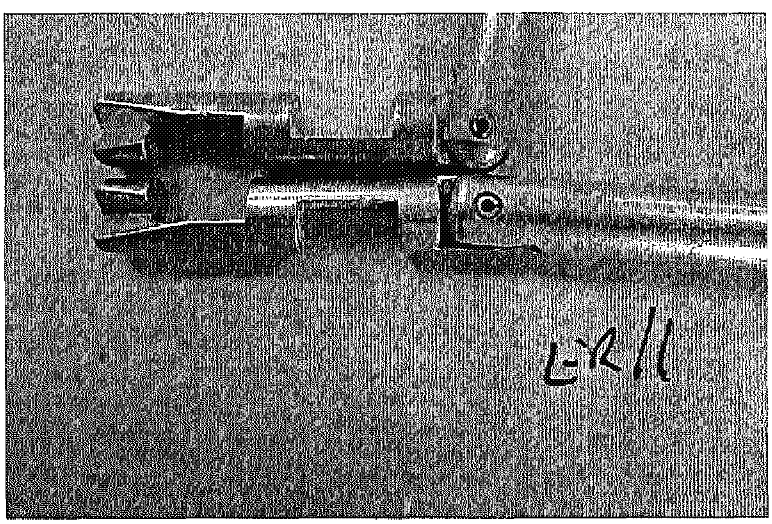
	A	B	C	D	E	F	G
DER/22	57.5	35.26	4.5	10.24	5.24	9.94	5.90
SJG/01	55.79	35.55	4.54	10.13	4.63	10.00	6.76
ER/1	58.72	35.29	4.00	10.29	5.04	10.12	6.0
LJH/67	55.15	36.41	7.69	10.06	4.28	10.08	4.53

The difference in dimension C is the dimension that results in drop key, Item LJH/67, being un-useable in fire control panels such as Items BJG/74 and ER/2.

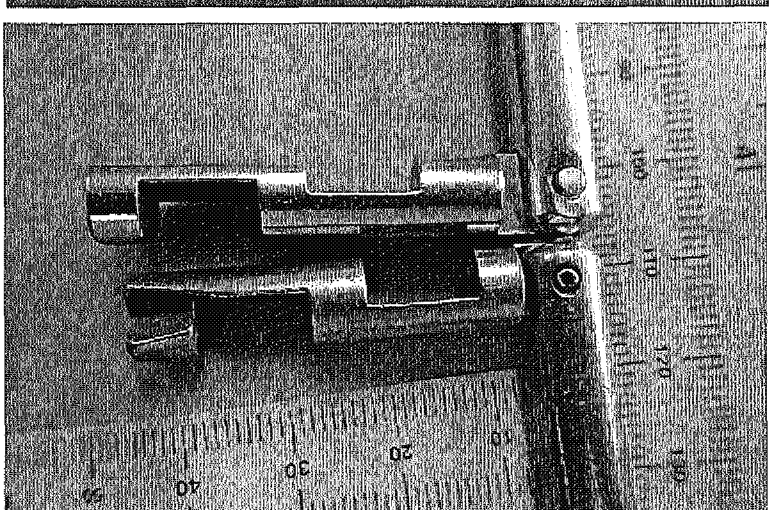
The drop key in Item DER/22, was inserted into the fire control panel, Item BJG/74, recovered from Grenfell Tower to determine the fit. The side wards of the panel had been bent as described in my report dated 12 November 2019. The key passed through the bent side ward on the "OFF" side without touching the edges of the slots. The key fouled on the bent side ward on the "ON" side, but was able to pass through with slight force. The observation that the key was fouling on the bent side ward on the "ON" side, indicates that it would also have fouled on the side wards in their original unbent state (This can be confirmed if the bent side wards were to be straightened and the key tried again). I cannot categorically state what the degree of fouling would have been and how much force would have been required to force the key through the side wards in their original unbent state in order to operate the electronic switch.

The drop key in Item DER/22 was also inserted into the exemplar fire control panel, Item ER/22, to determine the fit. They key functioned normally in the panel without fouling on the side wards.

In my opinion the key, Item DER/22, could also be considered as a slightly ill-fitting key for the Fire Control panel, Item BJG/74 (as described in my report dated 12 November 2019), and had such a key been used it could have been responsible for the damage observed on the Fire Control panel side wards of Item BJG/74.



Key DER/22 at the top and
Key ER/1 at the bottom



Key LJH/67 at the top and
Key ER/1 at the bottom

SJG/01 ONE (1) FIRE BRIGADE DROP KEY PURCHASED FROM EBAY + INVOICE

This was a commercially available drop key purchased by the Metropolitan Police Service. The drop key was measured to obtain the dimensions and it was visually compared to other drop keys, Items DER/22, ER/1 and LJH/67, which were also measured.

The drop key was found to be similar in all dimensions to the drop keys, Items ER/1 and DER/22. There was however a significant difference in dimension C between the other drop keys and the drop key, Item LJH/67. The drop key dimensions are provided in the table in the paragraph describing Item DER/22.

The drop key was inserted into the fire control panel, Item BJG/74, recovered from Grenfell Tower and the exemplar fire control panel, Item ER/2, to determine the fit. The key passed through the side wards on both sides without touching the edges of the slots of both panels.

Conclusions:

In my opinion:-

The drop key in Item DER/22 can be described as slightly ill-fitting. Had such a drop key been used it could have been responsible for the damage observed on the fire control panel side wards of Item BJG/74. If a fire control panel with the same dimensions as Item BJG/74 is encountered and a drop key such as the one in Item DER/22 is used, it may cause the same problems encountered during the response to the fire in Grenfell Tower. Because the panel BJG/74 is in a damaged state with bent side wards, I cannot categorically state what amount of force that would have been required to force it through the side wards in its undamaged state.

The drop key, Item SJG/01, functioned normally on the damaged panel BJG/74. My expectation is that it would also have functioned normally on the undamaged panel.

The drop key, Item DER/22 was similar in all dimensions to the drop keys, Item ER/1 and SJG/01. Although the dimensions of the three keys were similar, they were however not the same (as can be seen in the table with drop key dimensions in the paragraph describing Item DER/22).

There was several millimetres difference in dimension C between the drop keys, Items DER/22, ER/1 and SJG/01 and the drop key Item LJH/67.

The drop key, Item LJH/67, is not suitable for use in fire control panels such as Items ER/2 and BJG/74.

A summary of my conclusions for both panels can be found in the table below

	Control panel BJG/74 (Grenfell Tower)	**Control panel ER/2 (unused control switch purchased as an example)**
LJH/67	Grossly ill-fitting. If inserted into this control panel the key would not turn and would not be capable of switching the control panel on/off. Incapable of causing the side ward damage seen in this control panel.	Grossly ill-fitting. If inserted into this control panel the key would not turn and would not be capable of switching the control panel on/off.
ER/1	Slightly ill-fitting. With force * this key would be capable of being turned in this control panel and at the same time causing damage similar to that seen in this control panel side wards. In these circumstances this key could have operated the control panel electronic switch.	Functioned correctly
DER/22	Slightly ill-fitting. With force * this key would be capable of being turned in this control panel and at the same time causing damage similar to that seen in this control panel side wards. In these circumstances this key could have operated the control panel electronic switch.	Functioned normally without fouling on the side wards
SJG/01	Functioned normally without fouling on the side wards. Would not have caused any damage to the side wards and would have operated the control panel electronic switch	Functioned normally without fouling on the side wards

* Because the panel BJG/74 is in a damaged state with bent side wards, I cannot categorically state what amount of force that would have been required to force the key through the side wards in its undamaged state.

Report provided by: *Andre HORNE BMedSci*

Signature:

Address *Royal Armouries, Armouries Drive, Leeds, LS10 1LT*

Telephone number: [redacted]

Official Sensitive

Forensic Report

DECLARATION
All the information I have given in the following certificate is true to the best of my knowledge and belief. I will notify those instructing me of any change in this information. I am aware that any false or misleading information I have given in this document, or any deliberate omission of relevant information may lead to disciplinary or criminal proceedings.

EXPERT WITNESS DECLARATION FORM
I am an expert in the subject matters discussed and I have been requested to provide a report. I confirm that I have read guidance contained in a booklet known as *Disclosure: Expert's evidence and unused material* which details my role and documents my responsibilities, in relation to revelation as an expert witness. I have followed the guidance and recognise the continuing nature of my responsibilities of revelation. In accordance with my duties of revelation, as documented in the guidance booklet, I

(a) confirm that I have complied with my duties to record, retain and reveal material in accordance with the Criminal Procedure and Investigations Act 1996, as amended.

(b) have compiled an Index of all material. I will ensure that the Index is updated in the event I am provided with or generate additional material;

(c) that in the event my opinion changes on any material issue, I will inform the investigating officer, as soon as reasonably practicable and give reasons.

EXPERT WITNESSES SELF-CERTIFICATE
Revelation of information (Criminal Procedure and Investigations Act 1996)

Name of Expert Witness: Andre HORNE
Date of birth: [redacted]
Signature:
Defendant Name(s):

Address: Royal Armouries, Armouries Drive, Leeds, LS10 1LT

I have been instructed to provide expert evidence in relation to the prosecution of the above-named, or an investigation into the following : Grenfell Tower fire control panel.
I confirm that I have read the booklet known as *Disclosure: Experts evidence and unused material*, that has been given to me with this form, and that I am aware of my responsibilities as an expert witness to reveal to the Prosecution Team any information that might undermine my evidence.

PERSONAL INFORMATION

1. Have you ever been convicted of, cautioned for, or received a penalty notice for, any criminal offence (other than minor traffic offences)? [redacted]
2. Are there any proceedings pending against you in any criminal or civil court?
3. Are you aware of any adverse finding by a judge, magistrate or coroner about your professional competence or credibility as a witness?
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6. Are you aware of any other information that you think may adversely affect your professional competence and credibility as an expert witness?

Name of Expert Witness: Andre HORNE
Signature:

Appendix 11

Photographs of lifts at Grenfell Tower

Metropolitan Police

URN	Description
MET00065201	Car operating panel (horizontal)
MET00065229	Lift pit with water
MET00065250	Rear of lift car roof
MET00065300	Lift car ceiling from inside car
MET00065397	Lift car interior showing car operating panel on left hand wall
MET00065423	Floor entrance
MET00065481	Lift car interior showing car operating panel on left hand wall
MET00065517	Lift car ceiling
MET00065559	Lift car interior with security camera
MET00065570	Lift shaft and guide rails
MET00065571	Lift shaft and guide rails

Appendix 11

MET00065201 – Car operating panel (horizontal)

Appendix 11

MET00065229 – Lift pit with water

Appendix 11

MET00065250 – Rear of lift car roof

Appendix 11

MET00065300 – Lift car ceiling from inside car

RHO00000004_0335

Appendix 11

MET00065397 – Lift car interior showing car operating panel on left hand wall

RHO00000004_0337

Appendix 11

MET00065423 – Floor entrance

RHO00000004_0339

Appendix 11

MET00065481 – Lift car interior showing car operating panel on left hand wall

RHO00000004_0342

Appendix 11

MET00065517 – Lift car ceiling

Appendix 11

MET00065559 – Lift car interior with security camera

Appendix 11

MET00065570 – Lift shaft and guide rails

RHO00000004_0347

Appendix 11

MET00065571 – Lift shaft and guide rails

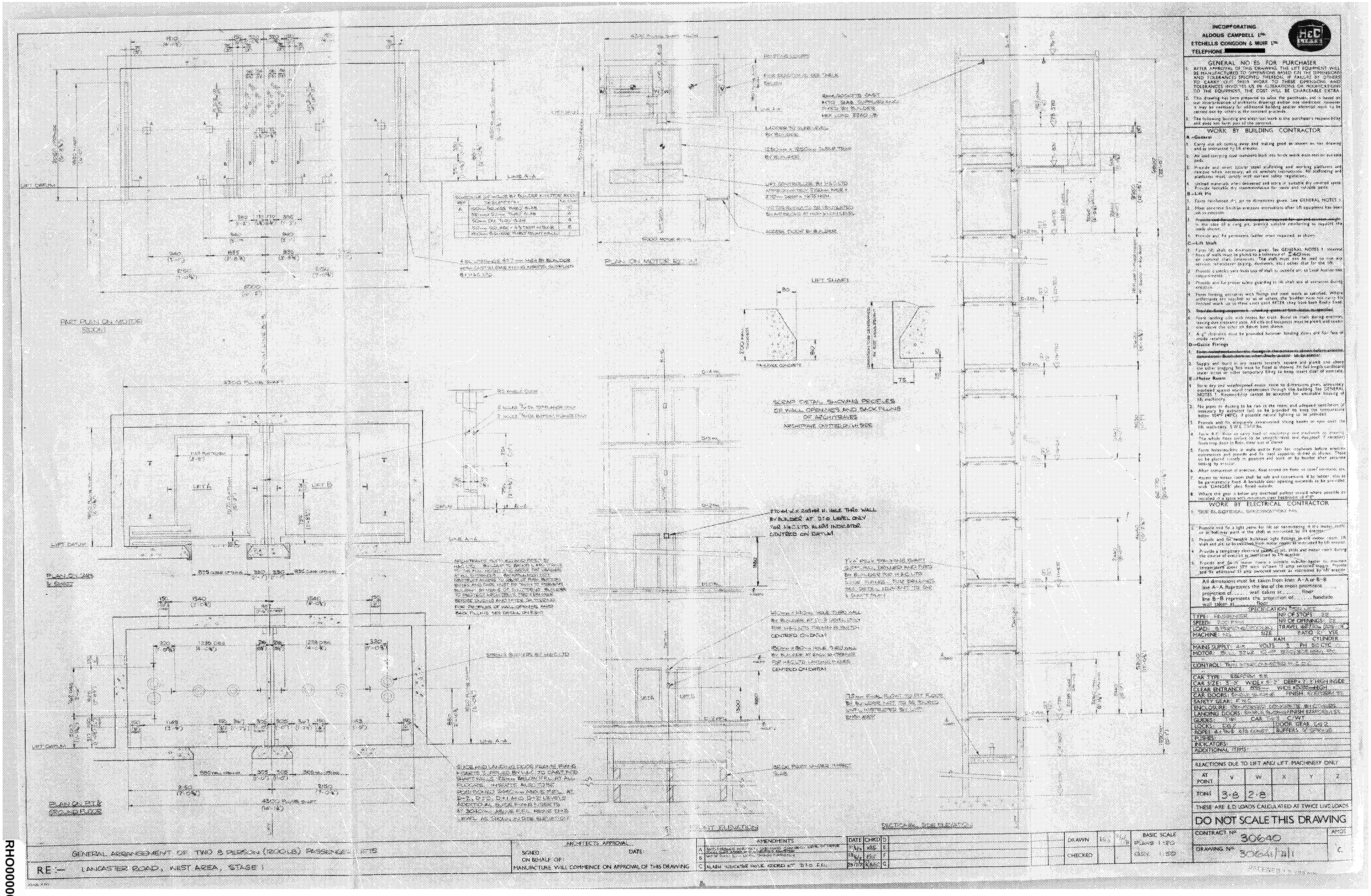
Appendix 12

TMO10023897

Hammond & Champness

Drawing No. 30641/7/1(C)

July 1971



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Appendix 13

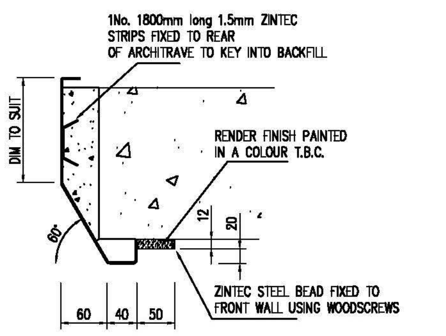
APX00008713

Apex

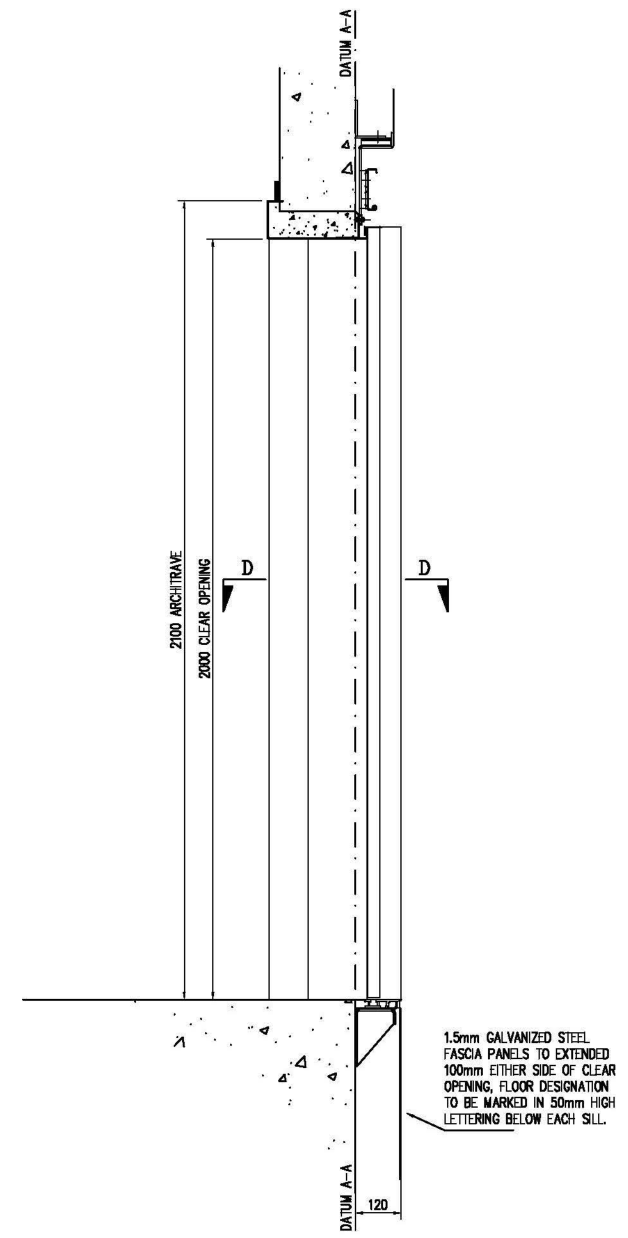
General Arrangement – Lifts H090 & H091

Drawing No. C5469/001

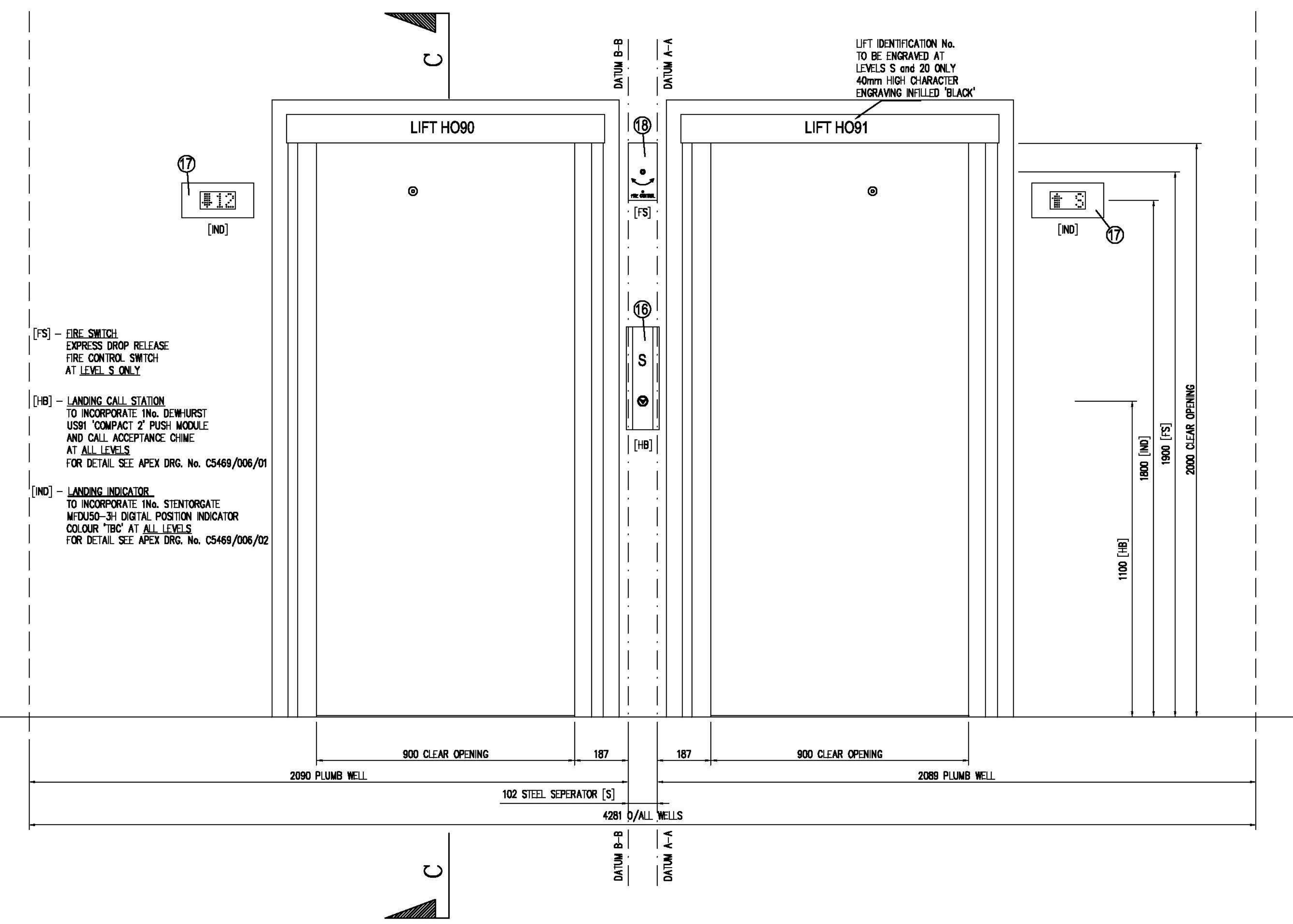
3 September 2004



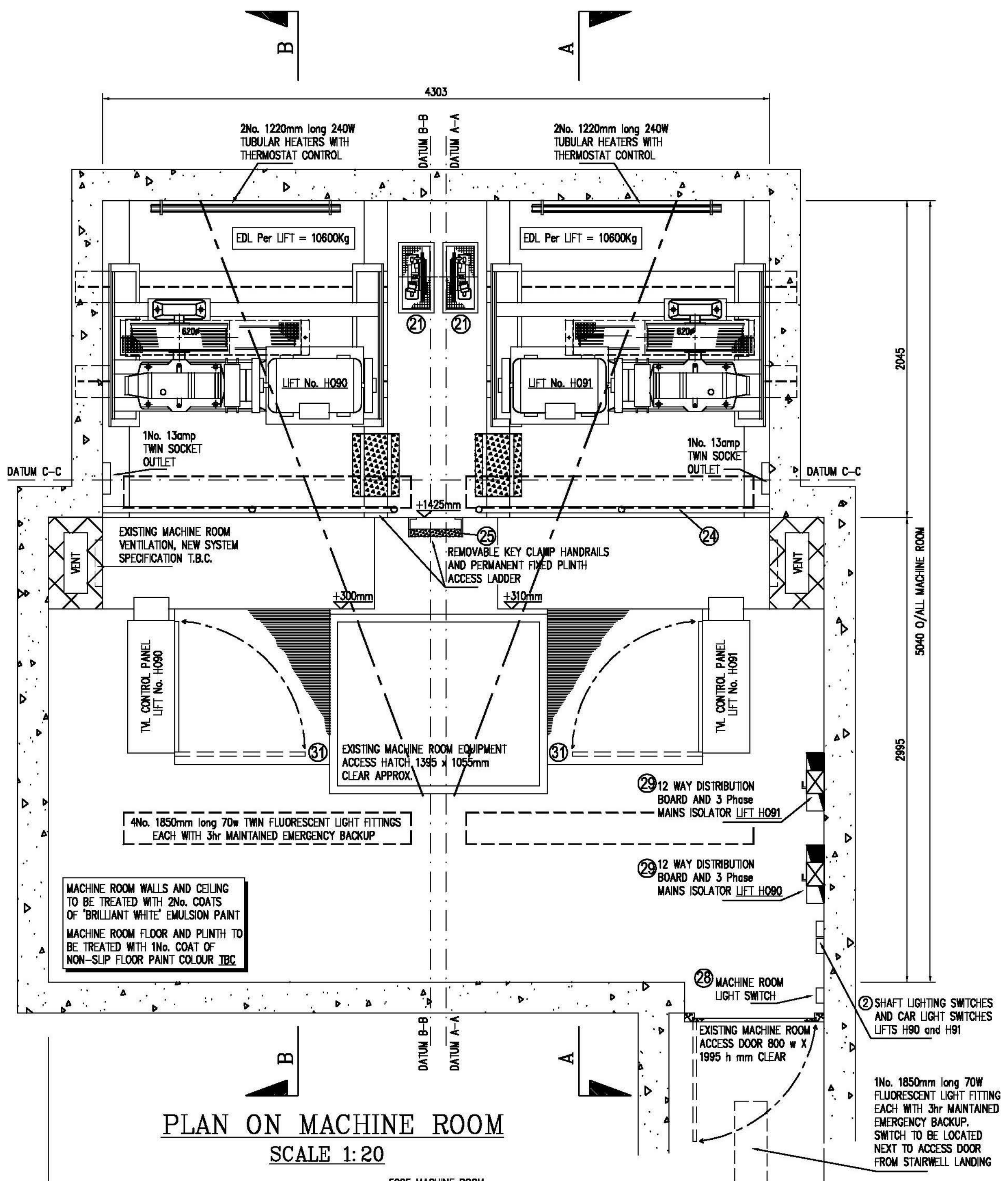
VIEW D–D
ARCHITRAVE DETAIL
SCALE 1:5



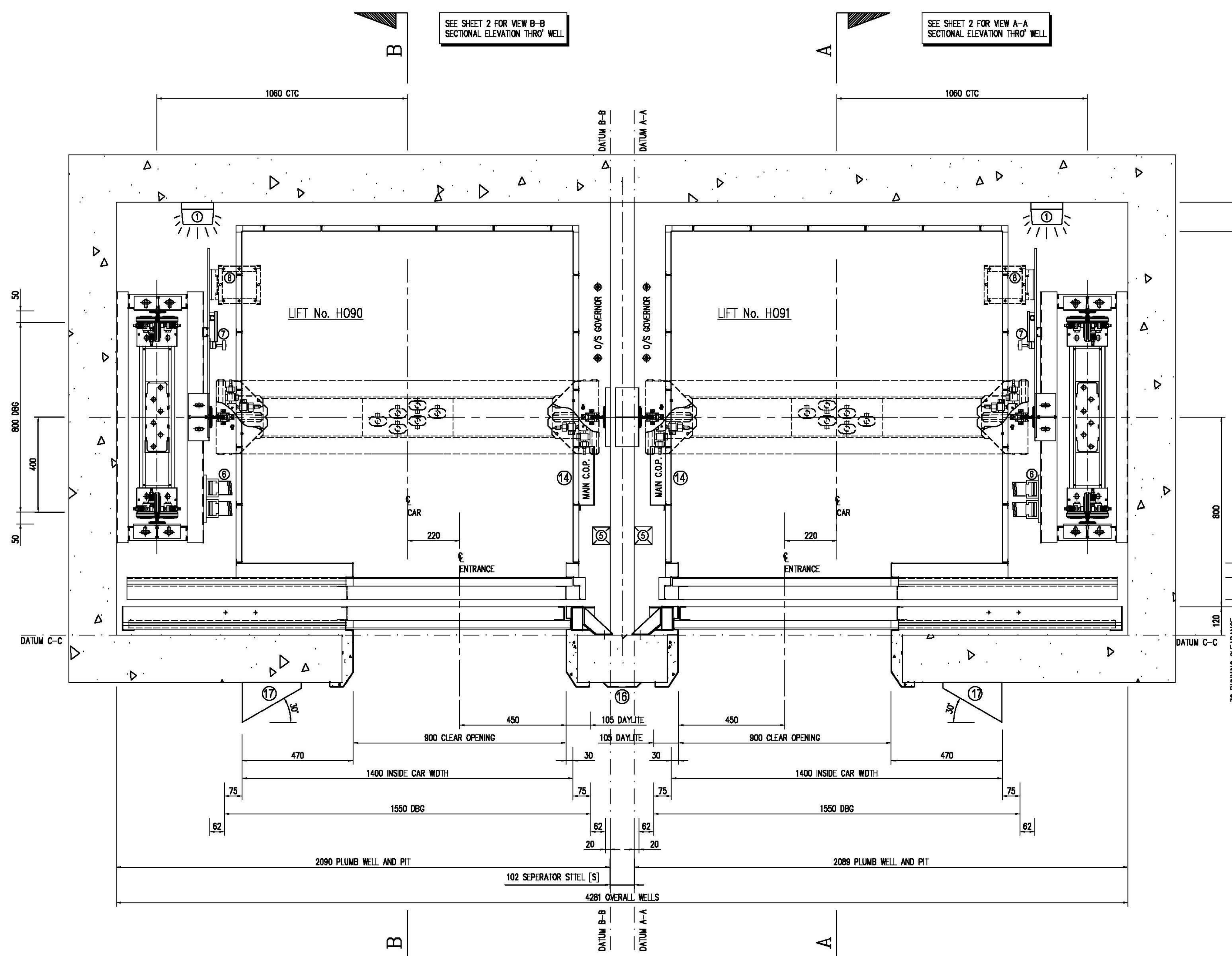
VIEW C–C
SECTION THROUGH ENTRANCE
SCALE 1:10



ELEVATION ON LANDING ENTRANCES
SCALE 1:10



PLAN ON MACHINE ROOM
SCALE 1:20



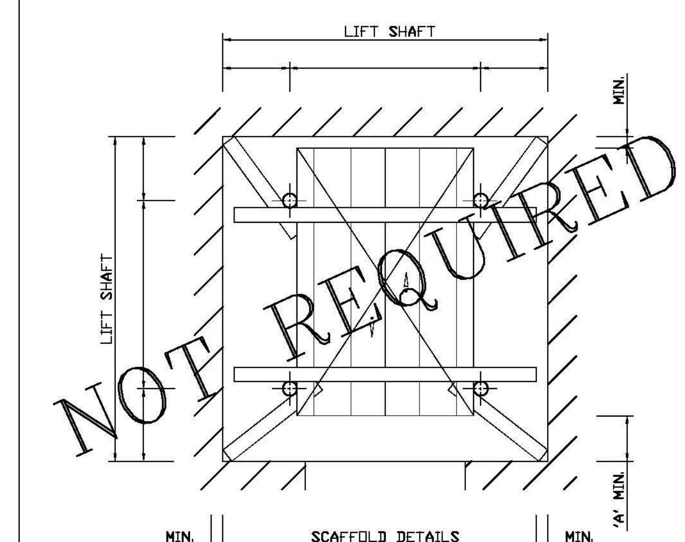
PLAN ON CARS IN WELLS
SCALE 1:10

LIFT EQUIPMENT ITEM NOTES

1. PERMANENT SHAFT LIGHTING.
2. 3 WAY SWITCHES FOR SHAFT LIGHTING, 1 No. IN LIFT PIT AND 1 No. IN MACHINE ROOM, CARTOP.
3. EMERGENCY STOP SWITCH IN LIFT PIT.
4. PIT ACCESS LADDER.
5. TRUNKING RISER.
6. TRAVELING FLEXES.
7 LIMIT SWITCHES.
8. LEVELING TAPE HEAD.
9. GOVERNOR TENSION PULLEY ~ WEIGHT.
10. CAR GUIDE RAILS T161 EXISTING RELOCATED.
11. CWT GUIDE RAILS T163 EXISTING RELOCATED
12. CAR ~ CWT BUFFERS OIL HYDRAULIC.
13. SAFETY GEAR BLOCKS, CAR.
14. CAR OPERATING PANEL.
15. CAR EMERGENCY TELEPHONE IN C.O.P.
16. LANDING PUSH STATION.
17. LANDING INDICATOR UNITS.
18. FIREMAN'S SWITCH AT GROUND FLOOR.
19. –
20. –
21. OVER SPEED GOVERNOR ~ SAFETY GUARD.
22. –
23. –
24. SAFETY ~ GUARDRAILS, NEW.
25. MACHINE PLATFORM ACCESS LADDER, NEW.
26. MACHINE ROOM ACCESS DOOR , EXISTING, MAX., 800 x 1995mm CLEAR OPENING.
27. MACHINE ROOM ACCESS TRAP, EXISTING, C/O 1055 x 1395.
    –
28. MACHINE ROOM LIGHT SWITCH, / EMERGENCY.
29. MAIN SWITCH GEAR, SEE BUILDERS NOTES E,F,G,H,J,K,L
30. HOISTING BEAMS EXISTING.
31. CONTROLLER SAFETY, INSULATED RUBBER MAT.
32. –
33. –
34. –
35. –

BUILDERS NOTES

A. LIFT DATUM'S AA, BB, CC. ALL DIMENSION ANS SETTING OUT TO BE TAKEN FROM THESE LINES.
B. PLUMB SHAFT SIZES SHOWN ARE MINIMUM PLUMB DIMENSIONS REQUIRED TO ACCOMMODATE LIFT EQUIPMENT FOR THIS CONTRACT. NO ALLOWANCE HAS BEEN MADE FOR BUILDERS TOLERANCE WHICH MUST BE ADDED. A TOLERANCE OF UP TO 25mm IS ACCEPTABLE UPTO A TRAVEL OF 30 METRES.
C. ALL DIMENSION SHOWN ARE IN MILLIMETERS.
D. METAL ARCHITRAVE'S BY APEX TO BE SHORED UP AND BACK FILLED THUS FULL HEIGHT, BUILD IN AND MAKE GOOD UP TO BOTTOM SILLS TO LIFT ERECTORS INSTRUCTIONS.
E. TEMPORARY 110v LIGHTING AND POWER REQUIRED IN LIFT SHAFT AND MACHINE ROOM, BY APEX.
F. THREE PHASE AND NEUTRAL SWITCH FUSE TO INTAKE ROOM AND ISOLATOR TO MACHINE ROOM BY APEX, ELECTRICAL SUB–CONTRACTOR. RATED AT TBC AMPS, FUSED AT TBC AMPS (MOTOR RATED)
G. CONSUMER UNIT TO MACHINE ROOM BY APEX, ELECTRICAL SUBCONTRACTOR TO SUIT ALL SERVICES.
H. APEX TO PROVIDE TO PROVIDE PERMANENT SHAFT LIGHTING IN EACH LIFT SHAFT, TO COMPLY WITH BUTLER & YOUNG SPECIFICATION.
J. APEX TO PROVIDE LIFT CAR LIGHTING SUPPLY AND SWITCHGEAR.
K. SHAFT LIGHTING AND CAR LIGHTING SUPPLY TO TERMINATE IN CONSUMER UNITS. ALL OTHER ELECTRICAL SERVICES BY APEX.
L. APEX TO PROVIDE PERMANENT LIGHTING AND SWITCH GEAR IN MACHINE ROOM.
   –
M. MACHINE ROOM TEMPERATURE TO BE MAINTAINED BETWEEN 5° AND 40°C FOR TRACTION LIFTS BY HEATING/VENTILATION BY APEX
   –
~~N. PROVIDE SMOKE VENT AT TOP OF SHAFT TO FRESH AIR. TO LOCAL AUTHORITIES REQUIREMENTS AND DETAILS.~~
~~P. LIFTING BEAM/BEAMS TO BE INSTALLED IN MACHINE/PUMP ROOM/TOP OF LIFT SHAFT BY APEX/OTHERS. BEAM/BEAMS TO BE DESIGNED TO SUIT A LIVE LOAD OF _____ KGS AT ANY POINT OF SPAN AND TESTED AND CLEARLY MARKED SWL _____ KGS.~~
Q. LIFT SHAFTS AND MACHINE ROOM TO BE TREATED TO INHIBIT THE FORMATION OF DUST.
   –
~~R. BUILDER TO BUILD IN _____ SETS OF _____ LONG _____ LONG _____ LONG INSERTS SUPPLIED BY APEX/BUILDER FOR DOOR CWT GUIDE FIXINGS.~~
~~S. BUILDER TO BUILD IN _____ SETS OF _____ LONG _____ LONG _____ LONG INSERTS SUPPLIED BY APEX/BUILDER FOR DOOR DOOR FRAME FIXINGS.~~
~~T. BUILDER TO ENSURE ALL INSERTS ARE FREE FROM CONCRETE.~~
U. SCAFFOLDING NOT REQUIRED



~~V. PROVIDE _____ LEVELS OF SCAFFOLD STAGING, MIDWAY BETWEEN SETS OF GUIDE FIXING INSERTS (FIXINGS). FRONT OF SHAFT (DIMENSION 'A') TO BE KEPT CLEAR FOR INSTALLATION OF LANDING ENTRANCES. PROVIDE A MIN. 3 BOARDS PER LEVEL RUNNING FRONT TO REAR. SCAFFOLD TOWER TO BE ADJUSTED AS AND WHEN REQUIRED BY LIFT ENGINEER TO SUIT PROGRESS OF WORKS.~~
W. ALL LIFT WORKS AND ASSOCIATED BUILDERS WORK, BUILDERS ATTENDANCE AND DECORATION WORK TO BE UNDERTAKEN IN ACCORDANCE WITH BUTLER & YOUNG SPECIFICATION FOR THE GRENFELL TOWER CONTRACT.
X. BUILDER TO CARRY OUT ALL NECESSARY BUILDERS WORK, BUILDERS ATTENDANCE WORK, CUTTING AWAY AND MAKING GOOD TO LIFT ENGINEERS INSTRUCTIONS.
Y. ALL BUILDERS WORK ETC., TO BE UNDERTAKEN BY APEX.
Z. BUILDER TO MAKE GOOD ALL NEW/REDUNDANT HOLES WHERE NECESSARY AND BUILD IN LANDING PUSH AND INDICATOR UNITS ETC., TO LIFT ENGINEERS INSTRUCTIONS.

	DATE	REVISION	COMMENTS
B	09/12/04	REVISED INLINE WITH COMMENTS RECEIVED – MARKED APPROVED	
A	24/11/04	REVISED INLINE WITH COMMENTS RECEIVED – MARKED APPROVED	

This drawing to be read in conjunction with drawing number

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UKAS ENVIROMENTAL MANAGEMENT

APEX LIFTS

ISO 9001 Registered

UKAS ENVIROMENTAL MANAGEMENT

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No. 32567

LIFT AND ESCALATOR ENGINEERS LTD.
Est. 1970
Apex House
LEFA business Park, Edgington Way, Sidcup, Kent. DA14 5BH
Tel. [redacted] ~ Fax. [redacted]
www.apexlifts.com ~ E–mail @apex–lifts.co.uk

By Appointment to Her Majesty The Queen Manufacturers and Suppliers of Passenger Lifts Apex Lift & Escalator Engineers Limited

APPROVED

Title GENERAL ARRANGEMENT – LIFT No. H90 and H91

Site GRENFELL TOWER, LANCASTER WEST ESTATE, LONDON. W11

Load 12 Persons 900 Kgs.	Speed 2.0 M/second		Drive VVVF	Control DC
Scale:– 1:10 1:5 } @A0	Drawn R.THORNE	Sheet 1 OF 3	Date 03/09/2004	Approved GP
Job No. C5469	Revision No. B		Drawing No.	C5469/001

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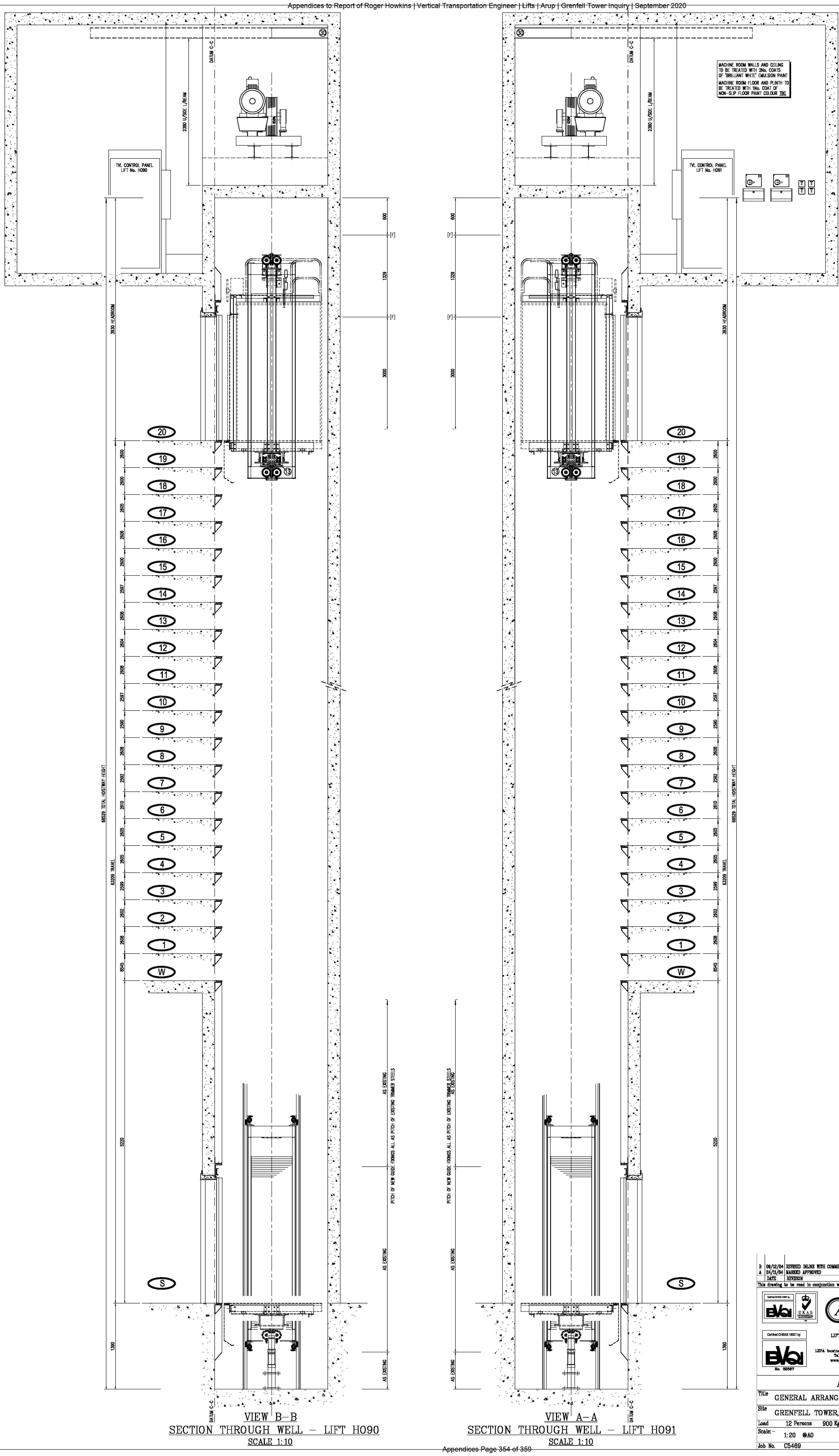

	DATE	REVISION	COMMENTS
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A	24/11/04	MARKED APPROVED	

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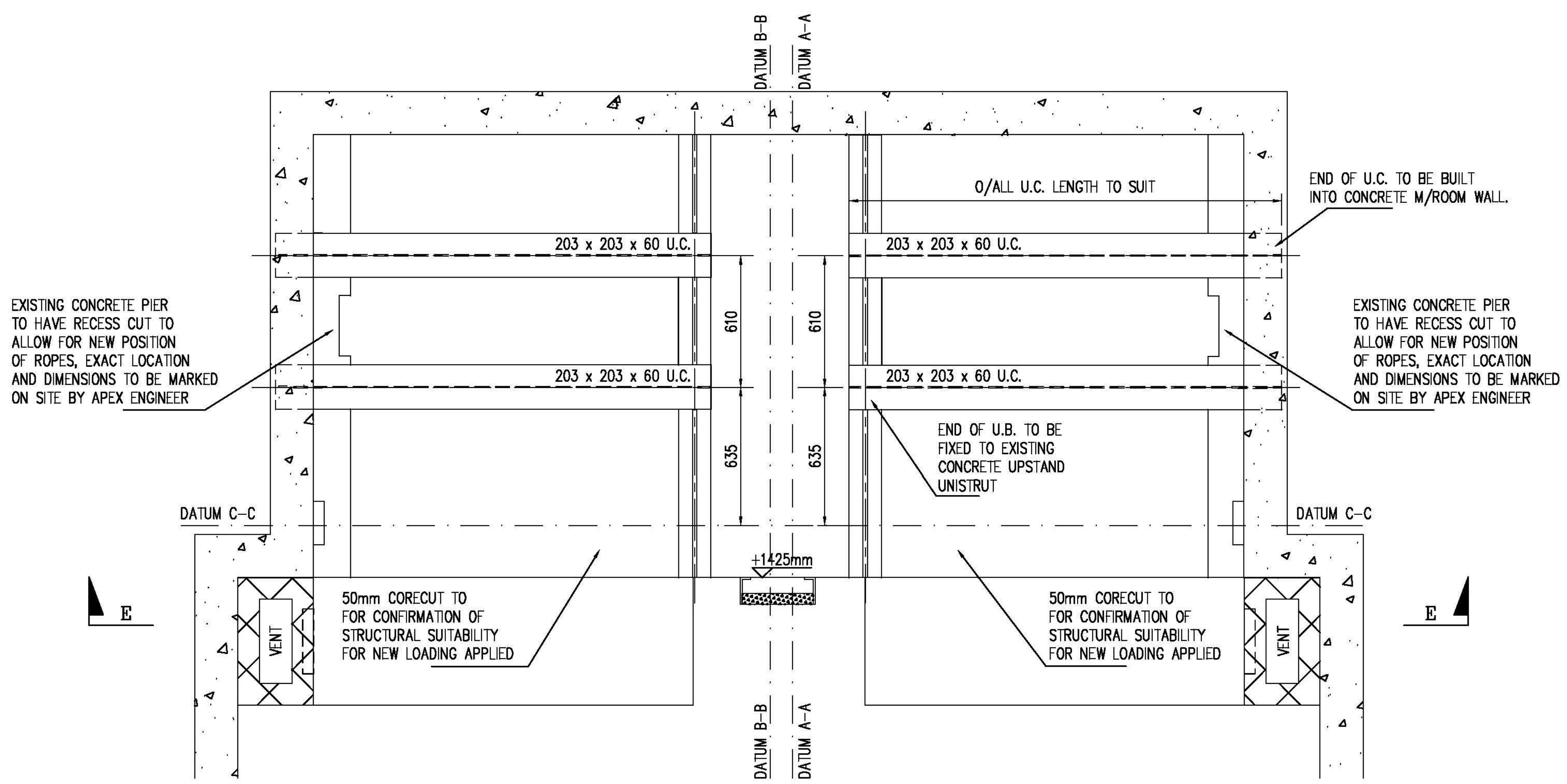
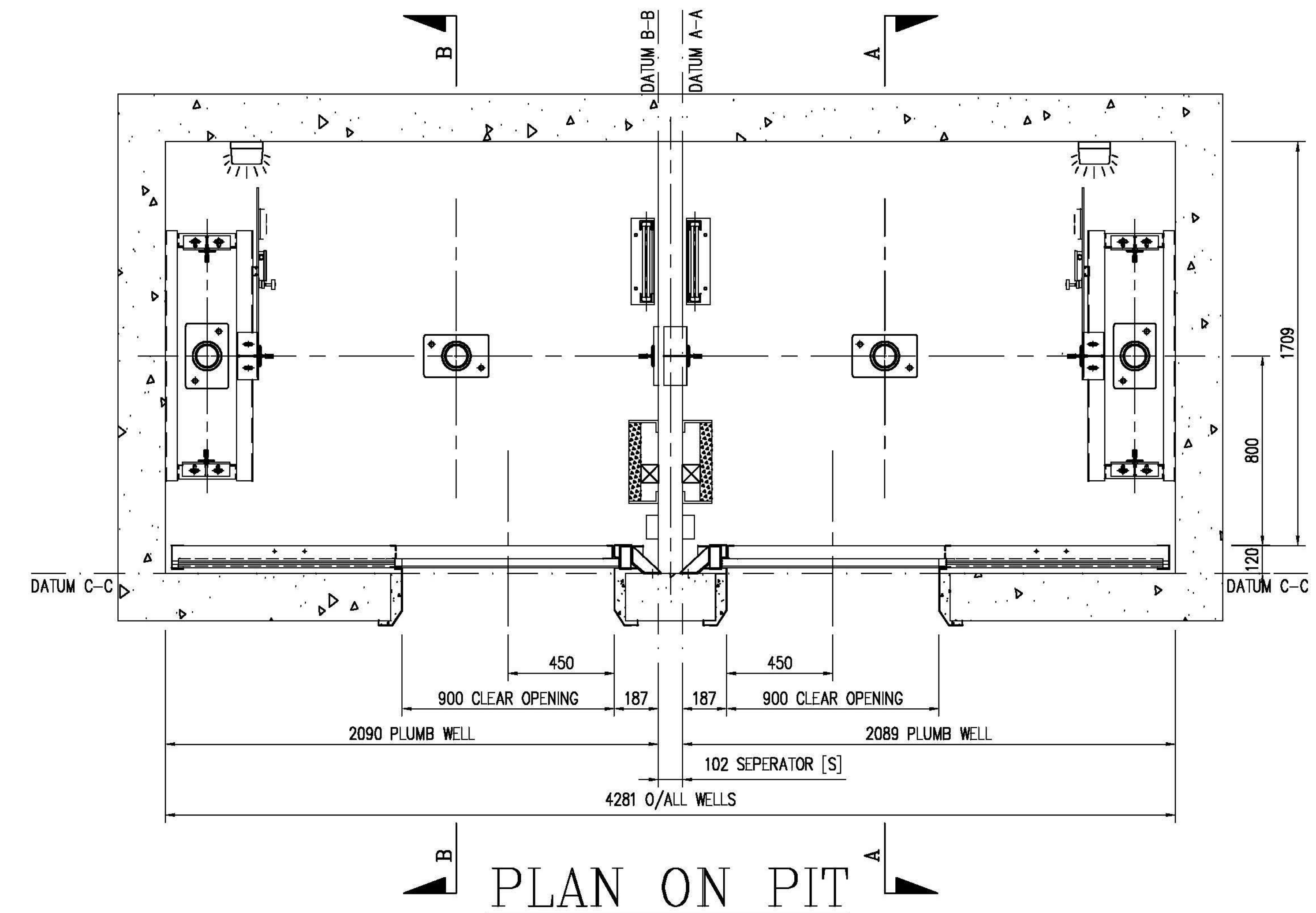
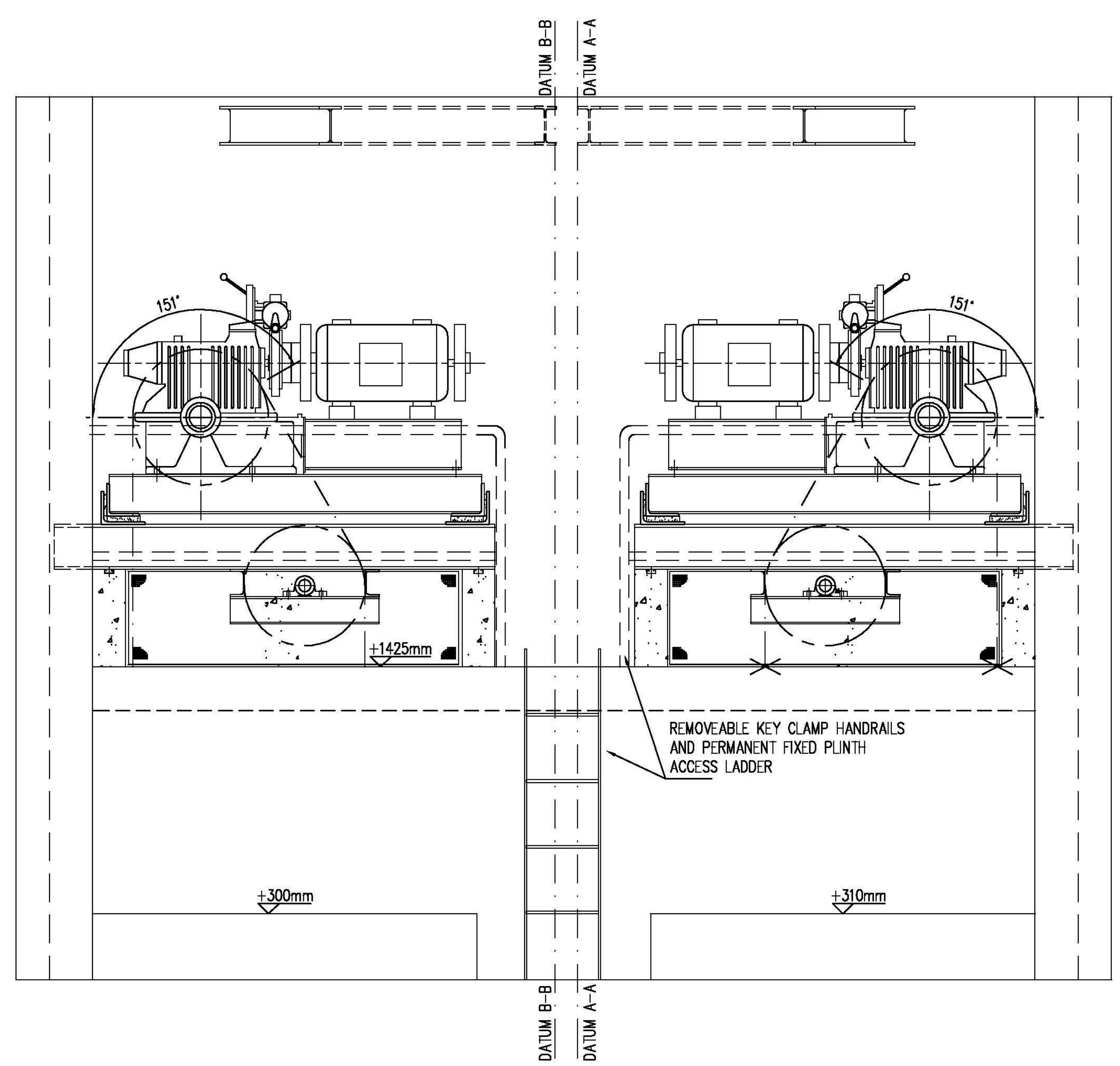
Load 12 Persons 900 Kgs.	Speed 2.0 M/second		Drive VVVF	Control DC
Scale:- 1:20 @A0	Drawn R.THORNE	Sheet 2 OF 3	Date 03/09/2004	Approved GP
Job No. C5469	Revision No. B		Draw	



PLAN ON MACHINE STEELS
SCALE 1:20



PLAN ON PIT
SCALE 1:20



VIEW E–E
ELEVATION ON MACHINE PLINTH
SCALE 1:20

B	09/12/04	REVISED INLINE WITH COMMENTS RECEIVED	
A	24/11/04	REVISED INLINE WITH COMMENTS RECEIVED	
A	24/11/04	MARKED APPROVED	
	DATE	REVISION	COMMENTS

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Title GENERAL ARRANGEMENT – LIFT No. H90 and H91

Site GRENFELL TOWER, LANCASTER WEST ESTATE, LONDON. W11

Load 12 Persons 900 Kgs.	Speed 2.0 M/second		Drive VVVF	Control DC
Scale:– 1:20 @A1	Drawn R.THORNE	Sheet 3 OF 3	Date 03/09/2004	Approved GP
Job No. C5469	Revision No. B		Drawing No.	C5469/001

Appendix 14

Curriculum Vitae

Roger Howkins

RHO00000004_0357

Roger Howkins

Profession
Vertical Transportation Engineer

Current Position
Consultant

Joined Arup
1989

Years of Experience
+50

Nationality
[redacted]

Qualification
HNC Electrical

Committees

1989-2002 CIBSE Lift Group

1995-2000 Council on Tall Buildings and Urban Habitat

1999-2001 EU – Improving Access to Existing Buildings

2000 -2003 ISO – Lift Ride Quality

2009-10 – Department of Health HTM 08.02 Review (Revised 2015-2016)

2009-Present – US Code A17.1 Code Committee Reviewer

2016 – International panel of experts on lifts and escalators Singapore Building and Construction Authority (BCA)

Publications

Publications include:

In event of fire use the elevators

Who's behind the call?

Elevator Core Areas – A Comparison

Universal Access or Disabled Access

Elevators for emergency evacuation and egress

Wer Steckt Hinter Auflugruf

En Caso de Incendo, Use Los Ascensores

Roger Howkins is a Consultant in the Arup VT Team, giving advice to all parts of the firm, both in the UK and Overseas, on the use of lifts, escalators and passenger conveyors in new developments and upgrading of existing equipment.

He has experience in providing expert witness and testimonies in the UK and overseas.

Commissioning and surveying of lifts, escalator and passenger conveyors projects is also undertaken, within the UK and overseas.

He has experience in surveying terrorist bomb and fire damaged lift and escalator installations.

Whilst the majority of the work has been in the UK or Europe, overseas projects have been undertaken, notably in Hong Kong, Philippines, Spain, Israel, Japan, UAE, USA, Australia, Switzerland and Kuwait.

In addition to his general expertise, he is an authority on lifts for airports, tall buildings, lift modernisation, traffic calculations and modern approach to system design involving panoramic lifts.

He has published an authoritative book on Lift Modernisation together with visual training aids and is a regular contributor to lift related publications.

Roger has extensive experience of managing major vertical transportation project teams to deliver innovative solutions to a variety of clients from inception to completion on a wide range of developments.

Hospitals (1989 – 2016)

- Kings College Hospital, London
  Lift engineer for various projects
- St Paul's Hospital, Vancouver
  Lift engineer for project
- UCL, London
  Lift engineer for project
- Onassis Hospital, Athens
  Lift engineer for project

Commercial Buildings (1989 – 2016)

- Fundacion Caixa Galicia – Spain
  Lift engineer for new HQ Building
- 122 Leadenhall Street, London
  Lift engineer for new high-rise building

- Custom House Dock, Dublin
  Lift engineer for project

Museums (1993 – 2016)

- Istanbul Cultural Centre, Istanbul
  Lift engineer for project
- British Museum, London
  Lift engineer for project
- Guggenheim, Abu Dhabi
  Lift engineer for project
- Victoria and Albert Museum, London
  Lift engineer for various projects
- Museum of Modern Art, Milan
  Lift engineer for project

Airports (1990 – 2016)

- Geneva, Switzerland
  Lift engineer for project
- Sabiah Gokcen, Istanbul, Turkey
  Lift engineer for project
- Frankfurt Terminal A Extension, Frankfurt
  Lift engineer for project
- Dublin Terminal 2, Dublin
  Lift engineer for project
- Kuwait Terminal 2, Kuwait
  Lift engineer for project

Transport Systems (1992 – 2016)

- Gibraltar Cable Car System, Gibraltar
  Lift engineer for project
- Crossrail, Bank Station, London
  Lift engineer for station project
- Tyne & Wear Metro, Newcastle
  Lift engineer for inclined lifts
- Lantau Airport Railway, Hong Kong
  Lift engineer for project

Tall Buildings and Towers (1990 - 2016)

- 122 Leadenhall Street, London
  Lift engineer for project
- BT Tower, London
  Lift engineer for project
- Canada Water, London
  Lift engineer for project

- Cork County Hall, Cork
  Lift engineer for project

Modernisation (1992 – 2016)

- BT Tower, London
  Lift engineer for project
- Channel 4, London
  Lift engineer for project
- River Plate House, London
  Lift engineer for project
- Hotel Gallia, Milan
  Lift engineer for project
- Bracken House
  Lift engineer for project