

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

Phase 1 Report – Section 4

**Overview of building works at Grenfell Tower,
including recent refurbishment 2012-2016**

REPORT OF

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Fire Safety Engineering

24th October 2018

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On behalf of	:	Grenfell Tower Inquiry
On instructions of	:	Cathy Kennedy, Solicitor, Grenfell Tower Inquiry
Subject Matter	:	To examine the circumstances surrounding the fire at Grenfell Tower on 14 th June 2017
Inspection Date(s)	:	6 th October, 1 st November, 7-9 th November 2017

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4 Overview of building works at Grenfell Tower, including recent refurbishment 2012-2016

- 4.1.1 This section provides an overview of the refurbishment works completed after the construction of Grenfell Tower in 1972. It is based on documentation provided to me in Relativity.
- 4.1.2 The review includes a description of the original design and construction of the building and provides a timeline of refurbishment works derived from documentation, since 1985 including a description of the programmes of work.
- 4.1.3 The main focus is the Refurbishment works in 2012 to 2016 – this is specifically to understand what parts of Grenfell Tower were altered during this latest refurbishment project and more importantly to ascertain the scale of works carried out.
- 4.1.4 However, the TMO tenant flat entrance door replacement from 2011, and the new tenant gas supply works in 2016 and 2017 have also become relevant to my work for this Public Inquiry.
- 4.1.5 Note, where it has been possible to confirm the involvement of specific companies in any of these aspects of works, an organogram has been provided.
- 4.1.6 The flat numbers for residential levels 1 – 23 in Grenfell Tower are shown for reference in Figure 4.2 through Figure 4.7 inclusive and Table 4.1. This is to help with orientation when reading the contents of my report.
- 4.1.7 Note, the residential flats on typical levels 4 – 23 are numbered ‘1’ through ‘6’. The specific number for each individual flat is based on its location in plan (reference) and the level it is on (sequential from 1 – 20, starting at level 4). For example, the flat in the Northeast corner of level 4 is flat 16, as shown in Figure 4.7.

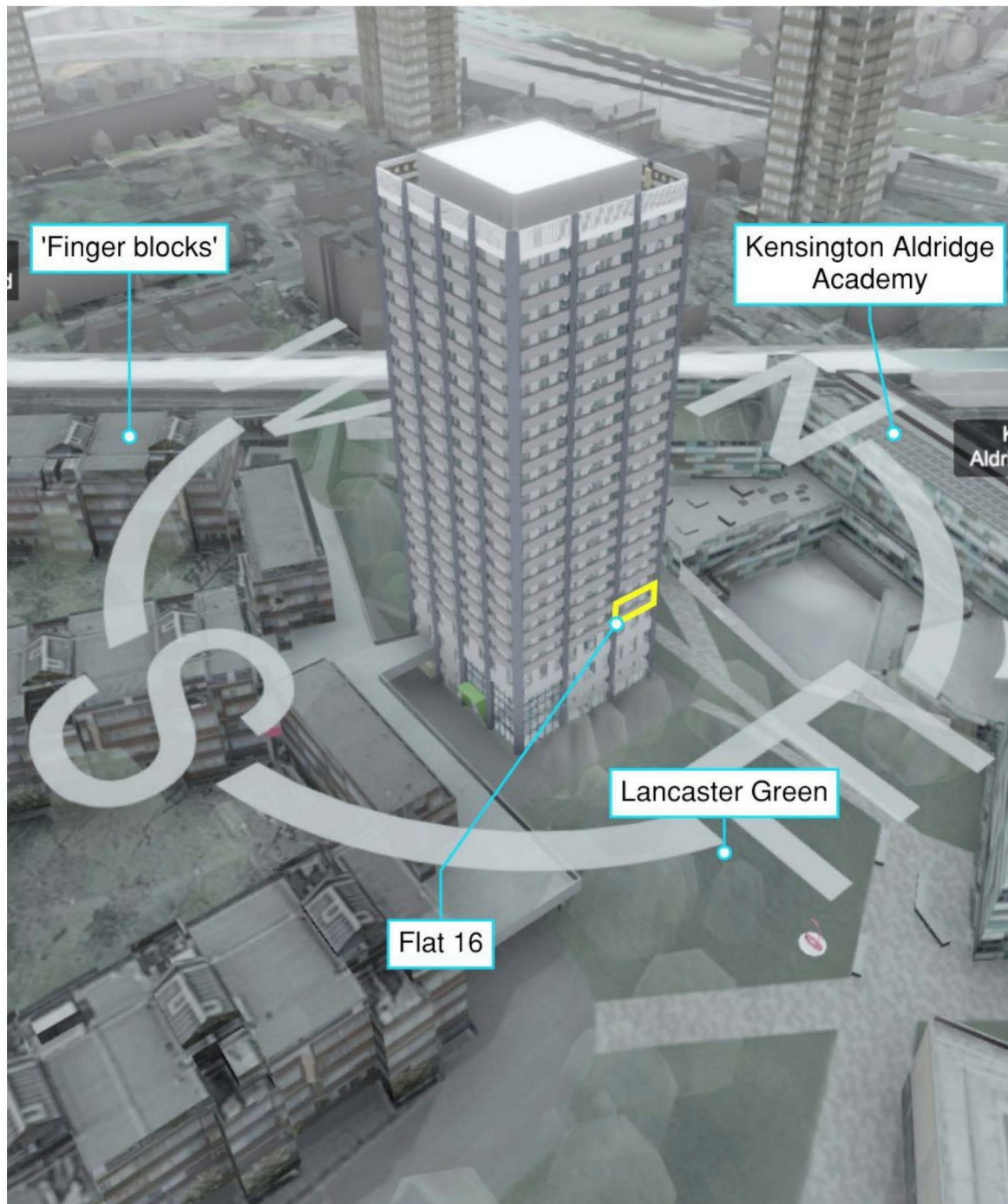


Figure 4.1: Flat 16 location in relation to surroundings in 3D model

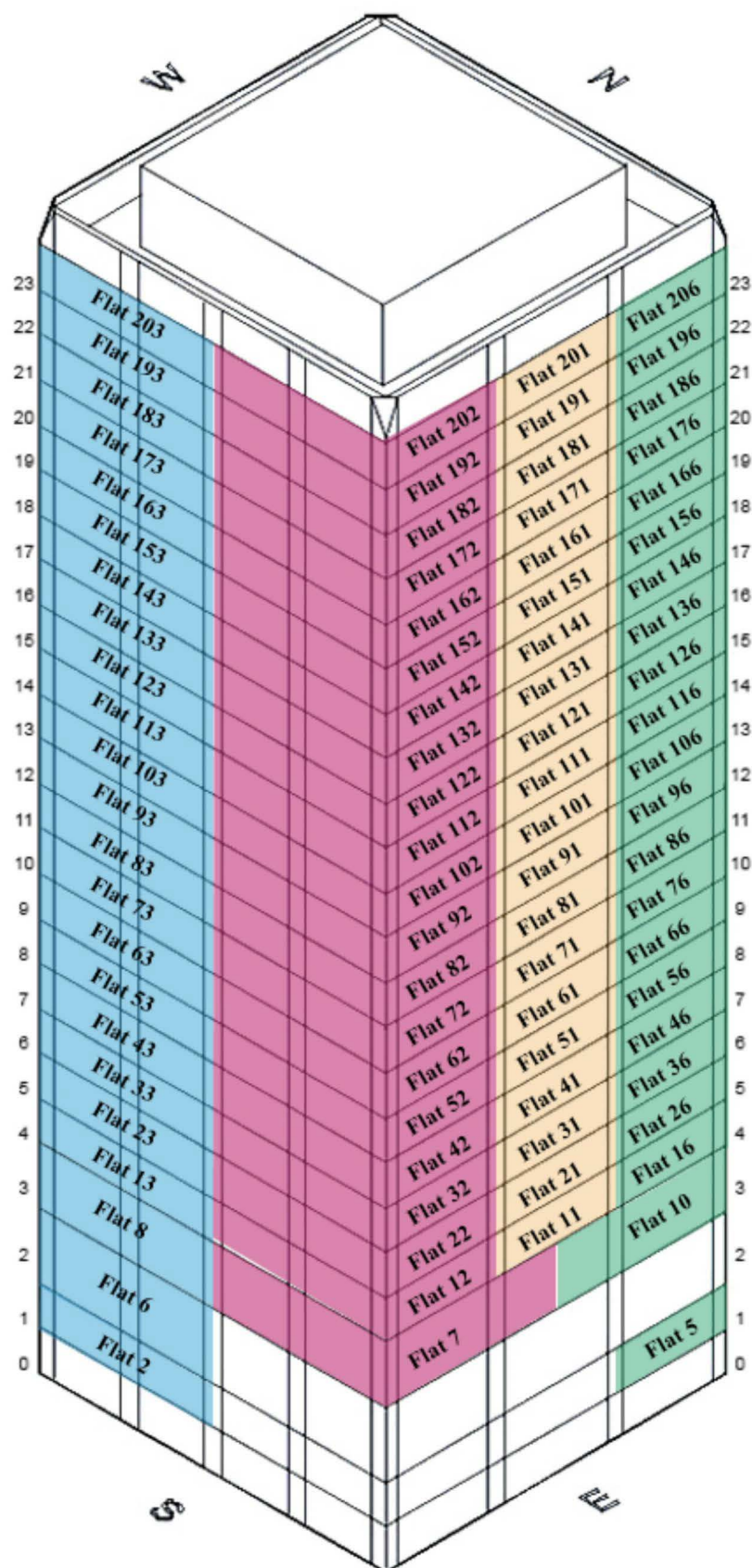


Figure 4.2: Residential flat numbers for South and East building elevations

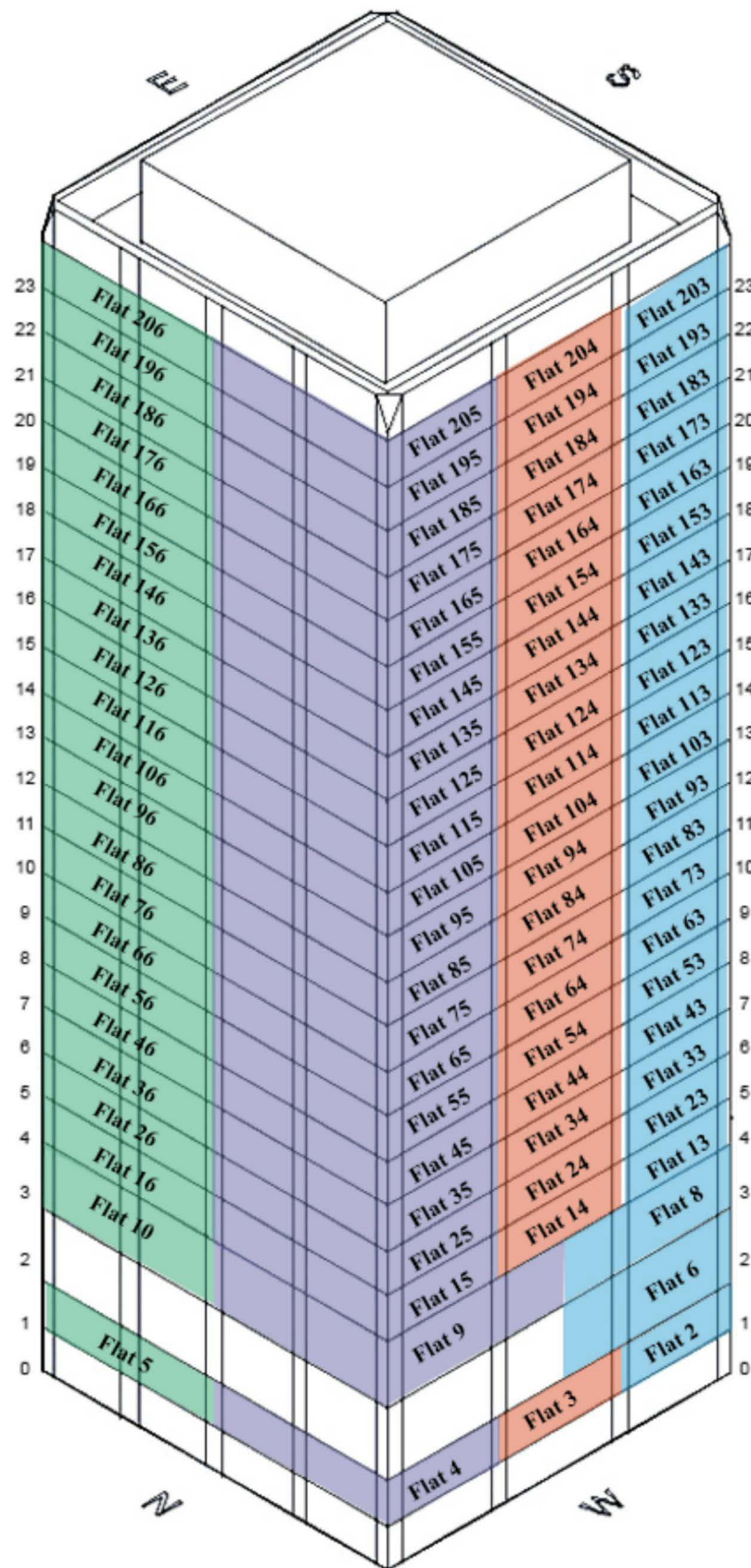


Figure 4.3: Residential flat numbers for North and West building elevations

Table 4.1: Residential flat numbers in Grenfell Tower, by level

Level	Flats
1	2, 3, 4, 5
2	6
3	7, 8, 9, 10
4	11, 12, 13, 14, 15, 16
5	21, 22, 23, 24, 25, 26
6	31, 32, 33, 34, 35, 36
7	41, 42, 43, 44, 45, 46
8	51, 52, 53, 54, 55, 56
9	61, 62, 63, 64, 65, 66
10	71, 72, 73, 74, 75, 76
11	81, 82, 83, 84, 85, 86
12	91, 92, 93, 94, 95, 96
13	101, 102, 103, 104, 105, 106
14	111, 112, 113, 114, 115, 116
15	121, 122, 123, 124, 125, 126
16	131, 132, 133, 134, 135, 136
17	141, 142, 143, 144, 145, 146
18	151, 152, 153, 154, 155, 156
19	161, 162, 163, 164, 165, 166
20	171, 172, 173, 174, 175, 176
21	181, 182, 183, 184, 185, 186
22	191, 192, 193, 194, 195, 196
23	201, 202, 203, 204, 205, 206

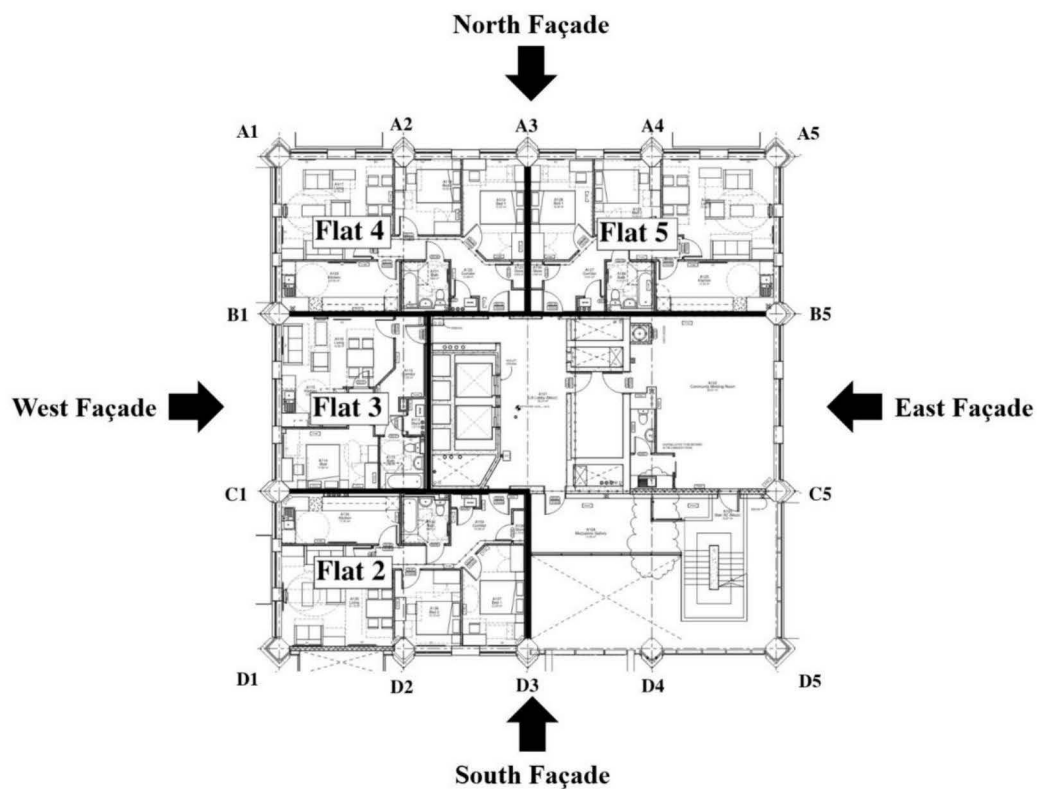


Figure 4.4: Residential flats 2 – 5 on level 1 (SEA00003231)

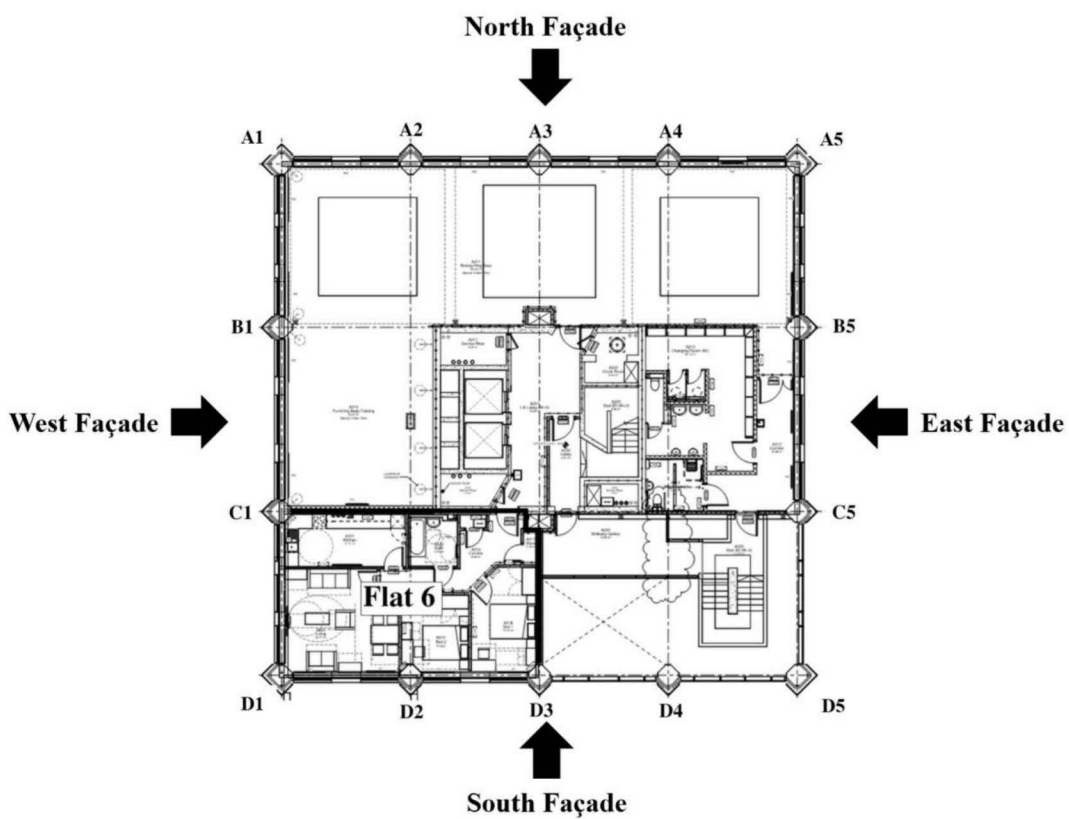


Figure 4.5: Residential flat 6 on level 2 (SEA00003149)

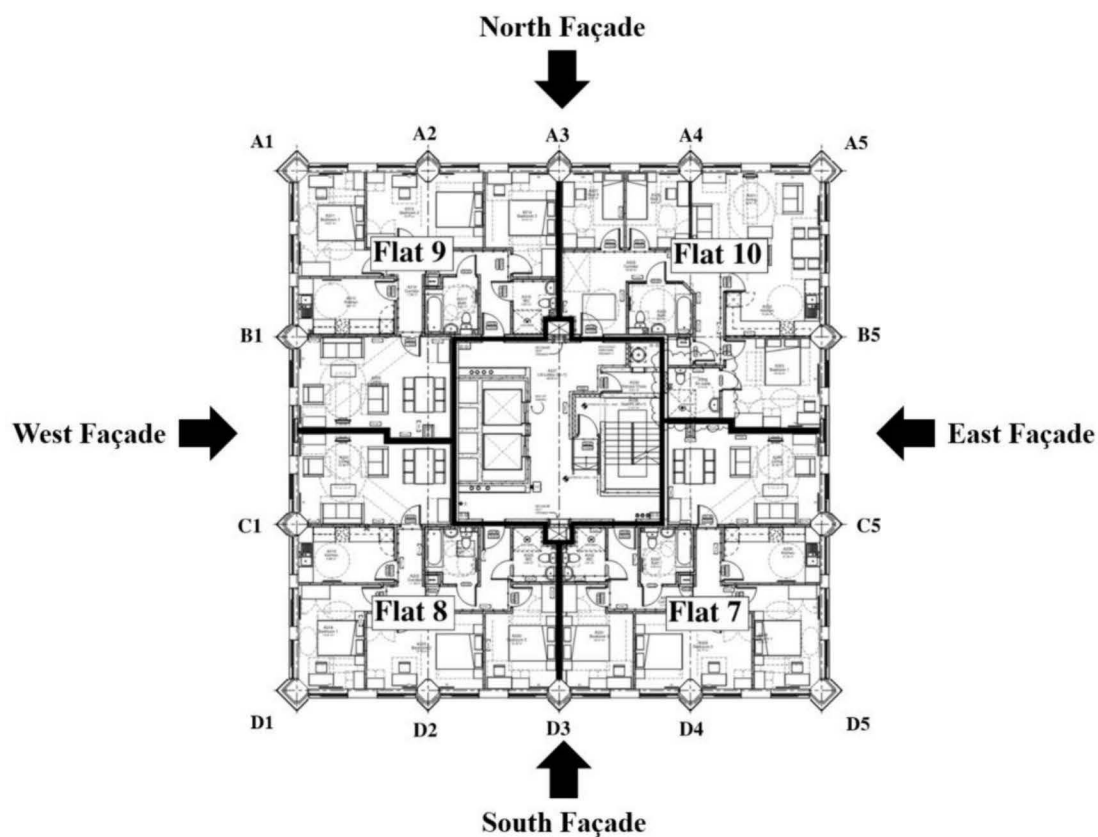


Figure 4.6: Residential flats 7-10 on level 3 (SEA00003229)

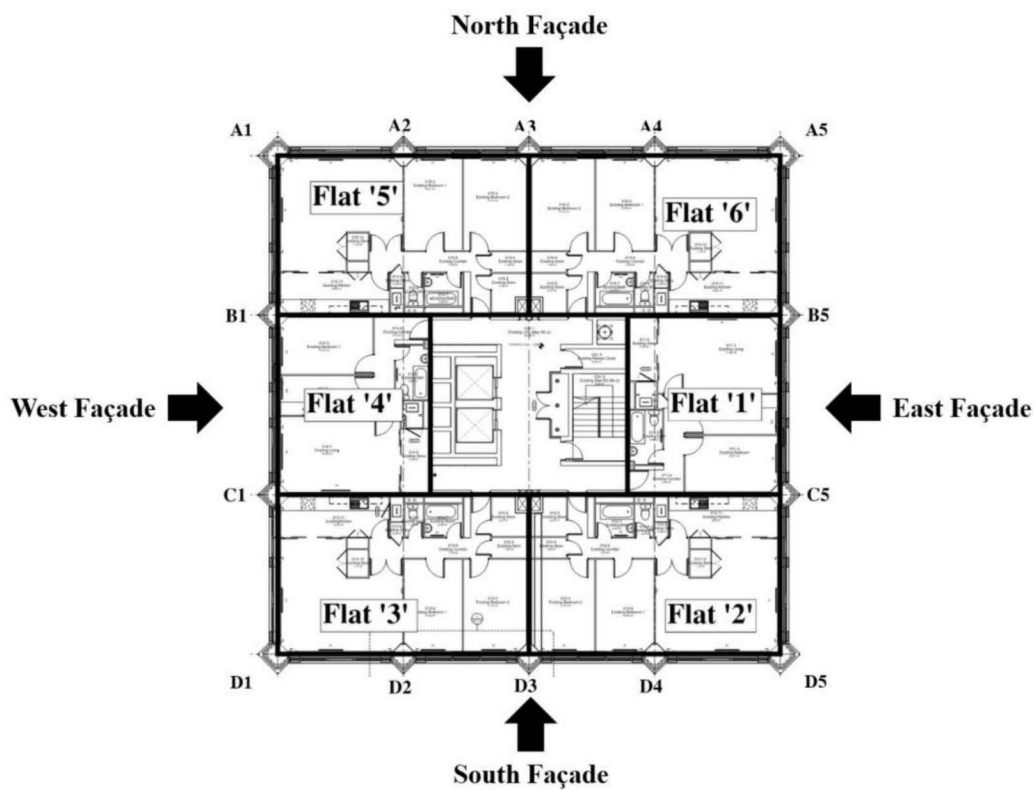


Figure 4.7: Residential flats on typical levels 4 – 23 (SEA00010474)

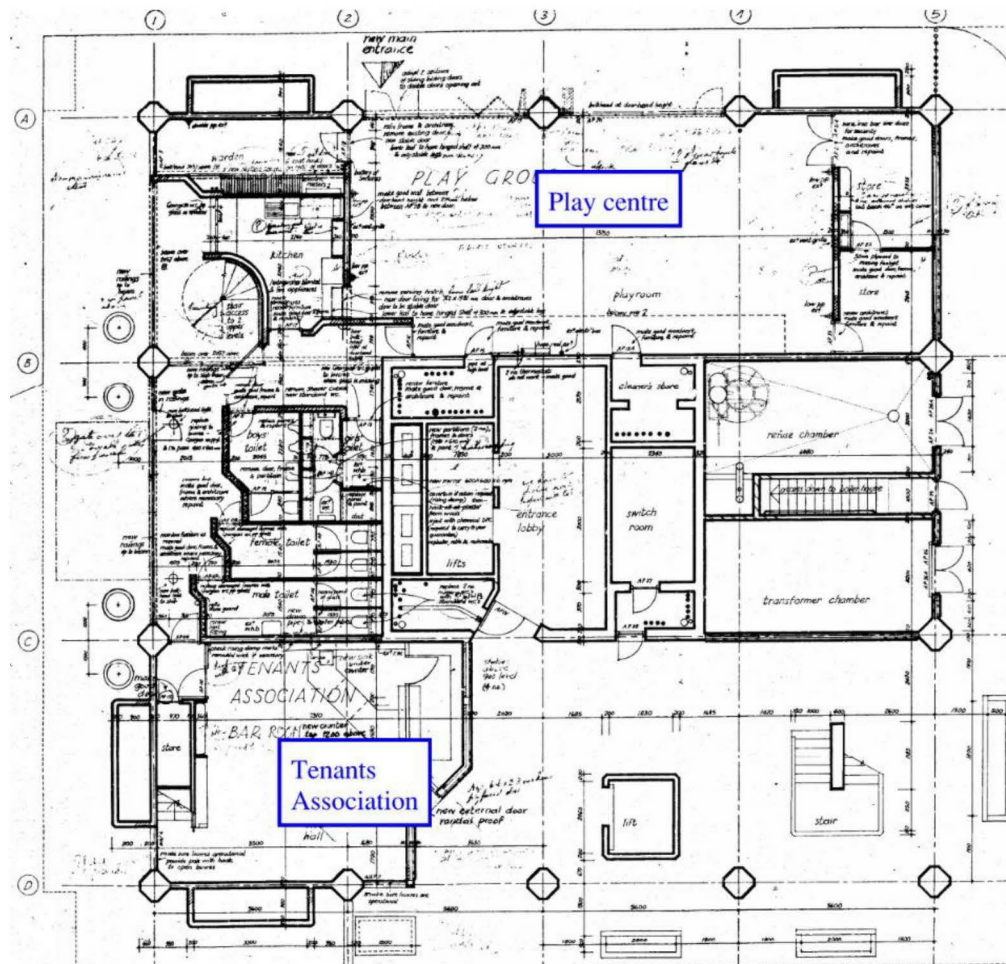


Figure 4.9: Original ground floor plan. (RBK00018861)

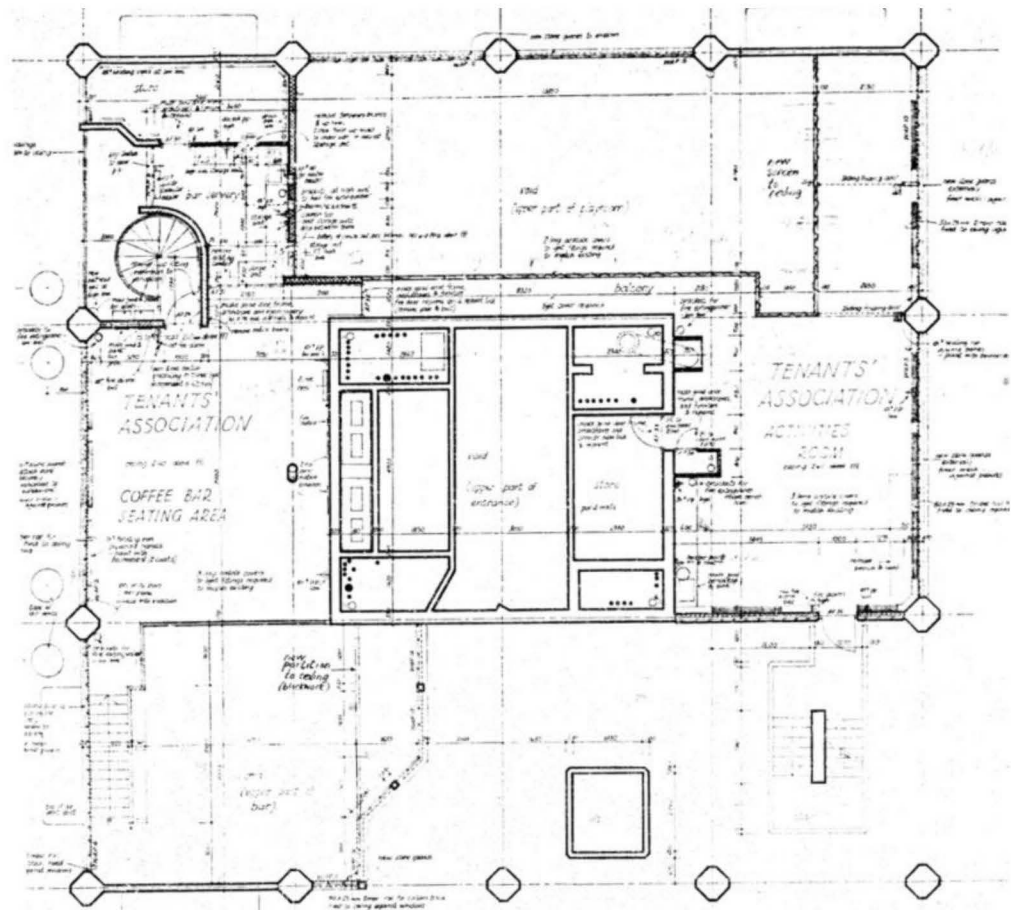


Figure 4.10: Original level 1 floor plan. (RBK00018862)

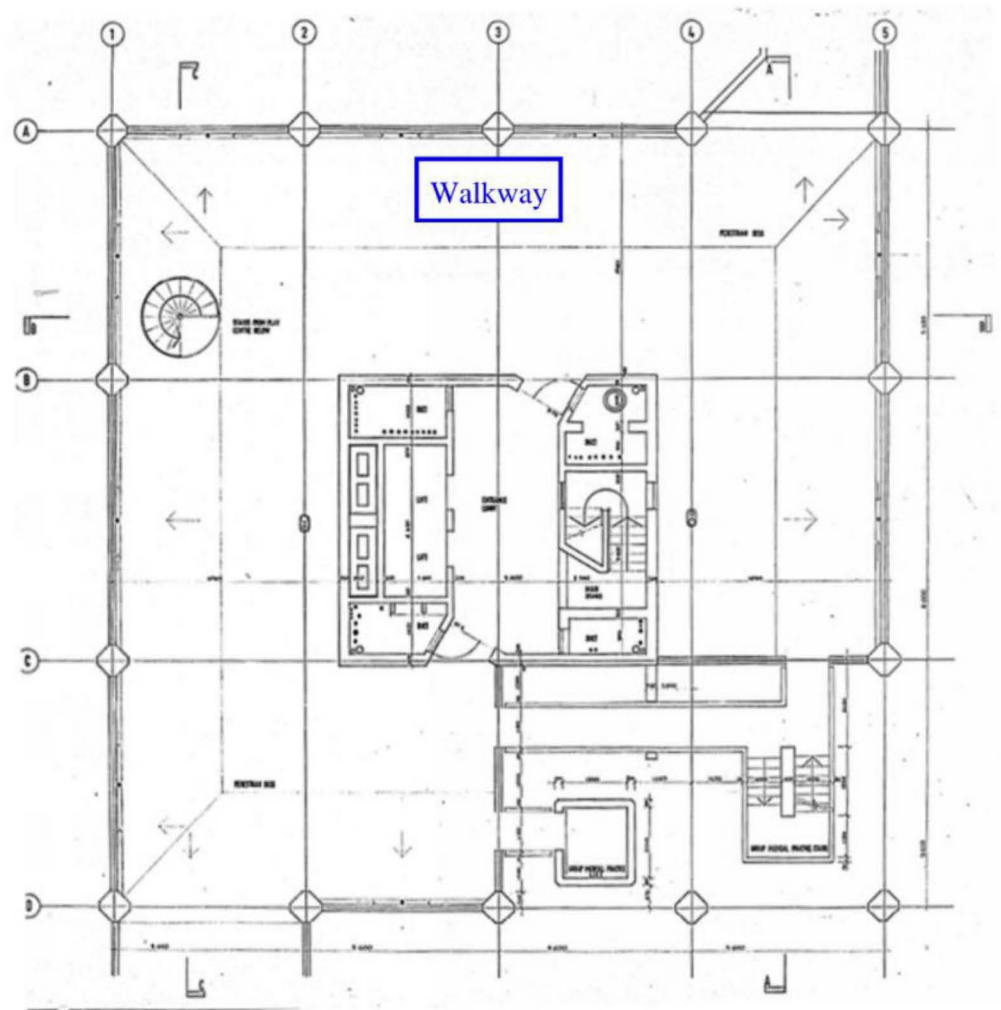


Figure 4.11: Original level 2 floor plan. (RBK00018833)

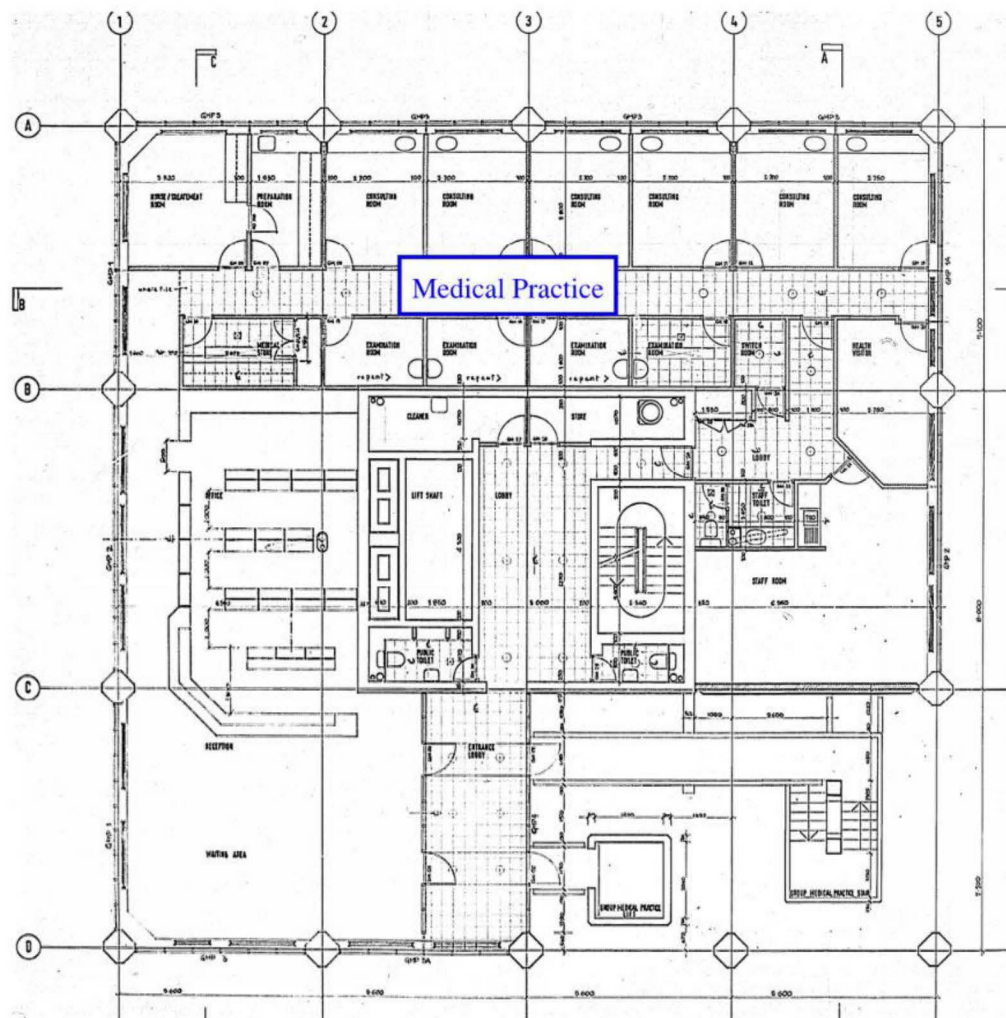


Figure 4.12: Original level 3 floor plan. (RBK00018834)

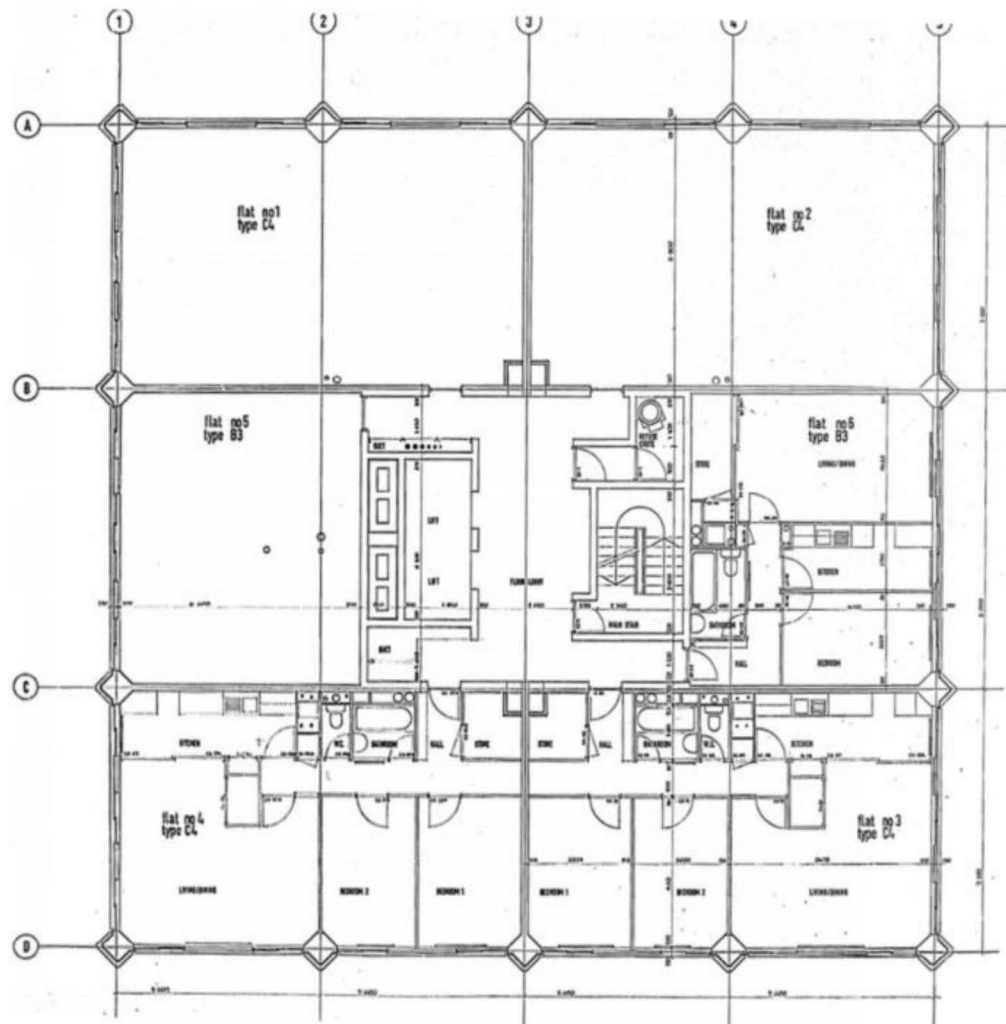


Figure 4.13: Original floor plan for residential levels 4 – 23. (RBK00018836)



Figure 4.14: Original construction of Grenfell Tower – building elevations (CCL00000028)

4.2.5 Evidence of CP3 1971 being used in the original design of Grenfell Tower

4.2.6 I will now outline the basis for my opinion that CP3 1971 was the guidance document relied upon for the original design of Grenfell Tower.

4.2.7 As I have explained in Section 3 of my Expert Report, Grenfell Tower was designed and constructed between 1968 and 1974 and this occurred during a transition period in the London statutory guidance for means of escape (i.e. between 1967 and 1974). [Dealt with by Section 38 of the London Building Act].

4.2.8 The London statutory guidance ‘LCC Guide Means of escape in case of fire’ (1967) contained a statement that the guidance was under revision and that, pending publication of the revised code (which did not happen in the end until 1974), applicants were advised to discuss their schemes with Greater London Council (GLC) officers during the design process. Therefore, between 1967 and 1974, whilst the statutory code of practice was under revision, designers were permitted to use alternate codes with the agreement of the GLC.

4.2.9 During this transition period, the national statutory guidance for means of escape was CP3 Part 4 (1962) (and then later CP3 1971). Therefore, it is possible that between 1967 and 1974 a designer could use either the LCC 1967, CP3 1962 or CP3 1971 in the design of means of escape in a high rise residential building in London. After the publication of the GLC statutory guide in 1974, CP3 1971 was adopted as the guidance document for means of escape in London.

4.2.10 I have reviewed the means of escape guidance in these three documents and compared the fire safety solutions those documents contain, with the fire safety solution installed in the original construction of Grenfell Tower.

4.2.11 The three guidance documents are as follows:

- a) **“Means of Escape in Case of Fire (Publication No. 3868)” published by London County Council as guidance to address Section 34 of the London Building Acts (Amendment) Act 1939.** This was first published in 1954 and later amended in 1967 (herein referred to as LCC 1967) and was the guidance in force in London during the design and construction of Grenfell Tower. [Note 4.2.8 above].
- b) **“British Standard Code of Practice CP3: Chapter IV Precautions against Fire, Part 1 Fire precautions in flats and maisonettes over 80ft in height” 1962 (herein referred to as CP3 1962)** was national guidance available during the early portion of the design stage for Grenfell Tower and was the guidance to satisfy the national legislation (Public Health Act 1939 & 1961); and
- c) **“British Standard Code of Practice CP3: Chapter IV-1 Code of basic data for the design of buildings. Precautions against fire. Flats and maisonettes (in blocks over two storeys)” 1971 (herein referred to as CP3 1971)** superseded CP3 1962, and was published in the later stage of the design of Grenfell Tower (197-1972), and also available during the

time of the construction of Grenfell Tower (1972-1974) to satisfy national legislation and regulation (Public Health Act 1939 & Building Regulations 1965).

- 4.2.12** By a process of elimination, which I explain below, in my opinion, the key indicator that suggests that CP3 1971 was used as the basis for the means of escape design guidance for Grenfell Tower is the single stair condition. It was not sited beside an external wall, and it had specific ventilated lobby arrangements to support its internal location.
- 4.2.13** All three design guides permitted a residential building to be constructed with a single stair for means of escape.
- 4.2.14** However, the statutory guidance LCC 1967 and CP3 1962 each required specific conditions to be met when a single stair was provided. These conditions were not met in the case of Grenfell Tower.
- 4.2.15** The LCC 1967 permitted blocks of flats to be served by a single stair for means of escape under three conditions only. None of these three conditions were met at Grenfell Tower, as examined in Table 4.2.

Table 4.2: Comparison of LCC guidance 1967 and Grenfell Tower configuration

LCC 1967 requirement for single stair condition	Grenfell Tower configuration
<p>(Page 7) NEW RESIDENTIAL BUILDINGS The following types of buildings (Classes VII and VIII) may be provided with a SINGLE PROTECTED STAIR CASE if they comply with the following requirements: -</p> <p>...</p> <p>Class VIII, - Blocks of flats and/or maisonettes “(a) – Flats or maisonettes having direct access to a common protected staircase, or to an internal protected lobby or corridor leading to a staircase or to an external balcony... The following requirements to be fulfilled:”</p> <p>B. with one or more floors over 42ft. “(v) – All dwellings in the storeys over 42ft should have alternative means of escape independent of the common stair either to the roof and thence to an adjoining building or to a balcony giving access to another building.”</p>	<p>a) Grenfell Tower did provide an internal protected lobby leading to a staircase and had one or more floors over 42ft [12.8m] therefore part B (v) was required to be complied with.</p> <p>b) However Grenfell Tower did not have an alternative escape via the roof to an adjoining building or via balcony giving access to an adjoining building.</p> <p>Grenfell Tower therefore could not comply with these requirements for a “single protected stair case”.</p>
<p>Class VIII, (b) “(b) – Flats or maisonettes having direct access to an open balcony or ventilated lobby connecting with a common, incombustible, fully-enclosed staircase, where the dwellings are only ONE IN LINE from the staircase”</p>	<p>No definition of ‘ONE IN LINE’ is provided. By reference to Class VIII (c) below ‘MORE THAN ONE IN LINE’ is described as where it is necessary to pass another dwelling in order to reach the staircase. It therefore appears ONE IN LINE means no other dwelling is required to be passed. Occupants of Flats 1 and 4 on each level needed to pass the entrance door to other flats to</p>

LCC 1967 requirement for single stair condition	Grenfell Tower configuration
	reach the stair. This means they were not ‘one in line’ from the staircase. Grenfell Tower therefore could not comply with single-stair blocks of flats described in (b).
<p>Class VIII, (c)</p> <p><i>“(c) – Flats or maisonnettes having a direct access to an open balcony or ventilated lobby connecting with a common, incombustible, fully-enclosed staircase, where the dwellings are MORE THAN ONE IN LINE from the staircase (i.e. where it is necessary to pass another dwelling in order to reach the staircase).</i></p> <p><i>As for (b) and with the following additional requirements:</i></p> <p>...</p> <p><i>(ii) Alternative means of escape from all floors over 80ft. by means of open balconies on both sides of the building and communicating with the common stair.”</i></p>	<p>Grenfell Tower did not provide open balconies in any location. Therefore, alternative means of escape were not provided to any dwelling above 80ft (approximately 24m).</p> <p>Grenfell Tower therefore could not comply with single-stair blocks of flats described in (c).</p>

4.2.16 CP3 1962 required buildings with a single stair for means of escape to also satisfy three conditions as per Section 208 part (c) (i) – (iii) which I have reproduced below (Figure 4.15):

<p>208. Stage three: main staircases in blocks of flats or maisonnettes.</p> <p>c. If any dwelling has access to only one main staircase the staircase enclosure should be entered on all floors from either:</p> <p>(i) a balcony, or [204 b (iv)]</p> <p>(ii) a ventilated lobby which adjoins an external wall and has a permanent opening in the external wall with a free area of not less than 15 sq ft and into which no dwelling, store or other fire risk opens and which communicates only with the staircase, with a lift or lifts if desired and through a smoke-stop door with a common approach hall or corridor, or with an external balcony, or [204 b (iii)]</p> <p>(iii) a corridor into which no dwelling, store or other fire risk opens and which communicates only with the staircase, with a lift or lifts if desired, and, through a smoke-stop door either with a private or common balcony, or with a private or common ventilated lobby which adjoins an external wall and has a permanent opening in the external wall with a free area of not less than 15 sq ft. [204 b (v)]</p>
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Figure 4.15: CP3 1962 rules on the provision of a single stair to a block of flats

4.2.17 The design of Grenfell Tower did not meet any of the three conditions stated in Figure 4.15.

- 4.2.18** This is because at Grenfell Tower, the staircase is accessed by a central ventilated lobby, and so cannot comply with the guidance of CP3 1962 in the following ways:
- a) Section 208 part (c) (i) - The Grenfell Tower ventilated lobby is not a balcony
 - b) Section 208 part (c) (ii) - The Grenfell Tower ventilated lobby does not adjoin an external wall in which there is a permanent opening of not less than 15 sq ft.
 - c) Section 208 part (c) (ii) - The Grenfell Tower ventilated lobby does not communicate with the stair case through a smoke-stop door off a balcony or ventilated lobby adjoining an external wall in which there is a permanent opening of not less than 15 sq ft.
- 4.2.19** Therefore, the design and construction of the Grenfell Tower means of escape was not based on CP3 1962.
- 4.2.20** In the absence of all of those conditions, I now consider CP3 1971.
- 4.2.21** CP3 1971 clause 3.4.3.1 (4) permitted blocks of flats and maisonettes to:
- a) be provided with a single stairway for means of escape through a Stage II escape route (corridor or lobby) where that escape route was provided with cross ventilation and there are no fire risks in the corridor (refuse chutes may be acceptable in certain conditions);
 - b) for such stage II escape routes travel distances of up to 15m are permitted between the flat entrance door and the stair entrance door.
- 4.2.22** Grenfell Tower had a single stairway for escape and was provided with a cross ventilated lobby within which travel distances did not exceed 15m which is therefore consistent with the provisions of CP3 1971.
- 4.2.23** As I have explained in Section 3 and Appendix D, the designer of Grenfell Tower, in addition to application of guidance for means of escape [Section 38 of the London Building Act] was also required to consider the guidance published to address Section 20 London Building Acts (amendment) Act 1939.
- 4.2.24** At the time of Grenfell Tower's construction, Greater London Council published guidance in a Section 20 Code of Practice (1970) to address this part of the Act. The guidance in this code of practice relevant to Grenfell Tower relates to provision of fire mains, fire lifts, and what is termed a "fire fighting lobby approach staircase".
- 4.2.25** Therefore, an overlap in guidance for fire-fighting provisions in a single stair case building, existed between the GLC Section 20 Code of Practice 1970 and the design code applied for means of escape in Grenfell Tower, CP3 1971, by means of the single stair and ventilation provisions for the lobbies.

- 4.2.26 In Appendix H I have presented the requirements of each code of practice relevant to fire fighting provisions. From this comparison I have found two key differences: the ventilation provisions to the stair and lobbies, and the fire resistance of the enclosure to the staircase and lobby.
- 4.2.27 The first key difference relates to ventilation of the stair and lobbies - the GLC Section 20 Code of Practice 1970 requires ventilation of the lobby using permanent openings to the outside. It also required a permanent vent of 0.9m^2 at the top of the stair and the bottom of the stair. In Appendix J I have set out clearly how these provisions were not present in Grenfell Tower.
- 4.2.28 In contrast, CP3 1971 required the stair to be provided with a 1m^2 vent at the top only, which was provided in Grenfell Tower. For the lobbies CP3 1971 permitted ventilation of the lobbies using automatically opening vents and ducts to ventilate internal lobbies. I therefore assess the compliance of the provisions for ventilation against CP3 1971 in my Expert Report.
- 4.2.29 The second key difference relates to the fire resistance enclosure of the lobby, stair case and fire lift. This applies to the fire resistance of the enclosing walls, floors and fire doors.
- 4.2.30 The GLC Section 20 Code of Practice (paragraph A1.02) requires the enclosure to the stair case, lobby and fire lifts to achieve twice the fire resistance standard required for elements of construction in the Constructional by-laws. CP3 1971 does not make recommendations of fire resistance for elements of construction '*unless the standards recommended are additional to statutory requirements*'.
- 4.2.31 Therefore, CP3 1971 recommends the walls enclosing the staircase, lobby and lifts comply with the statutory requirements; in London this was the Constructional by-laws.
- 4.2.32 With regard to doors CP3 1971 recommends a standard '*additional to statutory requirements*'. It recommends a specific performance of fire door to the stair opening onto the lobby and to the flats opening onto the lobby. These doors, coupled with the ventilation, protect the single staircase.
- 4.2.33 CP3 1971 required doors termed "Type 3" for flat entrance doors and "Type 2" for stair doors.
- 4.2.34 It is important to note that the GLC Section 20 Code of Practice also recommended performances for fire doors. A door termed "Class A" for the flat entrance doors and the staircase door.
- 4.2.35 In my investigation of historic doors in Appendix M I present evidence that Class A doors can achieve an integrity fire resistance as low as 12mins. Type 2 doors by contrast were required to achieve 30 minutes integrity fire resistance. Therefore, in relation to doors the GLC Section 20 Code of Practice 1970 permitted a lower standard of stair fire door than CP3 1971.

- 4.2.36** Figure 16b in CP3 1971 for the cross ventilation design of the lobby to a single stair case clearly states a Type 2 door for the stair case and a Type 3 door to the flat – these doors open directly onto the ventilated lobby, and the combination of doors and the ventilation protect the stair.
- 4.2.37** CP3 1971 describes in 4.3 Fire Resisting Doors *“Fire resisting doors are one of the most important links in the chain of fire safety precautions and care in their selection, to ensure that they are adequate for their purpose cannot be overstated”*.
- 4.2.38** It is for these reasons, I assess the compliance of the original construction of Grenfell Tower in my Expert Report using the guidance of CP3 1971, including the specific door requirements for ventilated lobbies - Type 2 in the stairs and Type 3 to the flats opening onto the ventilated lobbies.
- 4.2.39** I have made clear where a higher standard was found, and if it relates to the requirements of Section 20. As I have explained in Section 3, this was limited to the higher standard of fire resistance to the stair enclosure. See Appendix H and J of my report.

4.3 Timeline of building works

- 4.3.1** Table 4.3 below shows the major works that occurred in Grenfell Tower from 1985.
- 4.3.2** I have derived this from the information contained in a chronology of works submitted by RBKC (RBK00000275) and through inspection of documents submitted by Carl Stokes (CST00000384), KCTMO (TMO10048276) and Curtins Consulting Limited (CCL00000028), and as explained in detail in Appendix E.
- 4.3.3** I discuss the works summarised in in more detail in the following sections. Each section also identifies the works discussed on mark-ups overlaid on the Studio E As-Built drawings. This is in order to quantify what areas and to what scale the works altered Grenfell Tower, and where.
- 4.3.4** I describe the 2012-2016 refurbishment project in more detail from Section 4.7.

Table 4.3: Summary works for Grenfell Tower

Building works	Date	Description of Works	Extent of Works
Refitting of flat front doors	1985	Provision of new self-closing fire resisting flat entrance doors.	Unknown
Lift replacement	2004-2006	Replacement of two electric passenger lifts and installation of one hydraulic passenger lift inclusive of all builders, electrical, structural and other attended works.	Lift shaft spanning from ground floor to level 23, but did not serve Levels 1 or 3 Lift motor room at Roof level.
TMO tenant flat entrance door replacement	2011-2013	Programme of replacing 106 No. flat front entrance doors of dwellings occupied by RBKC tenants to comply with fire safety standards. The replacement doors were intended to achieve FD30S ratings, self-closing.	Flat entrance doors on Levels 4 to level 23
Refurbishment works	2012 - 2016	Over cladding of the façade.	Entire external envelope of building at all levels up to the crown of the roof edge balustrade. Did not include any works to the existing rooftop plantroom enclosure or the roof surface membranes.
		Reconfiguration of Walkway levels (Levels 1 to 3) to provide additional residential accommodation (9 no. new flats) and reconfigured non-residential accommodation. Installation of new flat entrance doors to nine new flats on those levels. Modification of the communal lobby to the stair on Level 2. Six new fire doors to the modified protected stair enclosures.	Levels 1 – 3
		Refurbishment and relocation of the nursery from Level 1 to Ground level.	Ground level
		Relocation and refurbishment of the boxing club from Ground and Level 1 to Level 2.	Level 2
		Provision of new community room, replacing part of the relocated nursery.	Level 1
		Modification to the open stair between Ground and Level 3 to	Ground level – level 2

Building works	Date	Description of Works	Extent of Works
		enclose it and create a new entrance lobby spanning 3 storeys.	
		Open doorways into the existing lift shafts to serve two new floors being served. Previously the lifts did not serve Levels 1 and 3 (previously called Mezzanine and Walkway+1).	Level 1 & 3
		New heating system was provided New central boiler plant located in basement, connecting to this heating system. Each flat, the nursery, boxing studio and the community use room at Ground are served by individual HIU (heat interface unit), providing space heating and instantaneous hot water.	All areas inside flats on every storey, all non-domestic accommodation at levels Ground to 3 and all common lobbies from Level 3 to Level 23.
		New boosted cold water distribution system was provided.	All areas inside flats on every storey, all non-domestic accommodation at levels Ground to 3 and all common lobbies from Level 3 to Level 23.
		Refurbishment and extension of the smoke/environmental ventilation systems.	Walkway plant (at high level above stair on Level 2) Roof top plant room areas Automatic opening ventilators (AOV) in lobbies on all floors from Level 2 to 23
		New branches and landing valves from the existing dry riser system to serve lobbies at Level 1, 2 and 3, and to provide a new inlet at Ground level.	Basement – level 3
		New gas connection from the existing Landlord gas system in the basement to serve the new boiler plant in the basement.	Basement level
New tenant gas supply	2016 – 2017	A new tenant gas supply, replacing one of the existing risers, was installed in Grenfell Tower to serve residential flats. This work was undertaken to rectify a gas leak discovered in 2016.	Basement level to roof Distribution pipe in lobbies on Levels 4-6, 8, 9, 11-14, 16, 17 and 21 Installation of new gas meters and associated pipework to 13 residential flats between levels 4 and 21.

4.4 Main flat entrance fire door replacement 1985

4.4.1 A Building Regulations application (AR/BR/2/150917) for the provision of new self-closing fire resisting flat entrance doors was made in 1985 (RBK00000275). No information has been provided as part of the disclosure of the number of flat entrance doors replaced.

4.4.2 It is unknown if any works were undertaken to the stair doors at this time.

4.5 Lift replacement works 2005

4.5.1 Description of works

4.5.2 The original construction of Grenfell Tower (1972) consisted of two lifts in the central core area. As described in Appendix L, these lifts would have been required by the relevant design guidance to be installed as “Fireman’s lifts”. This represents a lower standard of fire safety provision than modern “firefighting lift” installations, however CP3 1971 still required:

- a) A fire switch whereby firemen obtain the use of a lift without interference;
- b) Lifts to serve every residential floor;
- c) A platform area of at least 1.5m² and a capacity of 550kg;
- d) An independent power supply, routed through low risk areas, and
- e) The maximum distance from the stair door to the lift to be 10m.

4.5.3 Documents associated with the design, installation and commissioning of the lifts in 2005 and 2006 (APX00000094-96) submitted by Apex Lift & Escalator Engineers Ltd show that they were appointed as main contractors for the following works:

“Refurbishment of two electric passenger lifts and installation of one hydraulic passenger lift inclusive of all builders, electrical, structural and other attended works.”

4.5.4 I have reviewed the Health and Safety file (CST00000384) which includes the specification for the lifts. The lift replacement was undertaken as a “like for like” replacement. The lifts were not installed as full firefighting lifts in accordance with the relevant guidance in 2005, i.e. they were not provided with alternative power supplies and with water protection to their control systems. Please refer to Appendix L for additional details.

4.5.5 I have highlighted the 2005 lift replacement works in Figure 4.17 and Figure 4.18, with a side by side comparison of the original plan and existing plan (2012) of the typical residential levels (4 – 23) and the plant room (no original drawing available at this time).

4.5.6 The programme of works listed in the Health and Safety file (CST00000384) states the works are to occur between 14/01/2005 to 08/07/2005. The

commissioning certificate (the final testing before a lift is taken into service) of the final lift is dated 14th February 2006.

4.5.7 Fire switches were observed at both level 2 and at Ground level, however there is no reference, in the evidence available to me regarding the design, installation or commissioning documentation, as to when these switches were installed and/or replaced.

4.5.8 Figure 4.16 presents an organogram I have created of the companies that have currently been identified as contributing to the lift replacement works.



Figure 4.16: Organogram for 2005 lift works

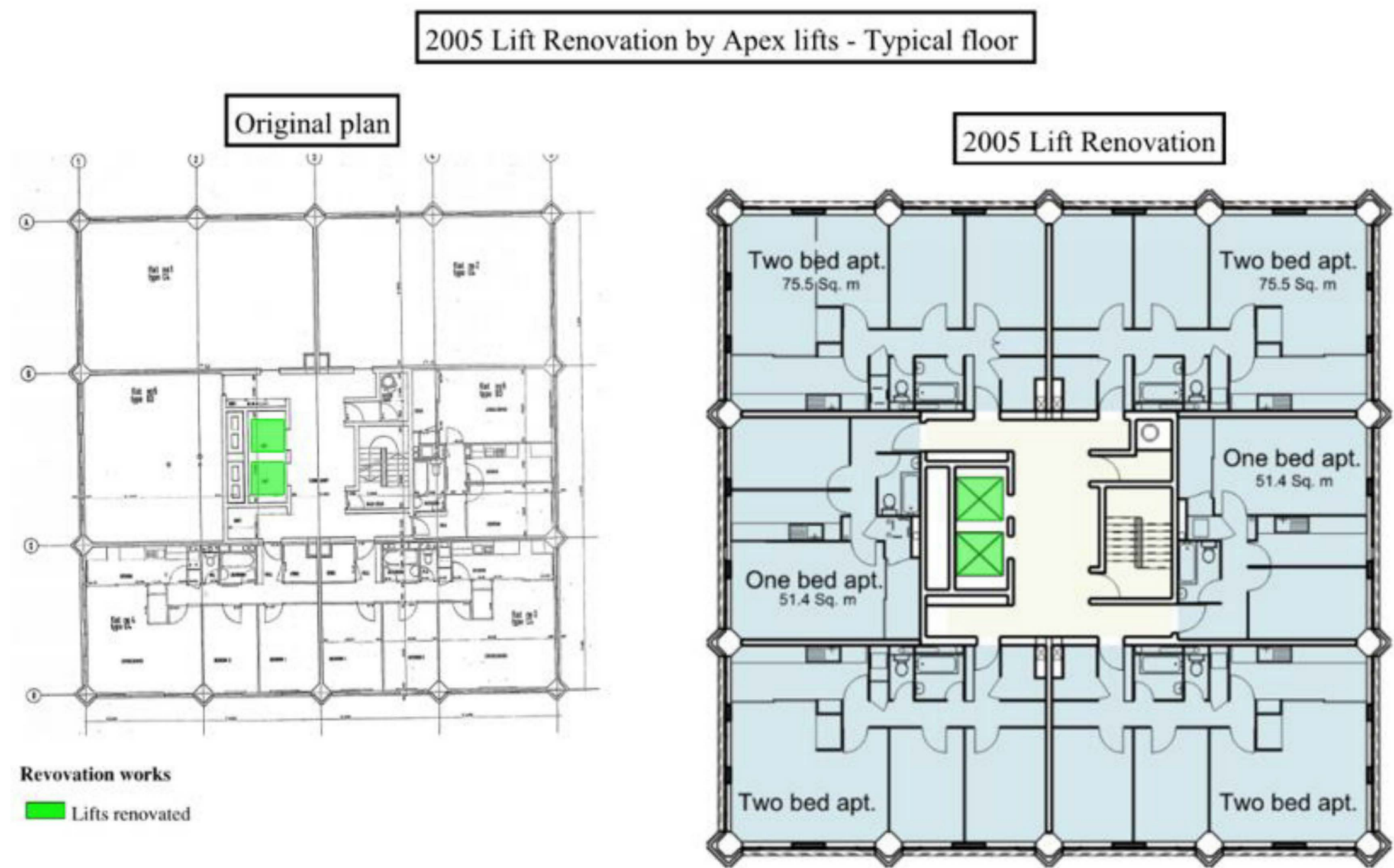
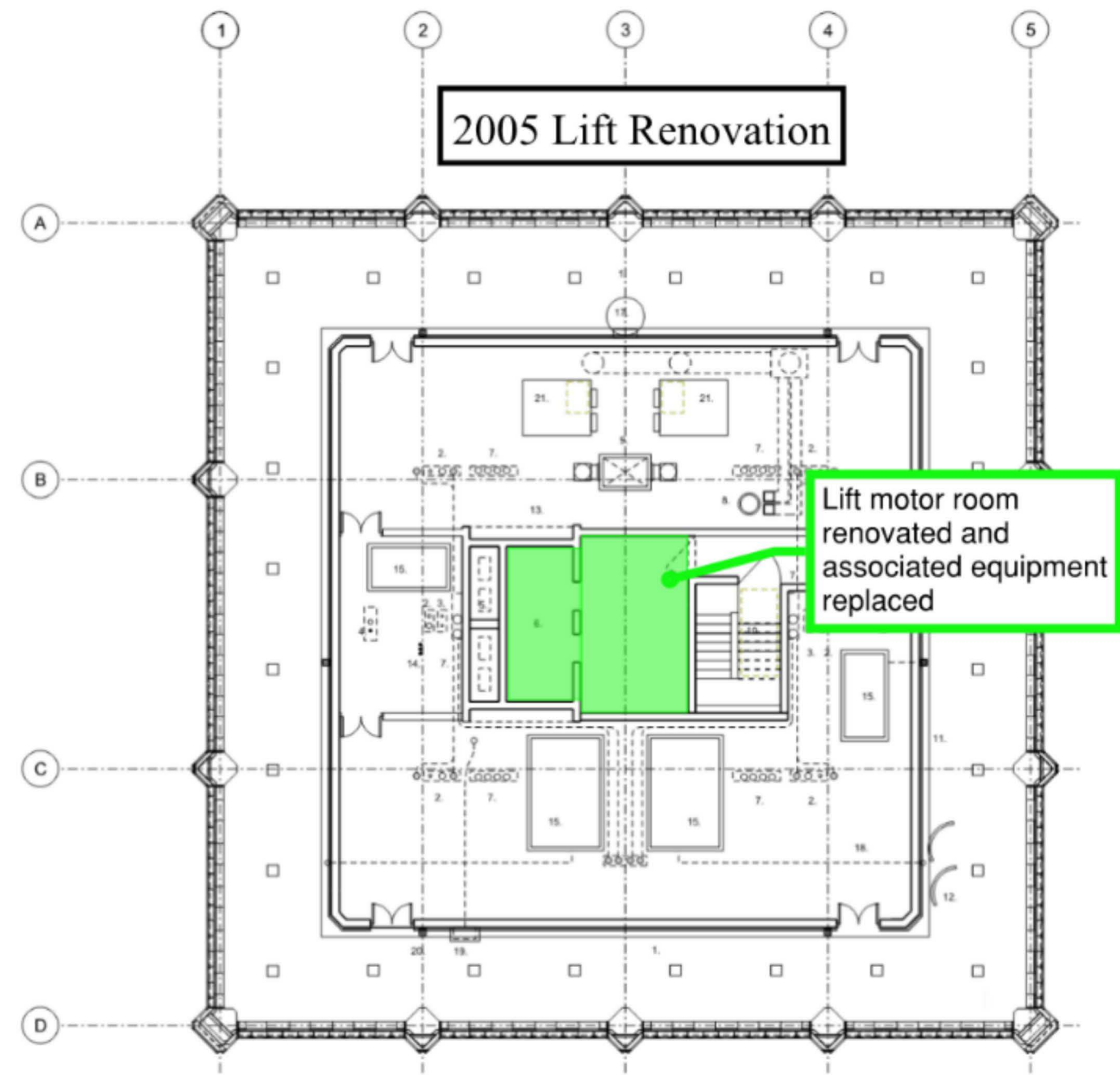


Figure 4.17: 2005 lift replacement on typical residential levels 4– 23. (RBK00018837, CCL00000028)

2005 Lift Renovation by Apex lifts - Rooftop lift motor room

Original plan

No plan available



■ Lifts renovated

Figure 4.18: 2005 lift replacement on plant level. (CCL00000028)

4.6 TMO tenant flat entrance door replacement – 2011 to 2013

4.6.1 Description of works

4.6.2 From 2011-2013, the TMO carried out a programme of replacing doors on dwellings occupied by RBKC tenants to comply with fire safety standards (see email TMO10037908 and MAS00000003).

4.6.3 Of the 120 No. original flats between levels 4 and 23; 14 were leasehold flats and 106 were tenanted flats as established from the list issued by Kennedys Law on 19/01/2017 on behalf of TMO.

4.6.4 A tenanted flat is one where the occupier rents the flat from the Royal Borough of Kensington and Chelsea (RBKC) Council. In this case the Council is responsible for demonstrating the compliance of the main flat fire doors with the required fire performance.

4.6.5 A leasehold flat is where the occupier owns the flat but not the land it sits on. The leaseholder rents the flat for a period of time from the free holder.

4.6.6 From the TMO's perspective (TMO10037573), the Leaseholder was responsible for demonstrating the compliance of the main flat fire doors with the required fire performance.

4.6.7 I have received a chronology prepared by RBKC dated 28 September 2018 (RBK00029883) of "*the involvement of RBKC in decisions relating to tenant and leaseholder flat entrance doors in Grenfell Tower*". This Chronology cites numerous incidences of correspondence and meetings between RBKC, RBKC Housing, RBKC Environmental Health, LFEPA [now abolished], LFB and Secretary of State for Communities and Local Government between November 2010 and May 2017.

4.6.8 It appears from this chronology that the issue of which entity was responsible for enforcement regarding compliance of leaseholder doors was an ongoing issue up to the time of the fire on 14 June 2017. I will investigate this in Phase 2 of the Inquiry.

4.6.9 109 No. Main flat entrance fire doors are listed on the 2011 door replacement specification spreadsheet written by Masterdor (MAS00000003). Three of the doors listed are duplicates (Flats 106, 114, 202). The reasons why there are duplicate doors on the list is unknown.

4.6.10 Discounting the duplicate doors, 106 No. fire doors appear therefore to have been supplied and installed by Manse Masterdor Ltd to replace main flat entrance fire doors in Grenfell Tower in May/June 2011. From the flat doors listed by Manse Masterdor the door replacement included 104 tenanted flat doors and 2 leaseholder flat doors.

4.6.11 The remaining 14 flat entrance doors, not listed for replacement in 2011 by the Masterdor specification spreadsheet were the doors for flats 56, 61, 86, 92,

105, 112, 142, 154, 156, 165, 166, 185, 195, and 206. Of these flats, 12 flats were at the time leasehold flats and 2 were at the time tenanted flats (flats 154 and 166). (MAS00000003)

- 4.6.12 These works did not appear to have involved the stair doors.
- 4.6.13 Figure 4.20 shows the location of the main flat doors, which were specified to be replaced.
- 4.6.14 Figure 4.19 presents an organogram I have created of the companies that have currently been identified as contributing to those door replacement works.
- 4.6.15 Where any physical evidence is provided regarding the type of door installed for specific flats in Grenfell Tower I may be required to revise my report.

Works started after consultation between

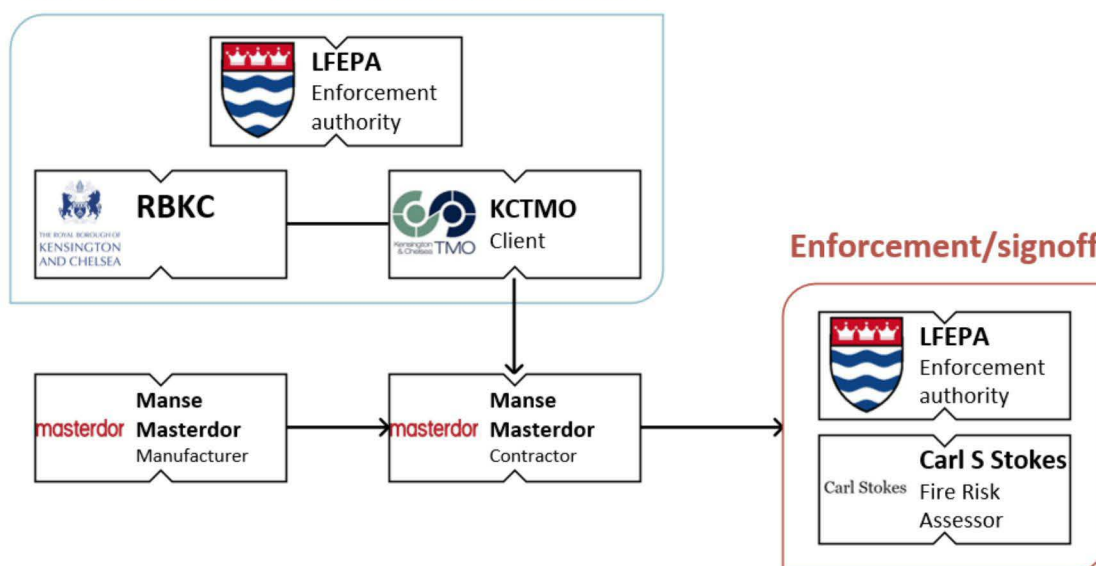


Figure 4.19: Organogram for 2011 door replacement works

TMO Tenant Main flat entrance fire door replacement (2011)

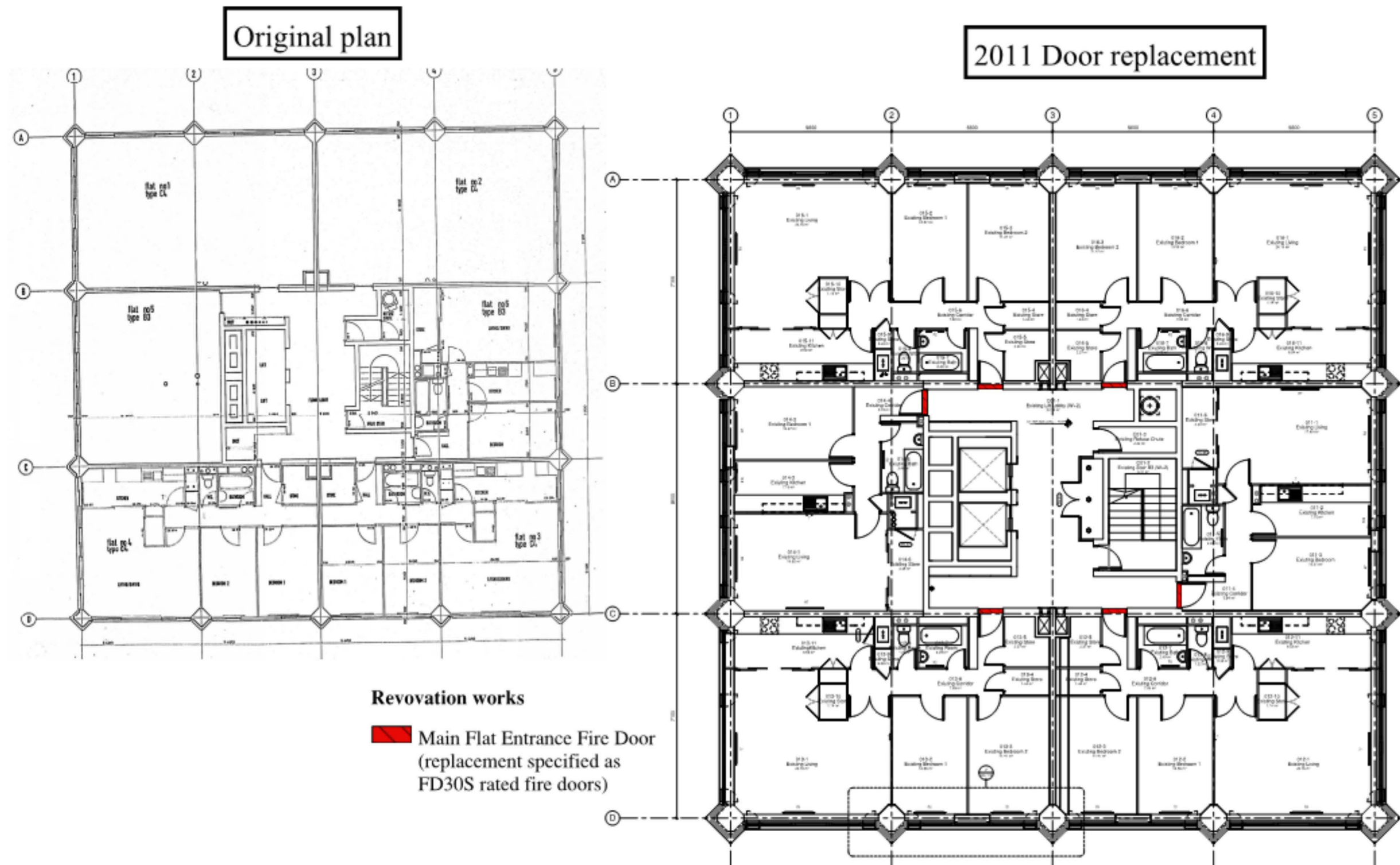


Figure 4.20: 2011 TMO tenant main flat entrance fire door replacement on levels 4 – 23. (RBK00018837; SEA00010474)

4.7 Refurbishment works: 2012-2016

4.7.1 Overview of works

4.7.2 The Rydon Building Manual for Grenfell Tower (RYD00000002) describes the refurbishment works that were undertaken at Grenfell Tower from 201 – 2016 as follows:

“The Works consist of the Design, Construction, Completion and Defects Rectification of the proposed re-cladding of Grenfell Tower and remodelling of its lower floors to provide improved accommodation for a nursery, boxing club, and 9 new residential flats and mechanical and electrical Installation to the entire tower with soft and hard landscaping works surrounding the tower.

The building is an existing tower block with 23 storeys and a ground floor

The general scope of the project is:

- *Adaption of 2 lifts to include 2 x new doors*
- *Recladding of the façade*
- *Reconfiguration of the podium levels to provide additional residential accommodation (9 no. new flats)*
- *Relocation and refurbishment of the nursery*
- *Relocation and refurbishment of the boxing club*
- *Provision of new community room*
- *Decorations to the existing lobbies*
- *Construction of a new entrance lobby (previously an undercroft)*
- *Modifications to the MEP systems as follows:*
- *New heating system to all areas*
- *New boosted cold water distribution system to all areas*
- *Refurbishment and extension of the smoke/environmental ventilation systems*
- *Alterations to the dry riser system*
- *Alterations to the door entry system*
- *External hard & soft landscaping”*

4.7.3 These works are discussed in more detail in the following sections. The items of work that were undertaken, and not included on this list, are the provision of services cupboards and new suspended ceilings in each of the existing residential levels (Levels 4 to 23), and the reconfiguration of the existing stairs as part of the construction of the new entrance lobby. (SEA00002540) These works are also discussed below.

4.7.4 Over cladding of the façade

4.7.5 As I have described in detail in Section 8, the refurbishment works intended to create a new external wall of a ventilated rainscreen cladding form. New cladding was installed on every level from Ground to level 23, with the outer surface summarised in Figure 4.21:

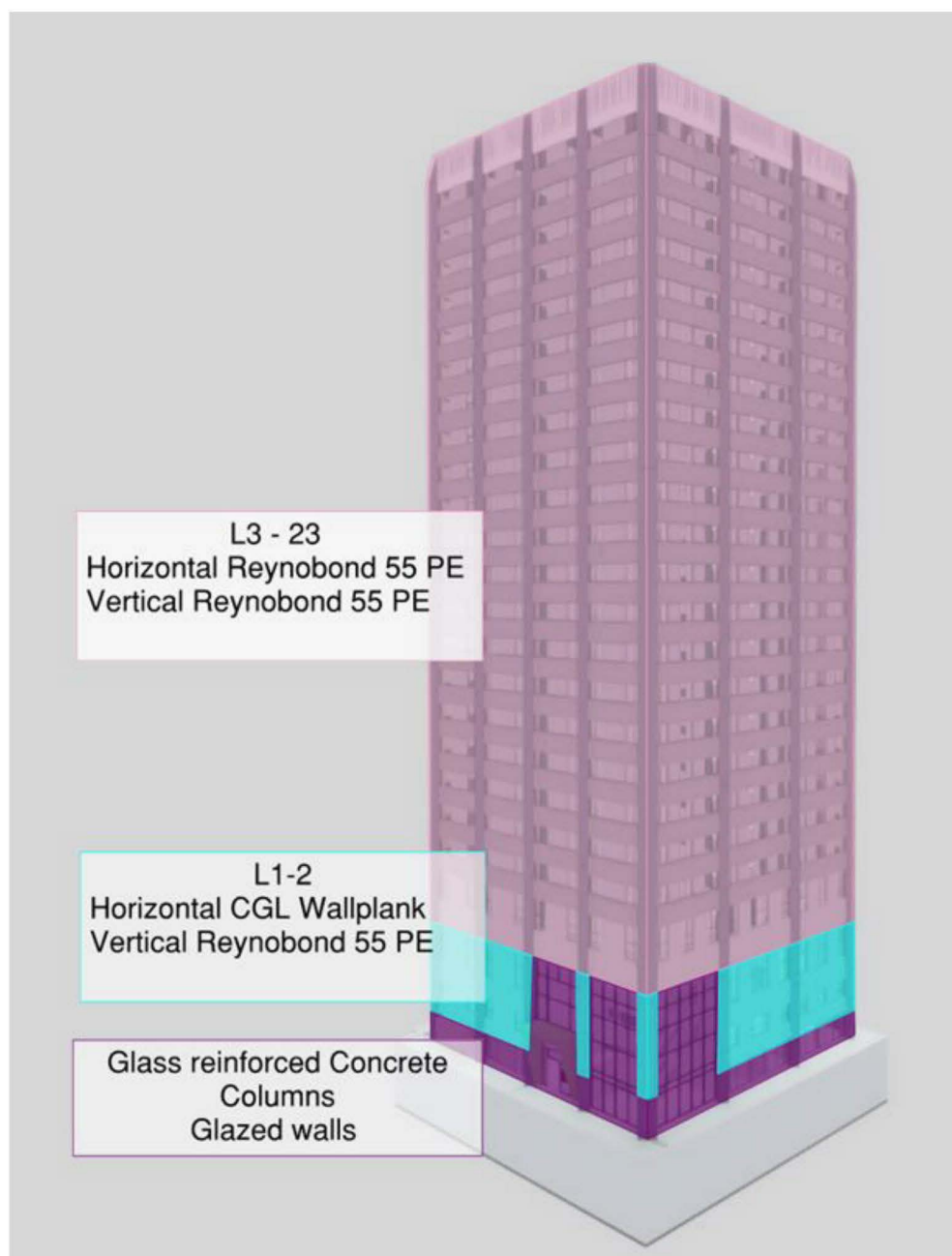


Figure 4.21: Outer surface of external wall by location on Grenfell Tower 3D model

4.7.6 The key components of the cladding installed on levels 4-23 were:

- a) Aluminium windows supplied by Metal Technology Ltd;

- b) Insulating core panels as infill between windows, formed of combustible Styrofoam supplied by Panel Systems Ltd;
- c) Window fan inserts specified as the combustible Kingspan TP10 insulation;
- d) 100mm thick Celotex RS5100 combustible PIR insulation board applied to columns;
- e) 80mm thick Celotex RS5080 combustible PIR insulation board (two layers) applied to the spandrels between floors;
- f) Kingspan K15 combustible phenolic foam insulation (two layers) applied to the spandrels between floors;
- g) Arconic Reynobond 55 PE Cassette system ACP (smoked silver metallic);
- h) Arconic Reynobond 55 PE Cassette system ACP (pure white);
- i) EPDM weatherproof membrane between the new windows and the existing concrete structure;
- j) Vertical cavity barriers on the columns;
- k) Horizontal cavity barriers;

See Figure 4.22 and Figure 4.23 for a summary photograph and 3D render of the cladding system as installed on Grenfell Tower.

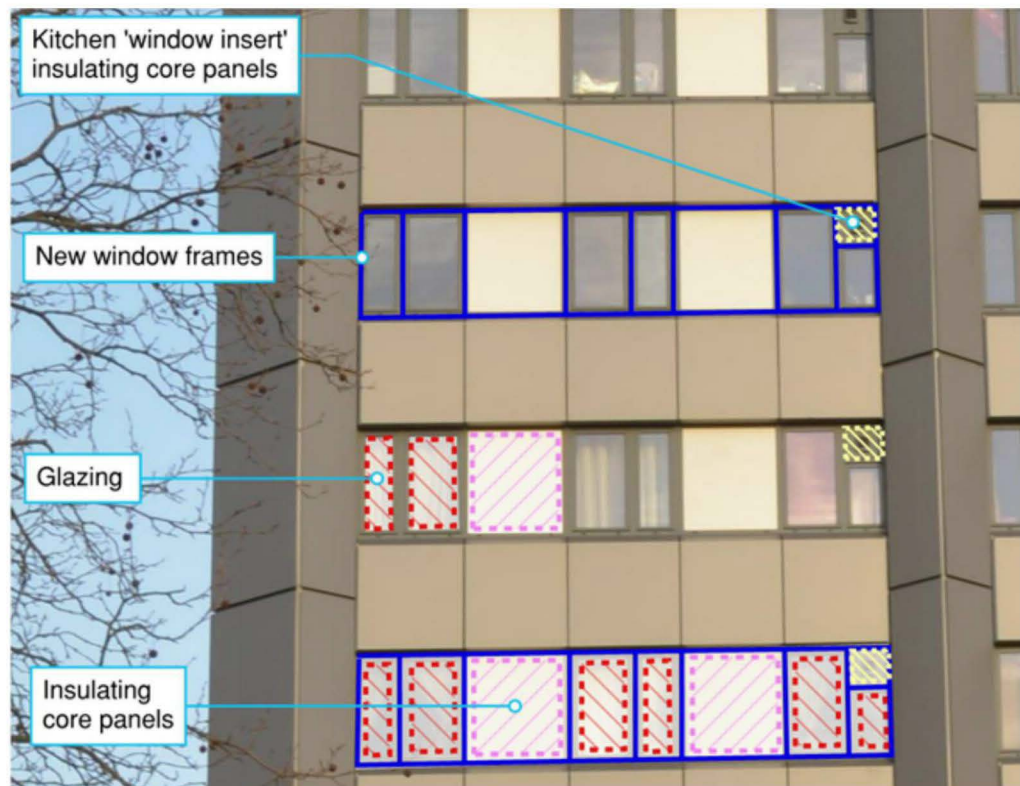


Figure 4.22: Summary photograph of externally visible cladding components (SEA00000350)

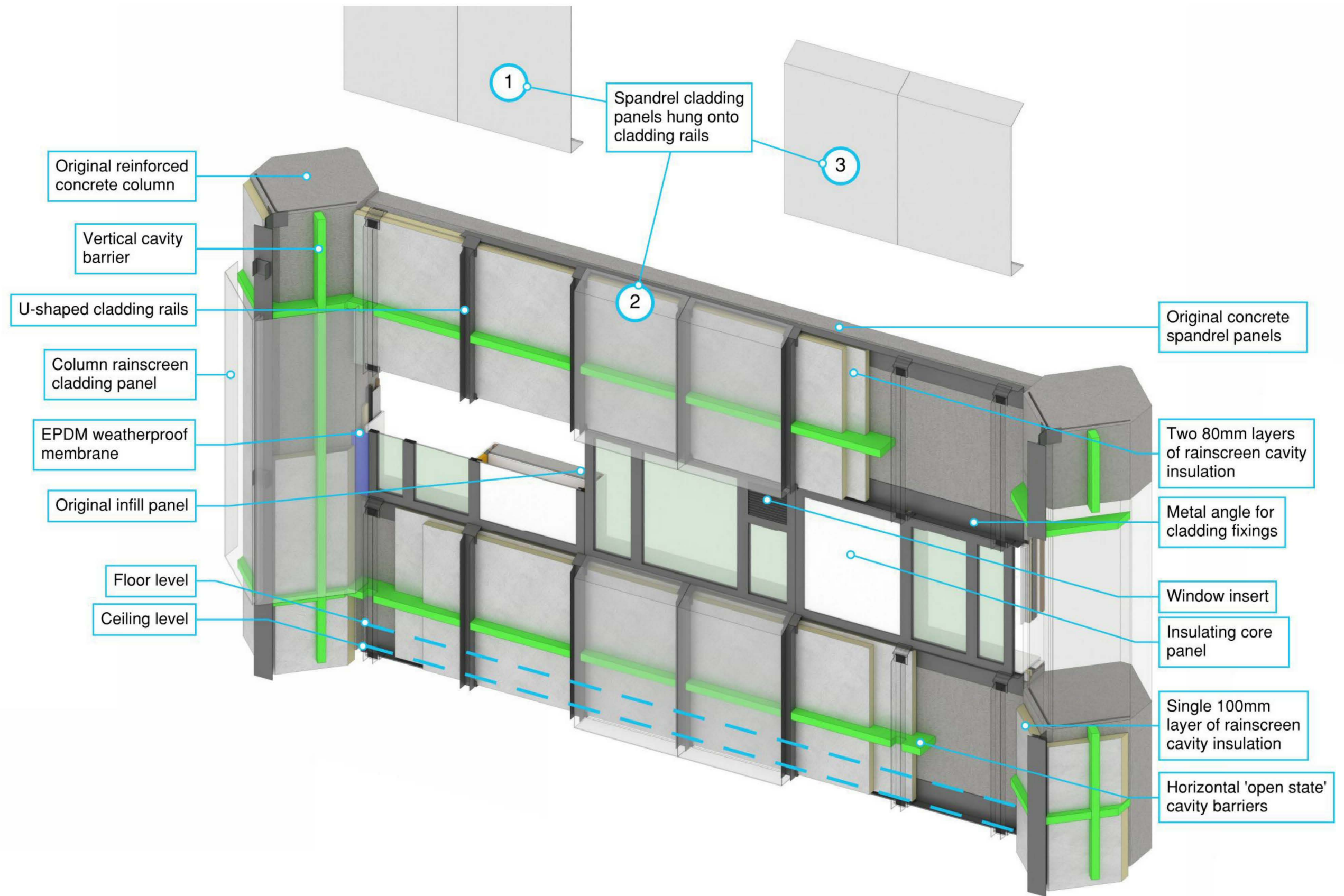


Figure 4.23: Render of external wall construction after completion of the refurbishment works

4.7.7 Figure 4.24 presents an organogram I created of the companies that have been identified to have contributed to the recladding works.

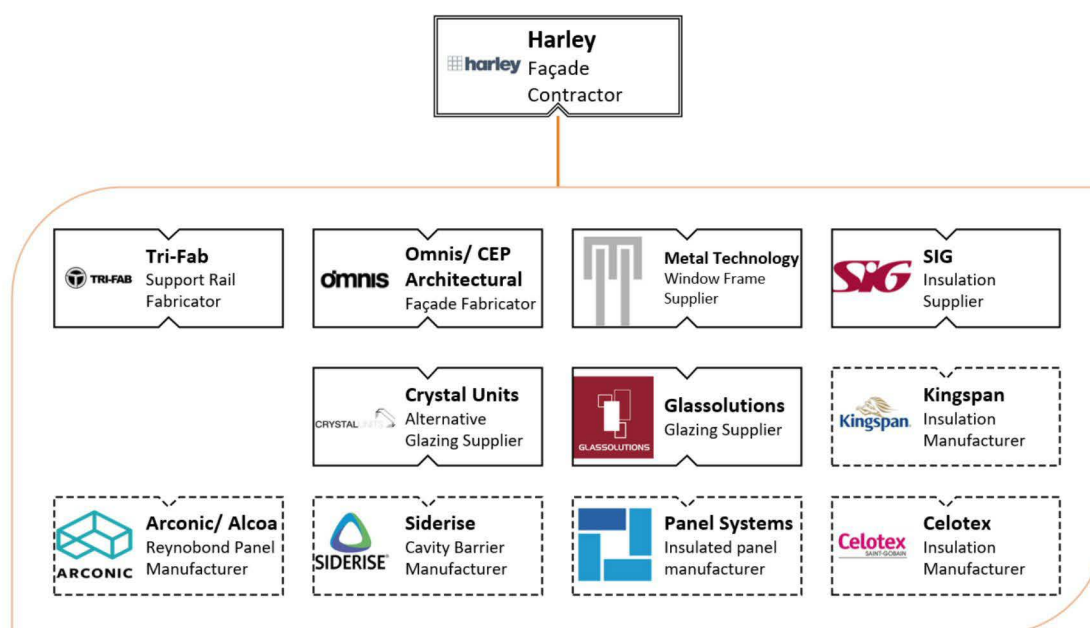


Figure 4.24: Organogram for facade works 2012-2016

4.7.8 Reconfiguration of the Walkway levels (Levels 1 to 3)

4.7.9 Ground floor:

4.7.10 I have reviewed the Studio E Stage D report, dated August 2013. Per the RIBA (Royal Institute of British Architects) Outline of Work 2007 (amended 2008), Stage D is the *Design Development* stage, is described as follows:

“Development of concept design to include structural and building services systems, updated outline specifications and cost plan. Completion of Project Brief. Application for detailed planning permission.”

4.7.11 The Studio E Stage D report described the refurbishment works planned for the ground floor as follows:

- “Enlarged entrance foyer, new stair and Part M compliant lift*
- Concierge / reception desk with view of main entrance, new lift and stair and the entrance to the main lift core. [Ultimately not provided]*
- A new enlarged meeting room and facilities for the Estate Office. This suite of offices is accessed by a new stair [Ultimately not provided]*
- New office for the EMB (Estates Management Board). This office is transferred from its existing location on the north-east corner of Barandon Walk. [Ultimately not provided]*

e) *Relocated nursery in an L-shaped configuration with the new entrance in roughly the same position as the existing.*

f) *A new fire escape stair” [Ultimately not provided] (CCL00000028)*

4.7.12 Not all of these works were undertaken. The meeting room and office for the Estates Management Board were removed from the works. The areas identified for the Estates Management Board were instead allocated to the new residential entrance, refurbished nursery and community room at Ground level.

4.7.13 It is important to note that the works at Ground level also included a new dry riser inlet to serve the existing fire main in the core. Please refer to Appendix H for further description of the dry riser works.

4.7.14 These changes also involved the installation of new services and connections for hot and cold water and for heating. These works are described by system in the following sections.

4.7.15 See Figure 4.25 and Figure 4.26 for overview images summarising some of the major changes, in a 3D model Arup created for the Public Inquiry:

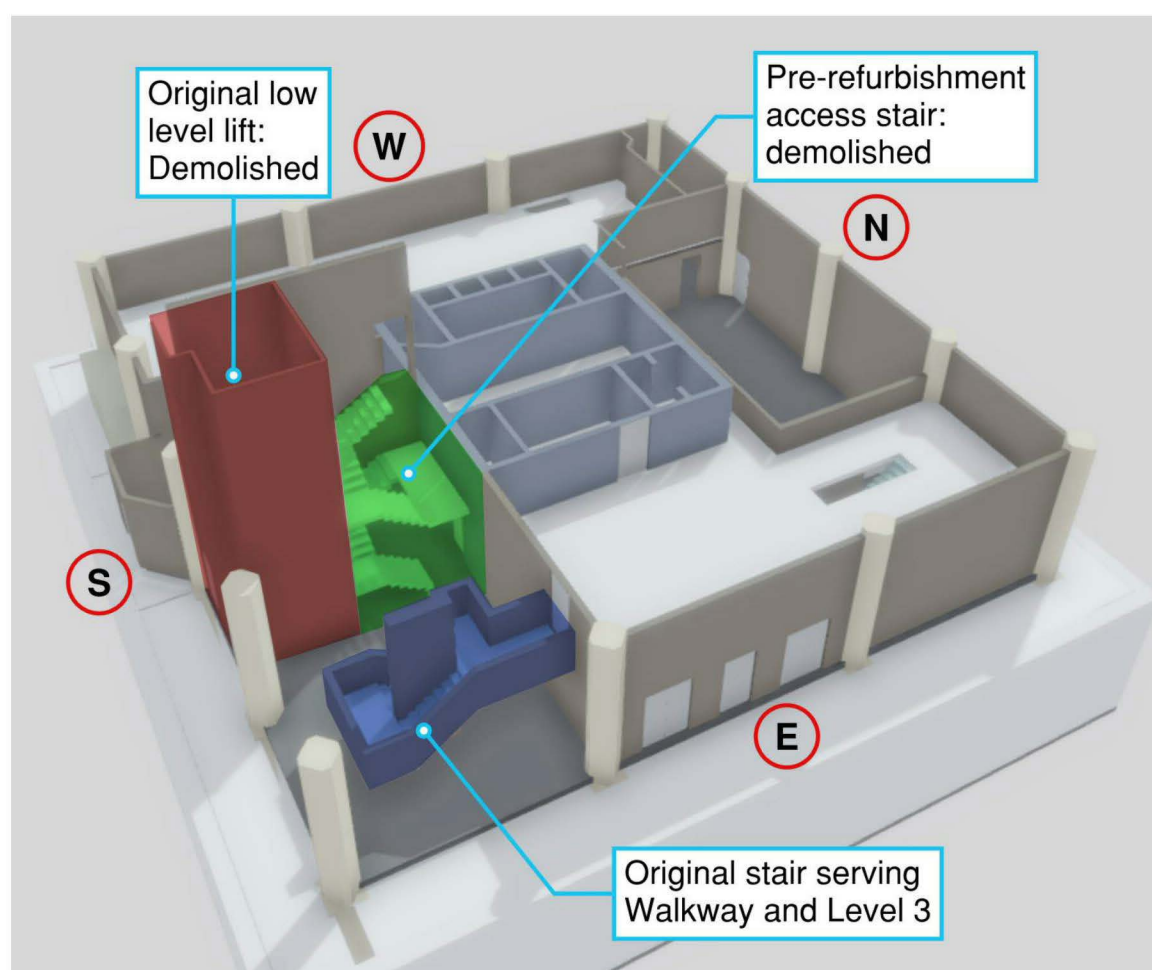


Figure 4.25: Overview of changes to levels G-3 in 3D model, pre-refurb

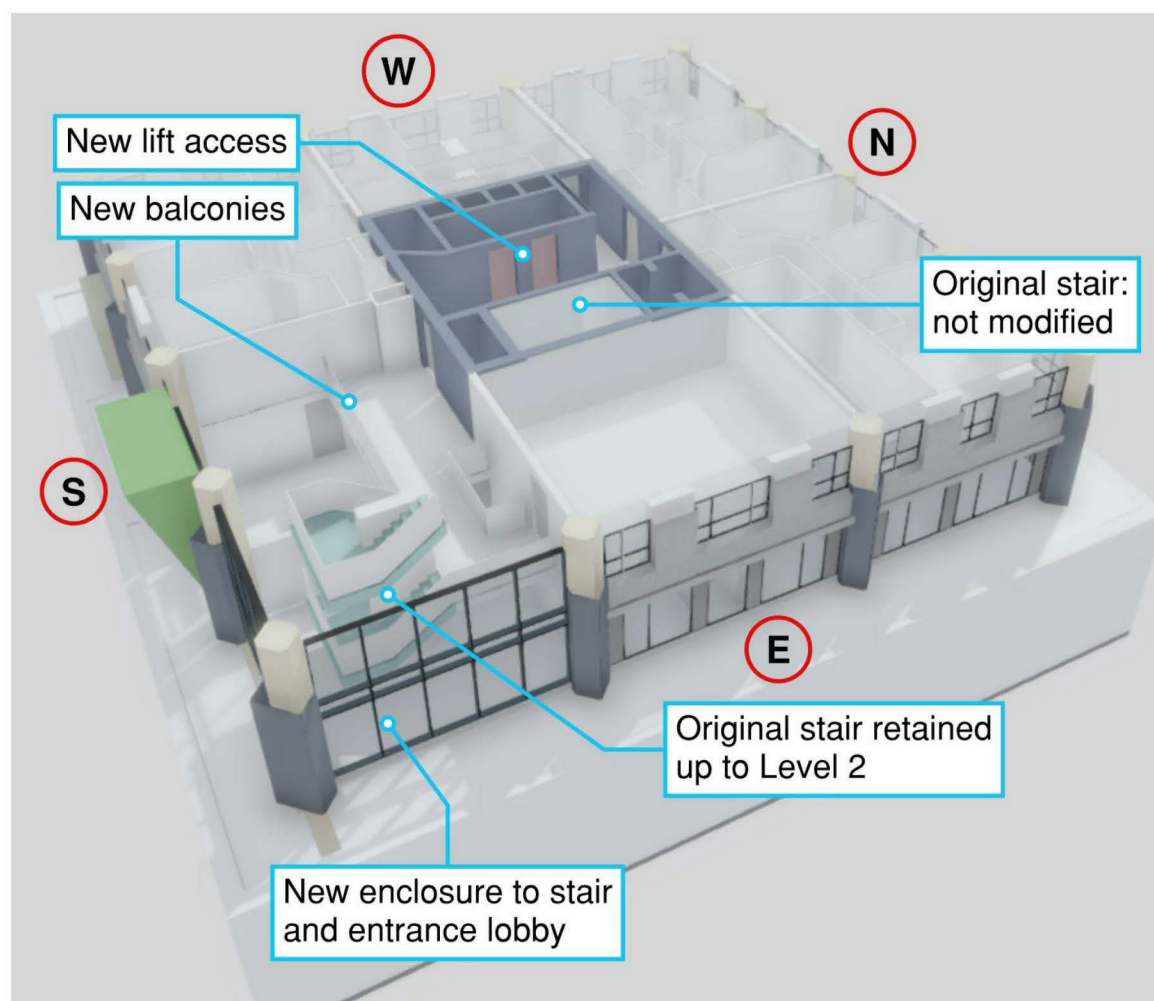


Figure 4.26: Overview of changes to levels G-3 in 3D model, post-refurb

- 4.7.16** There is evidence from the 2016 fire risk assessment significant findings (TMO00017691) that the fire lift control switch was noted by the assessor as being present at Level 2 and was required to be moved to Ground Level. I observed a switch in both the Level 2 and Ground floor lobbies.
- 4.7.17** WSP on behalf of the Metropolitan Police (MET00019973) have carried out an initial assessment of both these switches. I address this in Appendix L of my Expert Report. The WSP report notes that, when inspected, the Ground floor switch was seized and damaged/deformed. Therefore, while I observed a switch in the Ground floor lift lobby (see Appendix L) there is, at present, no evidence that it was correctly operating in order to function as intended.
- 4.7.18** WSP also inspected the switch on Level 2. They confirm the Level 2 switch was not connected. I deal with this issue in more detail in Appendix L of my Expert Report.
- 4.7.19** **Level 1:**
- 4.7.20** Studio E Stage D report (i.e. Scheme Design report), dated August 2013, described the refurbishment works planned for Level 1 as follows:

“This level is not currently served by the two central lifts and it is proposed that a new lobby slab and lift openings be created at Mezzanine level. The existing floor to ceiling dimension is low – as little as 2050mm – and Planning felt that this was not suitable for large family dwellings so 1 and 2 bed units only are proposed. A community meeting room (pink above) is proposed above the existing bins and transformer room.” (CCL00000028)

- 4.7.21** These changes are reflected in the Studio E As-Built drawings as indicated in Figure 4.49.
- 4.7.22** These changes also involved the installation of new services and connections for hot and cold water and for heating.
- 4.7.23** New openings were cut in the existing lift shafts for the lifts to serve this level.
- 4.7.24** As part of the enclosure of the existing stair connecting to Ground, a bridge connection was made to serve this level. Originally access to Level 1 was via dedicated stairs in the play centre and the office areas.
- 4.7.25** The works at Level 1 also included a new section of pipe extending from the existing rising fire main to a new dry riser outlet in the common lobby. Please refer to Section 4.7.88 for further description of the dry riser works.
- 4.7.26** The original smoke ventilation shafts were also extended down to serve this level.
- 4.7.27** **Level 2:**
- 4.7.28** Originally, this level was an open walkway connecting to the walkways connecting the various buildings in the Lancaster West Estate. Access to this level was either via lift from Ground, or via the open stair that was enclosed as part of the 2012-2016 works.
- 4.7.29** The Studio E Stage D report, dated August 2013, described the refurbishment works planned for Level 2 as follows:
- “The boxing club occupies the majority of the available floor plate. Access is via the new escape stair with disabled access via the main lift core. The existing fire escape stair in the core discharges into the lift lobby and the route is continued down to ground via the new stair.” (CCL00000028)*
- 4.7.30** Additionally, after Stage D the extent of the Boxing Club was reduced, and an additional residential unit inserted into the Southwest corner of the building. These changes are reflected in the Studio E As-Built drawings as indicated in Section 4.7.115.
- 4.7.31** Originally, the stairs from Ground passed through this level to Level 3. The refurbishment works terminated the stairs at this level and created a new access path into the stairs in the core.

- 4.7.32** The works at Level 2 also included a new section of pipe extending from the existing rising fire main to a new dry riser outlet in the common lobby. Please refer to Section 4.7.88 for further description of the dry riser works.
- 4.7.33** The original smoke ventilation shafts were also extended down to serve this level.
- 4.7.34** These changes also involved the installation of new services and connections for hot and cold water and for heating.
- 4.7.35** **Level 3:**
- 4.7.36** Studio E Stage D report, dated August 2013, described the refurbishment works planned for Level 3 as follows:
- “A new “shell and core” arrangement similar to the 20 floors above is proposed with some structural changes: new floor slab, new lift door openings, new connection to the refuse chute and a new connection to the escape stair. Four new units are arranged in each quadrant: 3no 4 Bed and 1 no 3 Bed Wheelchair accessible unit. The structural module has a strong influence on the layout: the bedrooms are situated on the north and south elevations and the living spaces face east and west where the structural module is wider. The kitchens are stacked directly below the kitchens to the two-bed units on the floor above, which is important to maintain a vertical continuity of services such as gas and water.” (CCL00000028)*
- 4.7.37** The stairs that originally served this level from Ground were removed, and the space in the Southeast corner of the building enclosed, with a new area of floor, to include a new residential unit.
- 4.7.38** These changes are reflected in the Studio E As-Built drawings as indicated in Section 4.7.115.
- 4.7.39** These changes also involved the installation of new services and connections for hot and cold water and for heating.
- 4.7.40** New openings were cut in the existing lift shafts for the lifts to serve this level, as described in section 4.7.43.
- 4.7.41** The works at Level 3 also included a new section of pipe extending from the existing rising fire main to a new dry riser outlet in the common lobby. Please refer to Section 4.7.88 for further description of the dry riser works.
- 4.7.42** The original smoke ventilation shafts were also extended down to serve this level.
- 4.7.43** **Adaption of lifts to include new doors**
- 4.7.44** The specific works related to lifts to be undertaken by the principal contractor Rydon are stated in the note GRENFELL LIFT ACTIONS. Resulting from meeting between TMO/ Rydon of 11 Feb 2015 as:

“In order to create the lift access to the 2 new floors, Rydon have to cut openings, install new doors and new panels/call signs and re-programme the 2 lifts at Grenfell.” (ART00003801)

4.7.45 These changes are reflected in the Studio E As-Built drawings as indicated in Section 4.7.115.

4.7.46 New heating system

4.7.47 A new heating system for all areas of Grenfell Tower was created during the 2012 – 2016 refurbishment works also. This system is described in the Description of Services document prepared by J S Wright & Co Ltd (RYD00000577) as follows:

“The building has been provided with heat for space heating and instantaneous domestic hot water by means of a central gas-fired condensing boiler installation, delivering LTHW (low temperature hot water) heating to the various areas...

Each flat, the nursery, boxing studio and the office area is served by individual HIU (heat interface unit) as indicated on the drawings, providing space heating and instantaneous hot water. The HIUs hydraulically separate the central plant installation from the local installation in each area.”

4.7.48 See Figure 4.27 for a summary of the hot water and heating system works shown on a 3D model of Grenfell Tower.

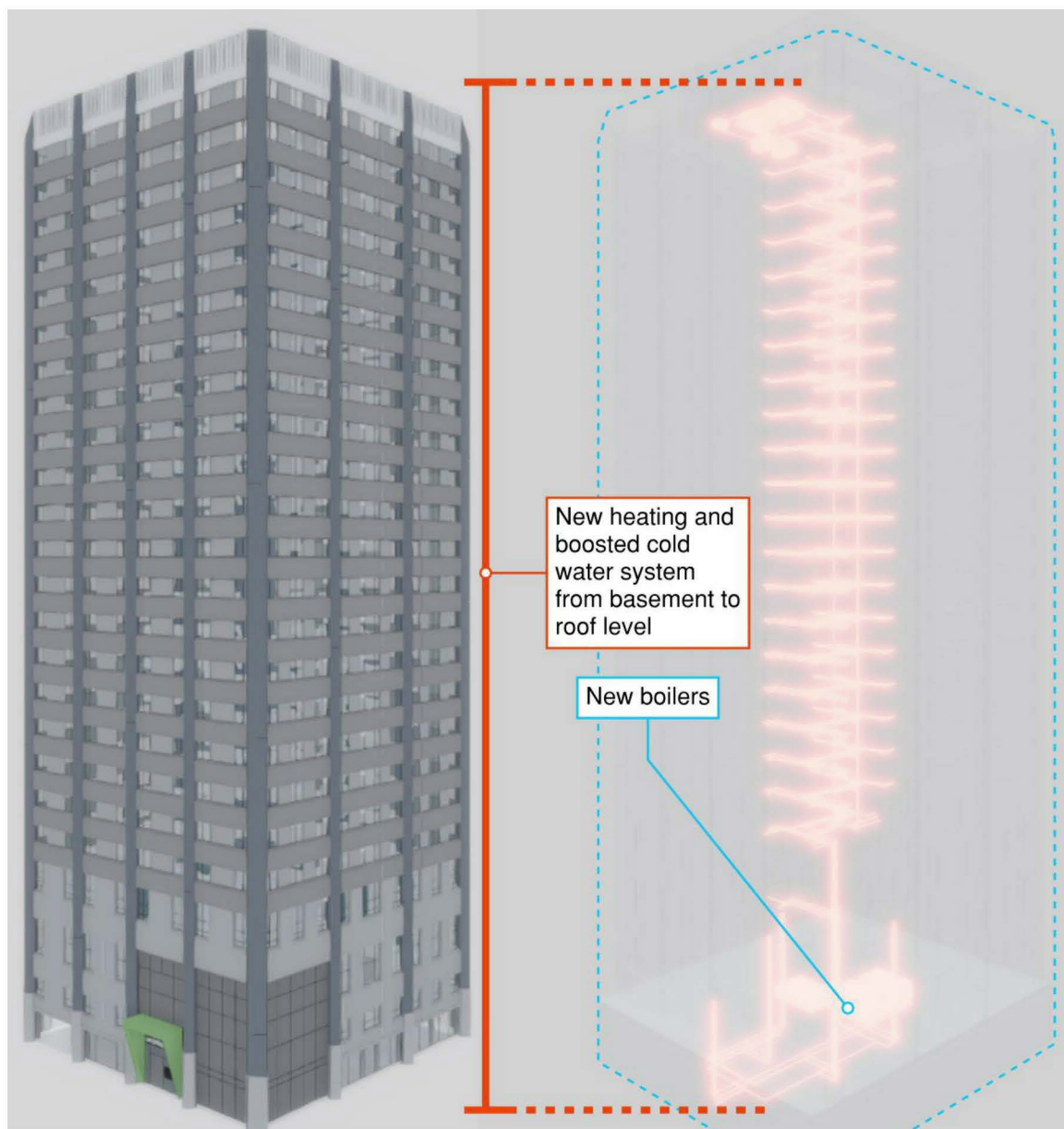


Figure 4.27: Summary of new heating and boosted cold water system works shown on 3D model

- 4.7.49** A new central gas-fired boiler plant was provided in the basement which consisted of 3 no. gas-fired condensing boilers (duty and standby boilers provided for space heating and hot water supply), as shown in Figure 4.28. The existing main boiler plant continued to serve the 'Finger Block' flats, which are in separate buildings from Grenfell Tower. (RYD00000577)

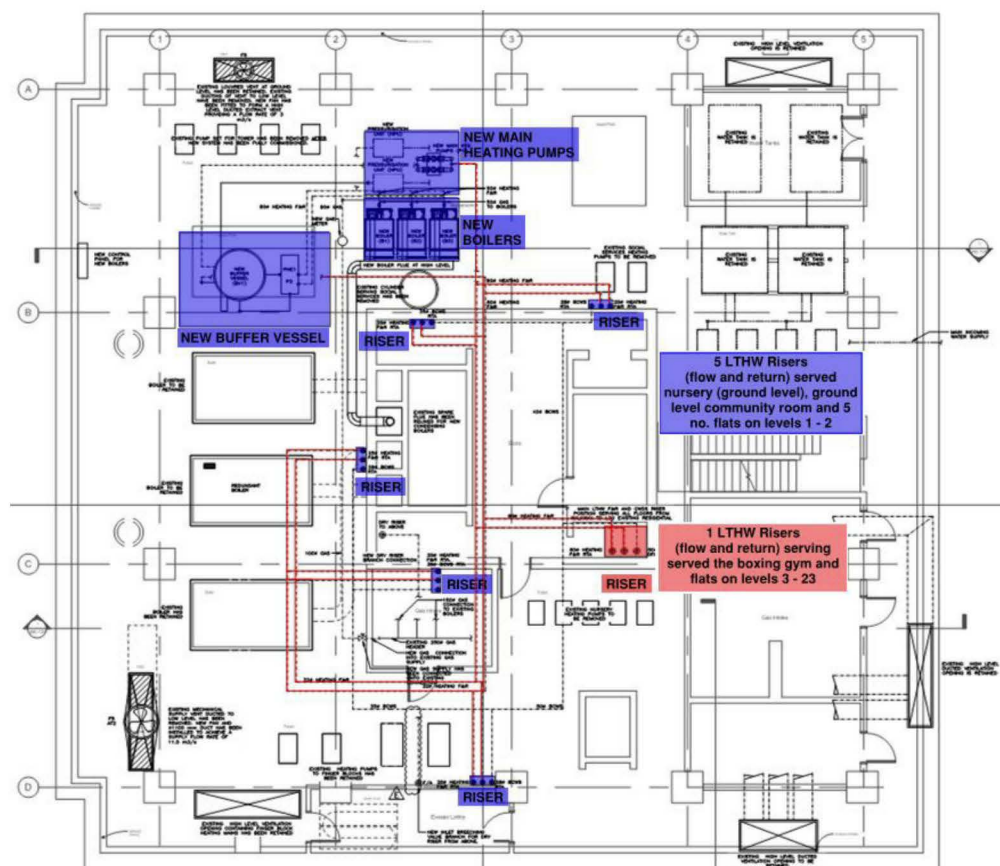


Figure 4.28: New central boiler plant and LTHW piping distribution on basement level (RYD00000577)

- 4.7.50** Based on my review of the J S Wright & Co Ltd ‘As Installed’ mechanical drawings (August 2014), the new Low Temperature Hot Water heating system (LTHW) flow and return piping was then distributed from these new boilers in the basement to every level above through 6 no. existing risers, as shown in Figure 4.28.
- 4.7.51** The nursery (ground level), ground level community room and 5 no. flats on levels 1 – 2 were served by 5 no. of the 6 LTHW risers, as shown in Figure 4.28. The remaining LTHW riser served the boxing gym and flats on levels 3 – 23 (RYD00000577).
- 4.7.52** As indicated in Figure 4.28, the pipes serving Levels 3 to 23 enter the existing Southeast riser in the core on the basement level. On Level 3, the LTHW flow and return pipes leave the Southeast riser (south of protected stairway), run laterally through the common lobby, and enter the protected stairway, as shown in Figure 4.29. These pipes rise to level 4, where a new service cupboard was created as part of the refurbishment works. A new service cupboard was created in the same place in the lobbies on each level from level 4 – 23 as part of the 2012 – 2016 refurbishment works. The LTHW pipes rise through these cupboards to level 23. (RYD00000577)

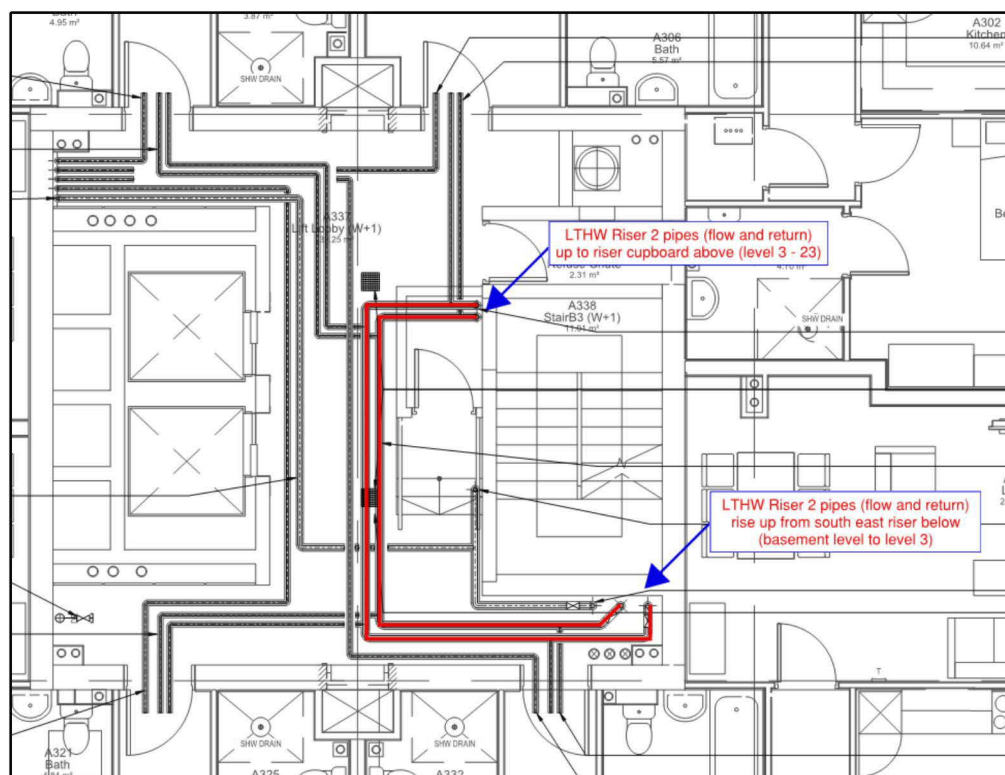


Figure 4.29: Lateral LTHW lateral piping through level 3 common lobby (RYD00000577)

- 4.7.53** The pipes appear to have been fire stopped at each floor level. The service riser does not appear to form a protected shaft. The new riser cupboard is not shown on the fire strategy drawings by Studio E (SEA00003112). The new cupboards are not described in the Exova fire strategy report (EXO00000582).
- 4.7.54** On the Studio E Employers Requirements and As-Built drawings the new cupboards were not identified as requiring to be made of fire resisting construction, in contrast to the new partitions being introduced on Levels 1, 2 and 3. Therefore, there is no evidence that the cupboards on levels 4 – 23 were specified to be made of fire resisting construction.
- 4.7.55** On each level from level 4 – 23, the LTHW pipes leave the riser cupboard and distribute laterally through the common lobby to each flat. As shown in Figure 4.30, a flow and return pipe enters each flat above the flat entrance door (RYD00000577).

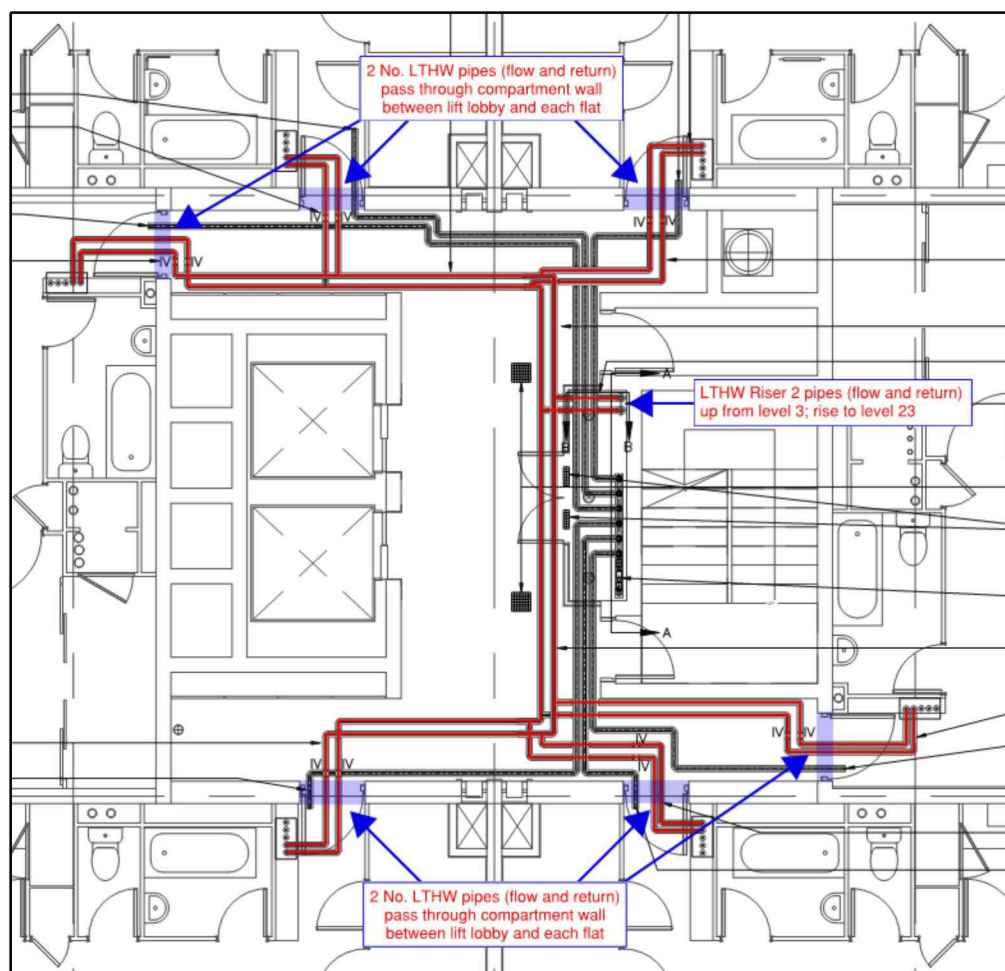


Figure 4.30: LTHW lateral distribution piping through typical residential level common lobby (RYD00000577)

- 4.7.56** These changes are reflected in the Studio E As-Built drawings as indicated in this section.
- 4.7.57** The pipe distribution works in the lobby were then concealed above a new suspended plasterboard ceiling, described in Section 4.7.98.
- 4.7.58** Based on the Studio E Grenfell Tower Regeneration Project Room Data Sheets, Employer Requirements, dated 20-11-2013, holes were core drilled through the concrete wall above each flat front door for new water and heating pipes to each flat on every level (SEA00002540). This means that 18 holes were drilled on each floor, and 360 holes over all levels. Please see Figure 4.31 for an example of this distribution taken during my post fire inspection of the building.

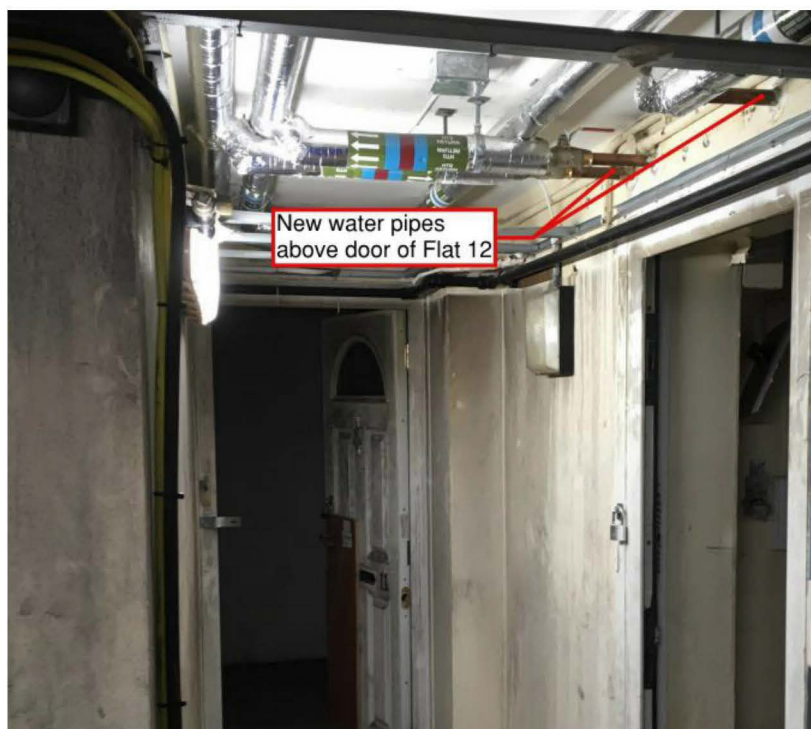


Figure 4.31: New pipework fitted in ceiling of Level 4 common lobby

- 4.7.59** The core drilling works were communicated to residents by a TMO notice, dated October 2014 (excerpt below):

“We will be carrying out work to your property from Wednesday on the 19th November 2014. The work will involve drilling three core holes above your front door this is to enable us to run the new pipework into your property.”
(MAX00001704)

- 4.7.60** Each existing residential flat on levels 4 – 23 was served by an individual HIU, which allowed residents to control their flat’s heating and hot water. According to the building fire risk assessor, The HIUs are electrically powered/operated with a fused spur. (RYD00094168) Figure 4.32 is an image of the HIU installed in every flat as part of the heating system works.

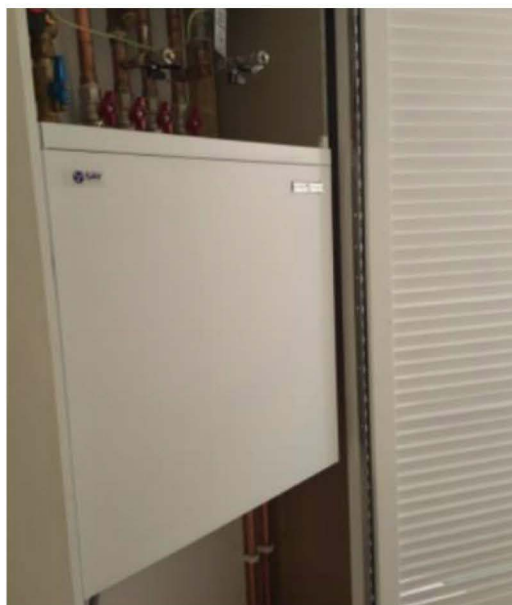


Figure 4.32: Heat interface unit (HIU) (RYD00000577)

- 4.7.61** As described in the Studio E Stage D report,
“Builder’s work and making good associated with M&E works: replacement of radiators and new heating pipework. Existing finishes to be protected throughout. New window sill/surround required to making good around replacement windows.”
- 4.7.62** New pipework was to be installed in each flat to serve the HIU’s, domestic plumbing and radiators. I have not determined the exact run of each set of pipes in each flat.
- 4.7.63** A total of 440 new radiators were installed, with 3 radiators (local heat emitters as referenced in RYD00000577) fitted to 1 bedroom flats and 4 radiators fitted to 2 bedroom flats on each level. See Figure 4.33 for a summary of how these works were arranged within each flat:

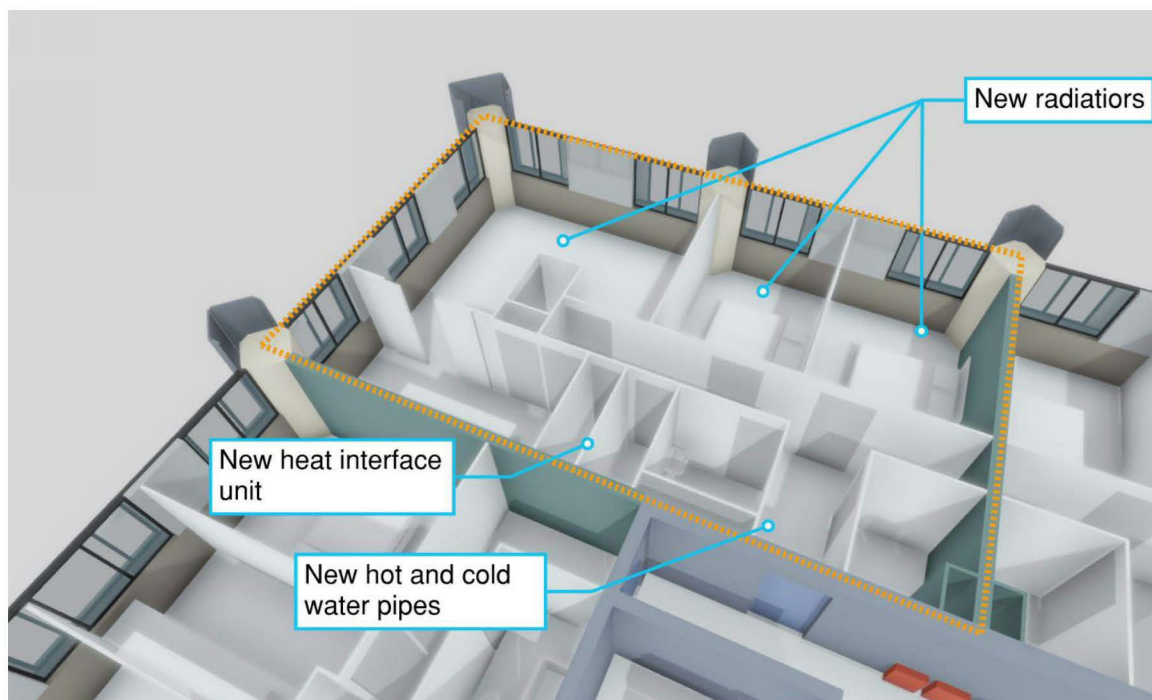


Figure 4.33: Summary of heating/hot water/ cold water works within dwellings shown on 3D model

4.7.64 **New boosted cold water distribution system**

4.7.65 A new boosted cold water distribution system was installed as part of the 2012 – 2016 refurbishment works. This system is described in the Description of Services document prepared by J S Wright & Co Ltd, which states:

“New potable cold water pipework has been run from the roof storage tanks to serve sanitary appliances in all areas of the building. The pipework on the upper residential floors has been installed in a vertical duct located in the lift lobbies outside the flats. At podium level, the pipework generally runs concealed in ceiling voids or in services riser ducts.

An additional pump set has been installed for a number of flats on the upper floors as the static pressure alone from the storage tanks will not be sufficient to ensure a reasonable pressure or flow of water through the heat interface unit. This additional pump set is located in the roof plant room...

New hot and cold water pipework has been installed to serve the new apartments, the nursery, boxing club and offices.” (RYD00000577)

4.7.66 As shown in Figure 4.34, the new Boosted Cold Water Service (BCWS) pump serves the roof plant level and residential levels 14 – 23, whereas ground floor – level 13 are served by the static pressure from the existing storage tanks. (RYD00000577)

4.7.67 Based on my review of the J S Wright & Co Ltd ‘As Installed’ mechanical drawings (August 2014), the new BCWS piping is distributed from the roof

plant level through level 4 via the new riser cupboard that was created in the common lobby on every level, as shown in Figure 4.35 (RYD00000577).

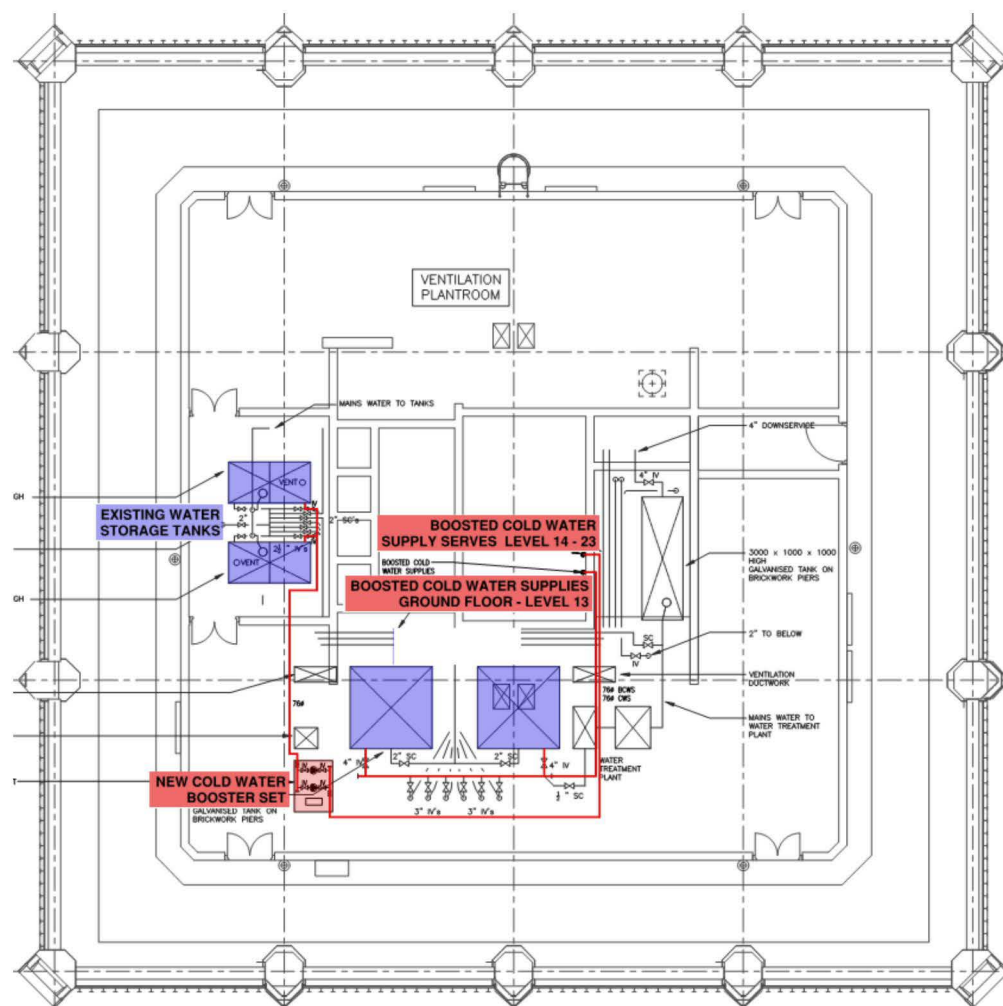


Figure 4.34: Refurbishment works to boosted cold water distribution system on Roof Plant Room. (RYD00000577)

- 4.7.68 On each level from level 4 – 23, the BCWS piping leaves the riser cupboard and distributes laterally through the common lobby to each flat, as shown in Figure 4.35.
- 4.7.69 The pipe distribution works in the lobby were then concealed above a new suspended plasterboard ceiling, described in Section 4.7.98.
- 4.7.70 As described in section 4.7.46 and shown in Figure 4.35, each Existing Common lobby on levels 4 – 23 was required to have three cores through concrete walls for new water and heating pipes to each flat. (SEA00002540) A TMO notice was provided to residents in October 2014 in preparation for this works to be completed (MAX00001704).
- 4.7.71 A single BCWS pipe enters each flat above the flat entrance door (RYD00000577), via one of the 3 holes described in section 4.7.46, as shown in Figure 4.35.

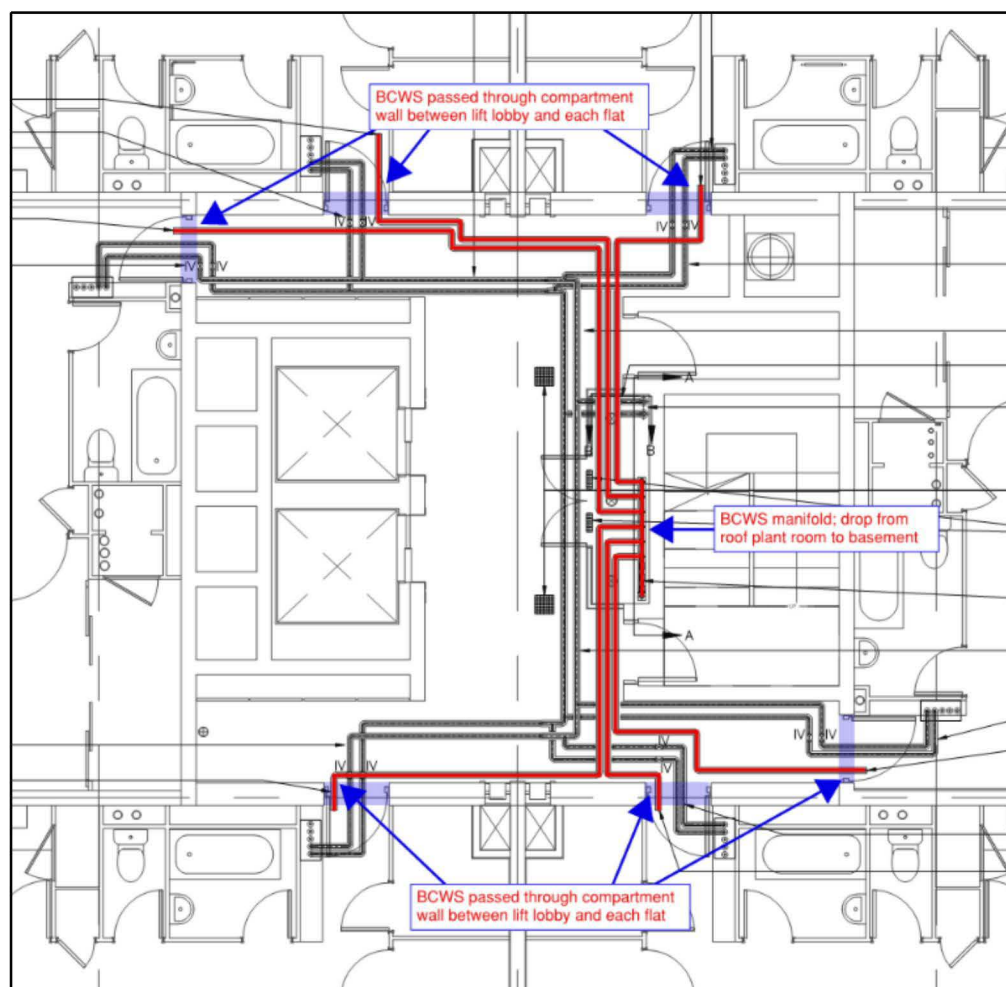


Figure 4.35: BCWS lateral distribution piping through typical residential level common lobby (RYD00000577)

- 4.7.72** The BCWS pipe leaves the riser cupboard on level 4 and enters the protected stairway on level 3, as shown in Figure 4.36. The BCWS then leaves the protected stairway and distributes laterally to the Southeast corner of the level 3 common lobby.
- 4.7.73** The BCWS pipe then drops into the Southeast riser from level 2 to the basement level; it serves the boxing gym on level 2. At the basement level, the piping is distributed to 5 no. other risers, as shown in Figure 4.37. These 5 no. other risers supply the nursery, community room, and flats on level 2 and 3.

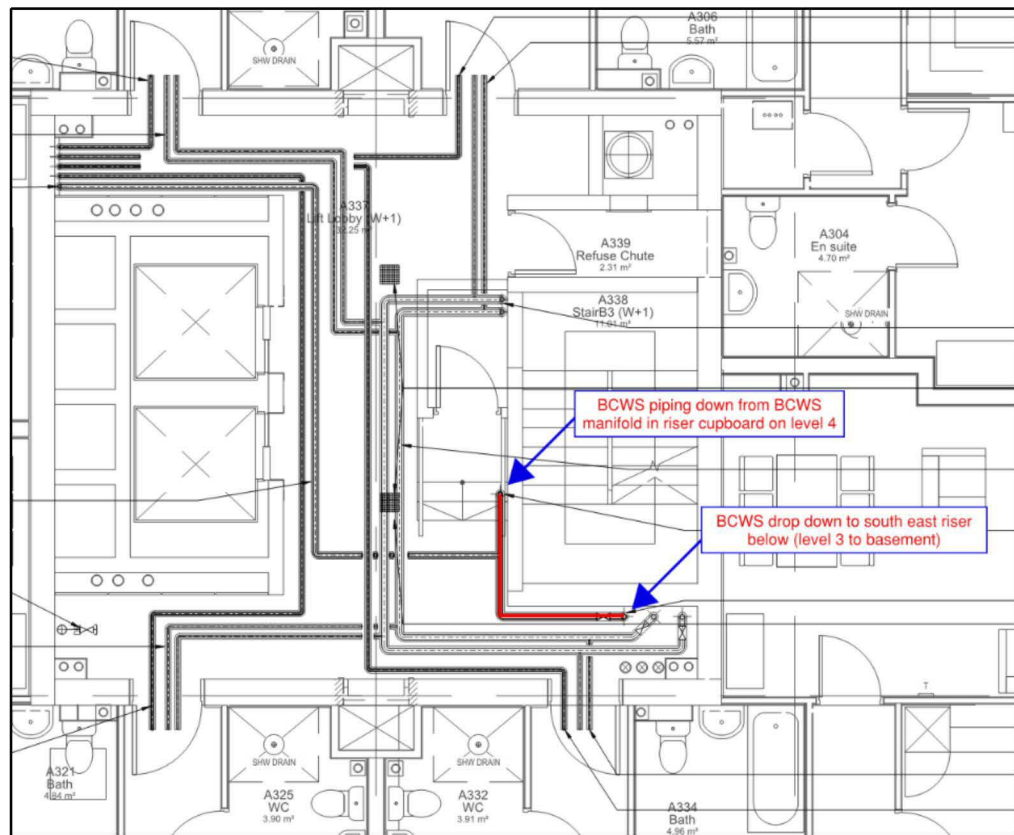


Figure 4.36: BCWS lateral distribution piping through level 3 common lobby (RYD00000577)

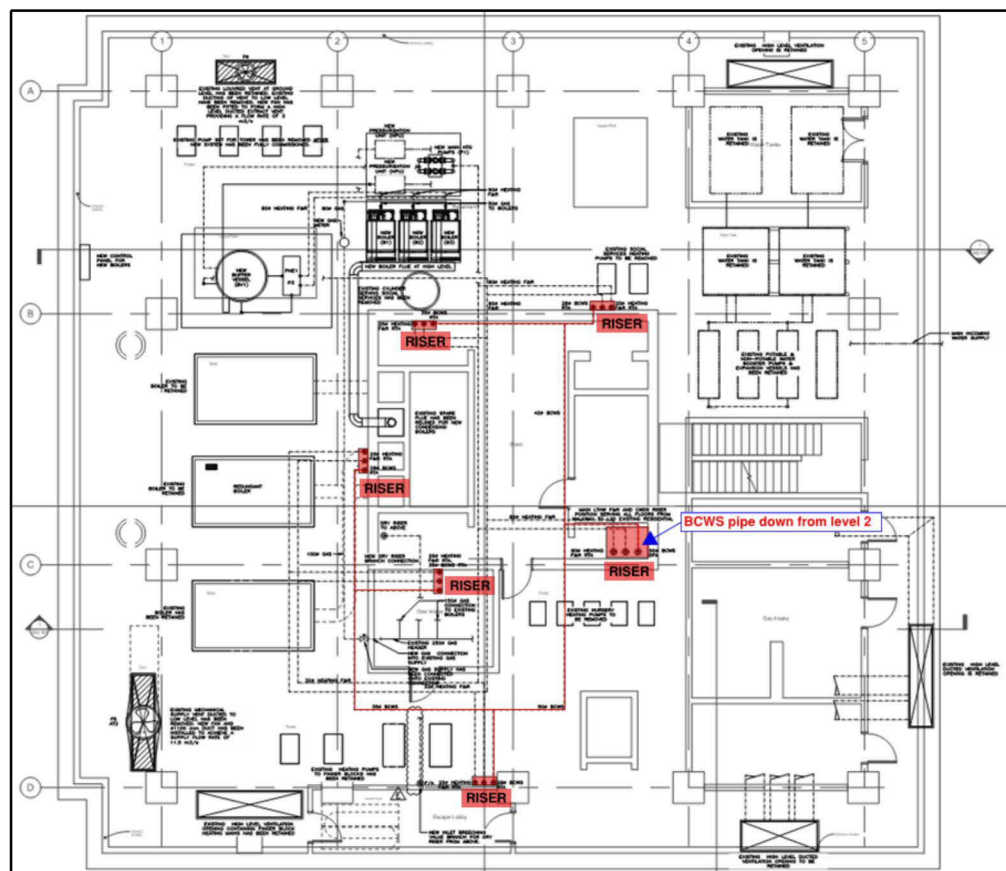


Figure 4.37: BCWS risers on basement level. (RYD00000577)

4.7.74 Refurbishment and extension of the smoke/environmental ventilation systems

4.7.75 Grenfell Tower was originally constructed with a lobby smoke control system and stairway ventilation.

4.7.76 The lobby smoke control system was refurbished in the 2012 – 2016 works.

4.7.77 The original and the refurbished smoke control system, were combined with an environmental ventilation system, to provide temperature control within the lobbies.

4.7.78 The intent of the refurbishment works to the existing lobby smoke control system was set out in the Employer's Requirements (MAX00006475) as:

"It is not viable to adapt the existing system to comply with current standards. Given the physical constraints of the existing building, the design approach has therefore been to retain the existing system and replace all of the existing components with new, equivalent or better components."

4.7.79 The performance standard of the original system was not known to RKBC, as stated in an email to Max Fordham (MAX00004353).

- 4.7.80** During the design process for the lobby smoke control system a number of configurations were proposed. In Appendix J, I describe the original system and the final proposed refurbishment system [Rev 6 Smoke ventilation technical submission – lobby smoke control system; by PSB] which appears to have been the system installed in Grenfell Tower.
- 4.7.81** In the event of fire, the environmental system was designed to switch into fire mode, on activation of automatic fire detection in a single lobby.
- 4.7.82** Some of the components of the original smoke control system were retained in the refurbishment, specifically the openings for Automatic Opening Vents (AOVs) in each lobby, and the four builder's works shafts – 2 north and 2 south – running from level 4 to roof level.
- 4.7.83** Based on the PSB technical submission Rev 6 PSB00000214 on detection of smoke:
- a) The environmental fan was to be shut down and electrically isolated.
 - b) The environmental fan, and its associated ductwork, was to be isolated from the smoke ventilation system by the bypass smoke dampers.
 - c) The AOVs on the fire floor only were to open.
 - d) The AOVs on all other floors were to be closed and locked out.
 - e) The smoke exhaust fan sets at roof level (serving the north shaft) and at Level 2 (serving the south shaft) were to operate to exhaust smoke from the lobby on the fire floor only.
 - f) The smoke exhaust fans at roof level were to exhaust smoke from the AOVs located at high level on the north side of the lobby into the north vent shafts to discharge at roof level.
 - g) The smoke exhaust fans at Level 2 were to exhaust smoke from the AOVs located at low level on the south side of the lobby into the south vent shafts to discharge to outside at Level 2, via fire rated ductwork.
 - h) Fresh air was to be drawn into the lobby where the system had activated only, from the stair via the permanently open vent at the head of the stair.
- 4.7.84** Fire fighter controls were provided at Ground level, and from every lobby.
- 4.7.85** The system once activated dialled an offsite service, to call the fire brigade.
- 4.7.86** I provide a detailed explanation of the combined environmental and smoke control system in Appendix J of my Expert Report.

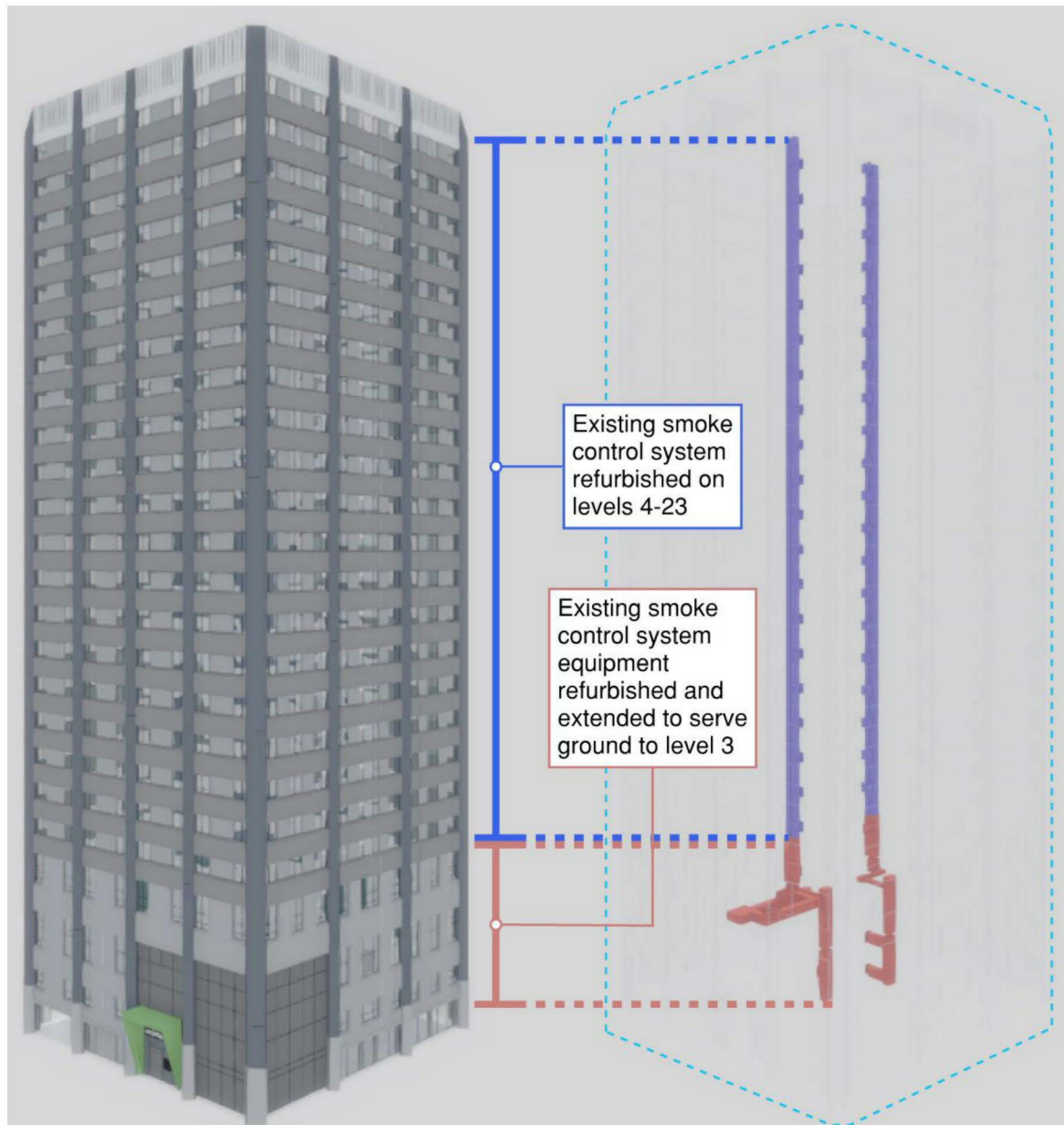


Figure 4.38: Summary of smoke control system works shown on 3D model

4.7.87 Figure 4.39 presents the organisations that have currently been identified as contributing to the refurbishment of the smoke ventilation system.

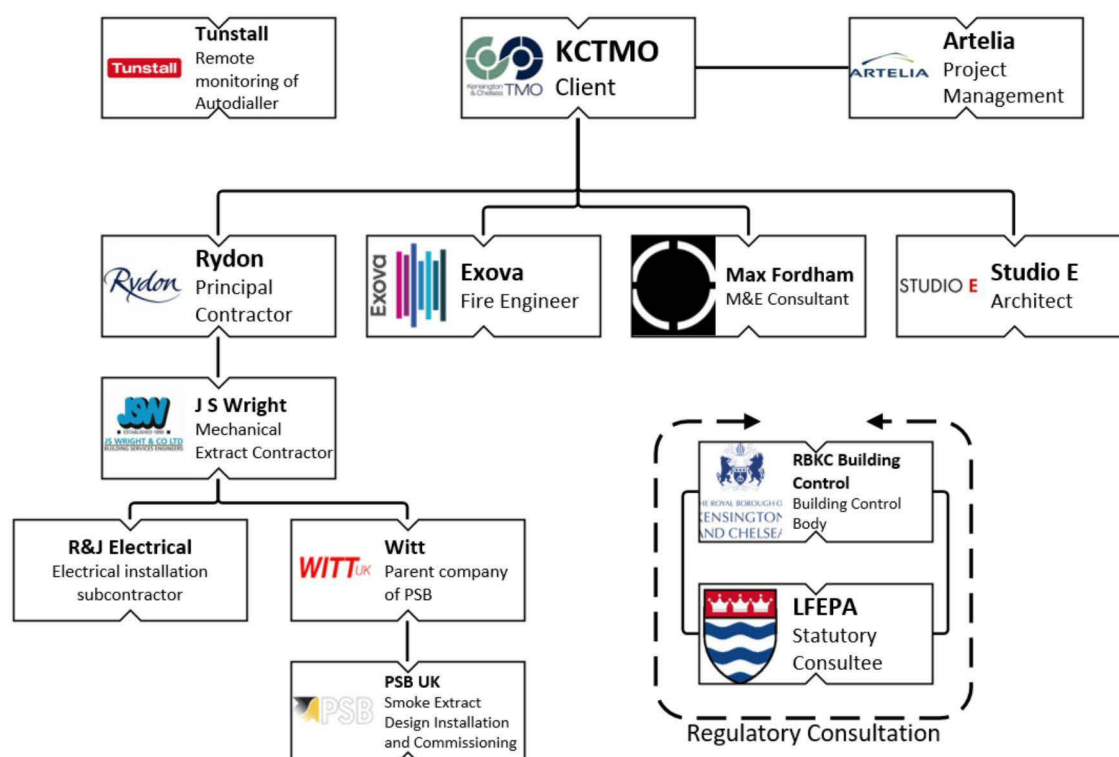


Figure 4.39: Organogram for smoke control refurbishment

4.7.88 Alterations to the dry riser system

4.7.89 The information in the original building design drawings identifies that the dry rising fire main was originally provided with an inlet valve at Ground Level, adjacent to the core entrance. This fire main served all levels between Level 4 and Level 23. The original fire main did not serve Levels 1, 2 or 3. It is not currently known how those levels were provided with firefighting hose coverage as part of the original design.

4.7.90 The Description of Services document prepared by J S Wright & Co Ltd describes the alterations to the dry riser as follows:

“The existing dry riser system has been modified to suit the new areas at podium level. The inlet valve has been relocated to the front of the building near the main entrance. Refer to drawings for locations of new landing valves.”

4.7.91 Based on my review of the J S Wright & Co Ltd ‘As Installed’ mechanical drawings (August 2014), the following modifications were made to the dry riser as part of the 2012 – 2016 refurbishment works (please refer to Figure 4.41):

- a) A new landing valve (dry riser outlet) was provided in the Southeast corner of the common lobbies on levels 1 & 2;
- b) New branches connecting the rising fire main to the new outlets on levels 1 & 2 were provided;

- c) A new landing valve was provided on level 3, connected directly to the existing rising fire main;
- d) A new inlet breaching valve on south façade at ground level;
- e) A new drain at basement level;
- f) A new run of pipe connecting the new inlet valve to the existing dry rising fire main at ground level (this pipe was run through the basement to connect to the new drain at basement level).

4.7.92 A schematic of these modifications is shown in Figure 4.41 (RYD00000577). The revised outlet location on Level 2 is indicated in Figure 4.42, with a photograph of it from my post fire inspection provided in Figure 4.40.

4.7.93 These changes are reflected in the Studio E As-Built drawings, as indicated in this section.

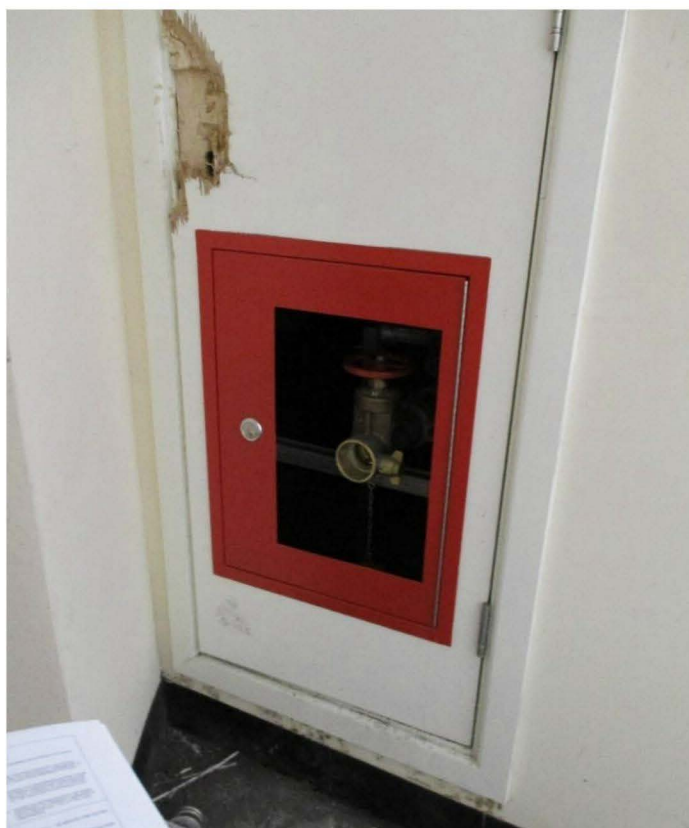


Figure 4.40: Example new dry rising fire main outlet at Level 2

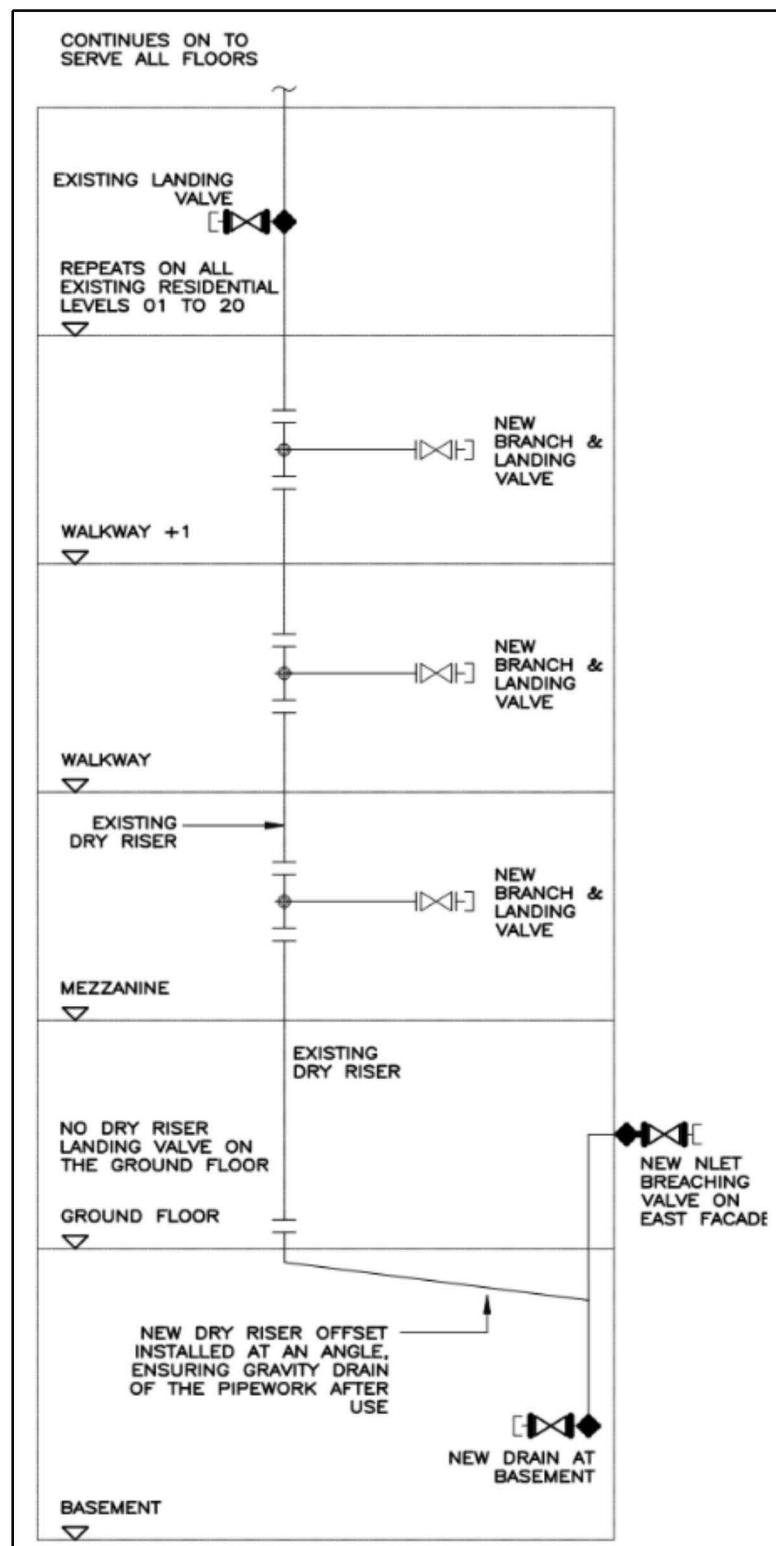


Figure 4.41: Dry riser schematic (RYD00000577)

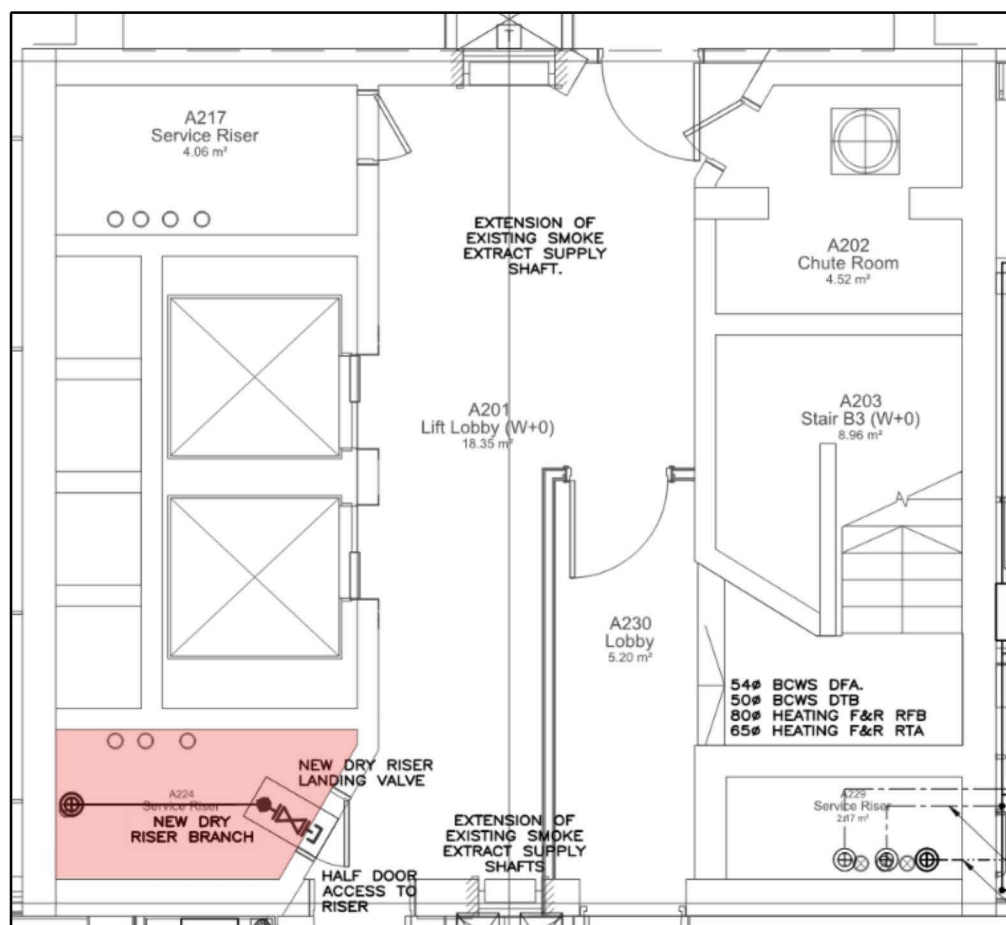


Figure 4.42: New dry riser on level 2 (RYD00000577)

4.7.94 **New Landlord gas connection to serve the new boiler plant**

4.7.95 As described in section 4.7.46, a new boiler was installed in the basement level of Grenfell Tower during the 2012 – 2016 refurbishment works.

4.7.96 A new connection from the existing gas system, referenced as the ‘Landlord Gas Supply’ in Appendix K, was also provided during the refurbishment works to serve the new boiler. This pipe connection is shown in red in Figure 4.43.

4.7.97 This conclusion is based on my review of the Max Fordham Employer’s Requirements for MEP Services (dated 28/11/13) and my site inspection of the gas supply systems (MAX00006475).

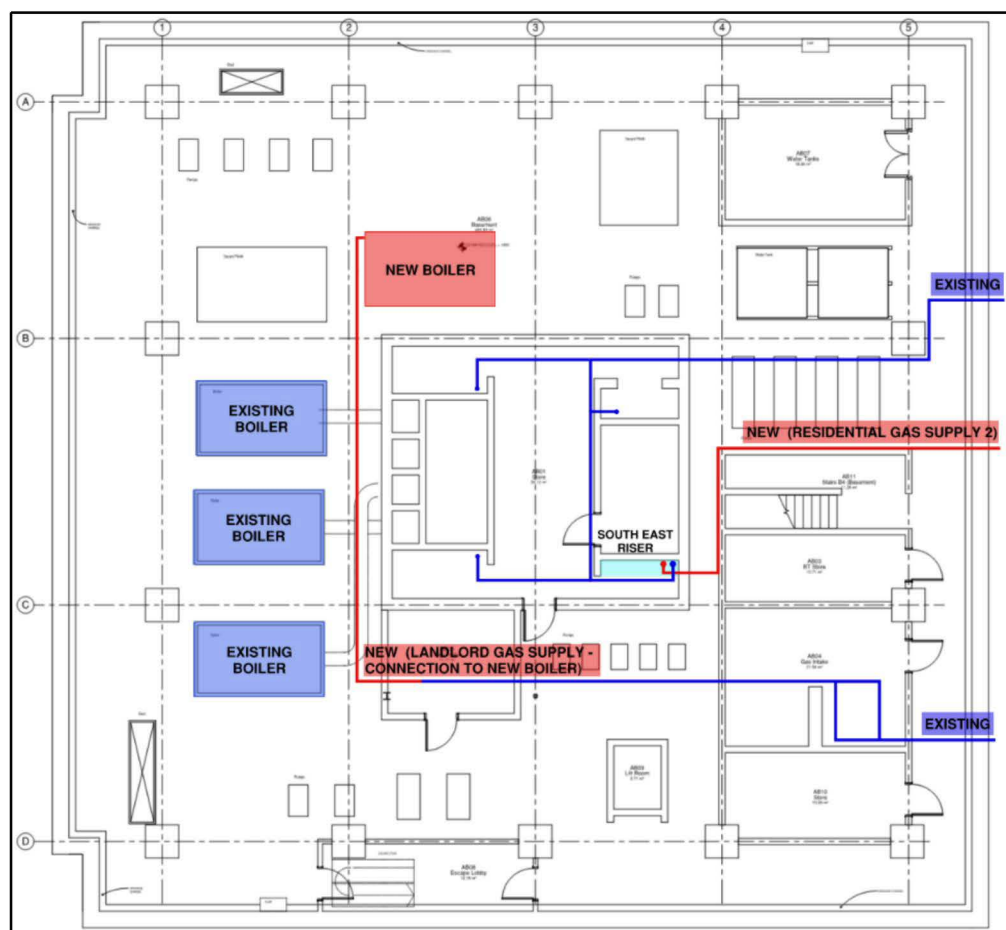


Figure 4.43: Gas works in basement (based on HAR00007951)

4.7.98 Ceilings in lift lobbies

4.7.99 Based on the Studio E Grenfell Tower Regeneration Project Room Data Sheets, Employer Requirements, dated 20-11-2013 (SEA00002540), each Existing Common lobby on levels 4 – 23 was required to have a new ceiling throughout.

4.7.100 A letter from Carl Stokes, Grenfell Tower Fire Risk Assessor, to the KCTMO describes his findings from his site visit to Grenfell Tower on 9 April 2015. This includes the following observations:

“New ceilings are being installed on the flat/lift lobby areas along with a boxed in area where the valves and pipes of the new heating system will be located, below are photographs taken on the 14th floor level where the new ceilings and cupboards have been partly constructed. The ceilings and the cupboards are fire rating and to the specification as stated in the construction documentation as issued by the TMO, I am told.

The construction of the ceilings and the cupboards is of plasterboard on a timber frame with the doors of the cupboards being 30 minute fire rated doors fitted with cold smoke seals and intumescent strips. The doors will have locks on them.

I was told that where the ceiling abut up to the walls the access panels of the risers are being cut at the new ceiling height so access to the electrical cable risers is maintained.” (CST00000170)

- 4.7.101** Pre-fire photographs of the Level 14 new ceiling installations are shown in Figure 4.44 and Figure 4.45.
- 4.7.102** Carl Stokes’ correspondence indicates that he believed that the ceiling and new cupboards were of fire resisting construction. There is no evidence in the refurbishment design information reviewed to date to support this.
- 4.7.103** During my site inspections I did observe the new ceiling cupboard enclosure. The ceiling construction was mounted on metal stud framing and not timber as stated by Mr Stokes. Please refer to Appendix C and Section 14.

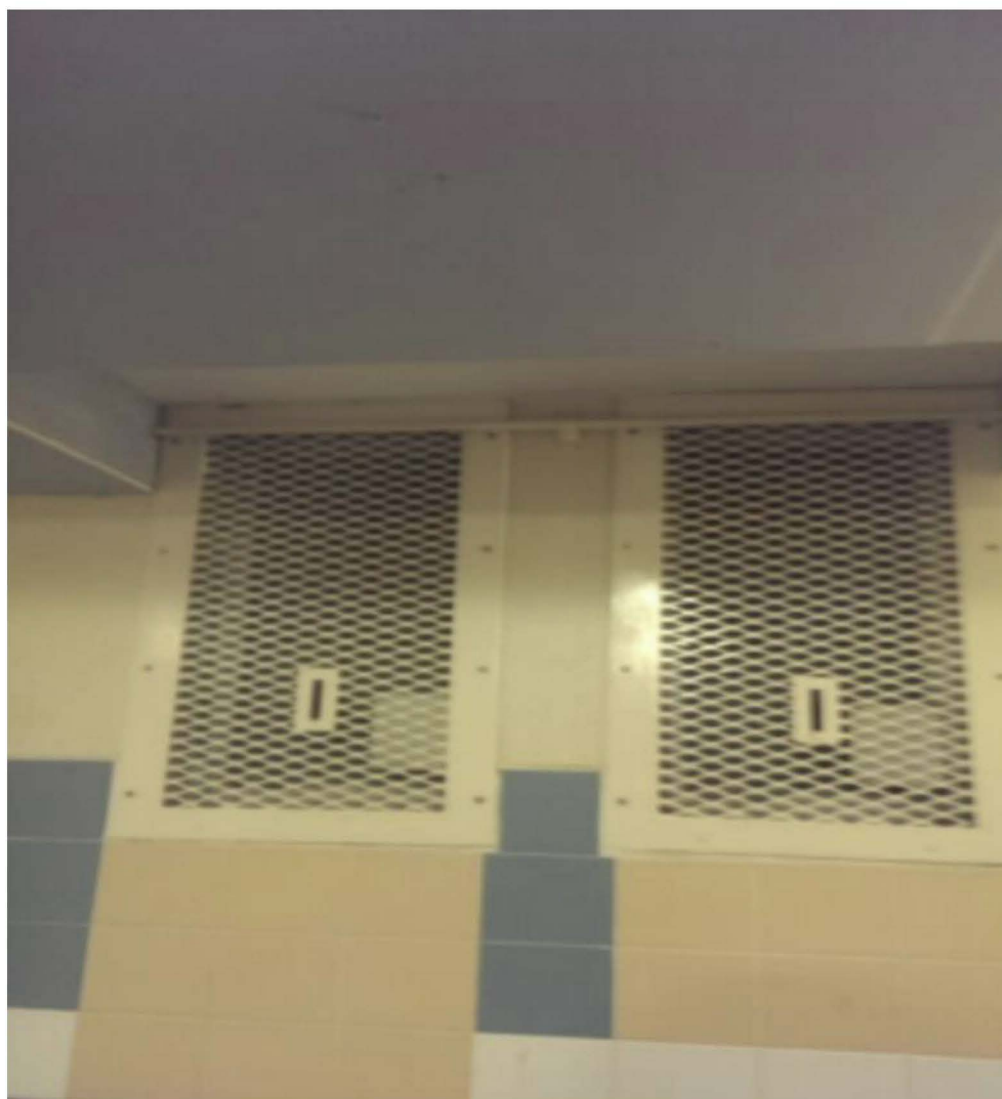


Figure 4.44: New ceiling around vents on Level 14 (CST00000170)

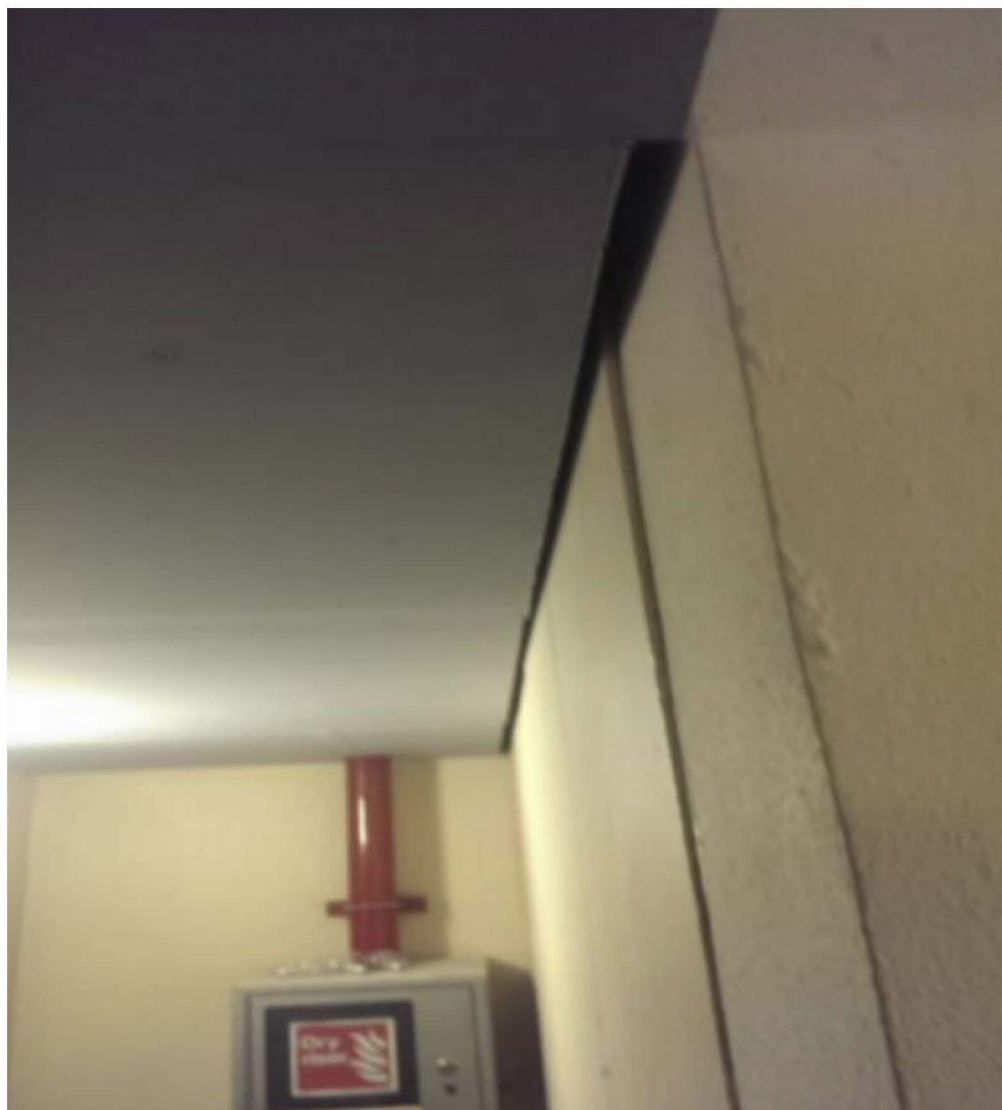


Figure 4.45: Wall access panels to be cut at new ceiling height so access to the electrical cable risers can be maintained (CST00000170)

4.7.104 New fire doors installation 2016

4.7.105 As part of these works, nine new flats were created at level 1 - 3, each with an associated main flat entrance fire door, specified to be FD60S fire rated. (RYD00000435)

4.7.106 Additionally, eight new fire doors to the escape stair/firefighting stair were installed as follows: 2 no. FD60S at Ground, 2 no. FD30S at Level 1, 3 no. FD30S at Level 2 and 1 no. FD60 at Level 3. Please refer to the sketches in Appendix I for the locations of these new fire doors and for full details regarding current evidence of their fire performance.

4.7.107 New tenant gas supply, 2016 – 2017

4.7.108 A new tenant gas supply, referred to here as Residential Gas Supply 2 in Appendix K, was provided between October 2016 and June 2017 to serve flat ‘2’ on Levels 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17 and 21.

4.7.109 This new tenant gas supply was required because of corrosion within one of the existing gas risers (Riser 2, serving flat 2 on each level) which led to a small gas leak. The survey and discovery of the leak was completed on 30th September 2016, after which Riser 2 was isolated (1 October 2016) (Stephen Mason statement CAD00000004).

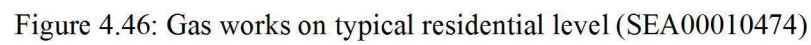
4.7.110 I traced this new gas supply pipe during my Tower inspection. It enters the building on the east side of the basement level and enters the Southeast riser in the core of the building. It rises vertically to Level 2, where the gas pipe leaves the riser, enters the Community Meeting Room and then turns and enters the protected stairway; see Appendix K.

4.7.111 This gas supply system is then routed through the protected stairway from Level 2 to Level 23.

4.7.112 At the abovementioned levels, a lateral gas pipe passes out through the stair wall across the lobby at ceiling level and enters flat ‘2’ at the right-hand side of the flat entrance, as shown in Figure 4.46. This pipe is also shown in outside Flat 12.

4.7.113 Within the stair the riser was enclosed in construction that was complete from levels 4 to 22 at the time of the fire on 14 June 2017, but was not fully enclosed to the roof vent. The construction separating the lateral distribution pipes on each of the floors (where provided) was not installed at the time of the fire. As described in Appendix K, the fire resistance performance of the enclosing construction is currently unknown.

4.7.114 The arrangements for ventilation of the enclosure to the riser within the protected stair were not complete at the time of the fire on 14 June 2017.



4.7.115 Location of refurbishment works, 2012 – 2016

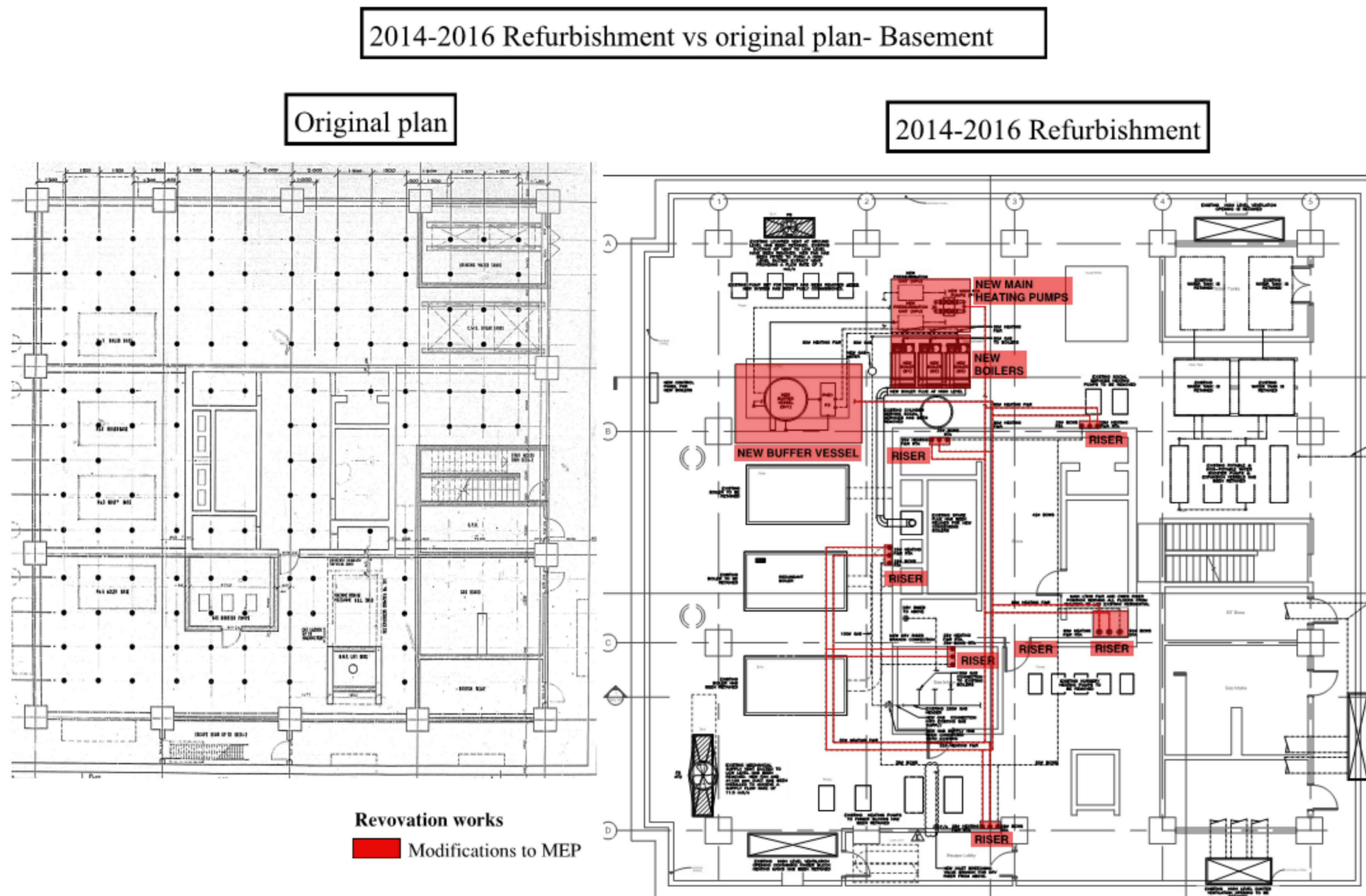


Figure 4.47: Basement level – refurbishment plan and original basement plan (RBK00018843, RYD00000577)

2014-2016 Refurbishment vs original plan- Ground Floor

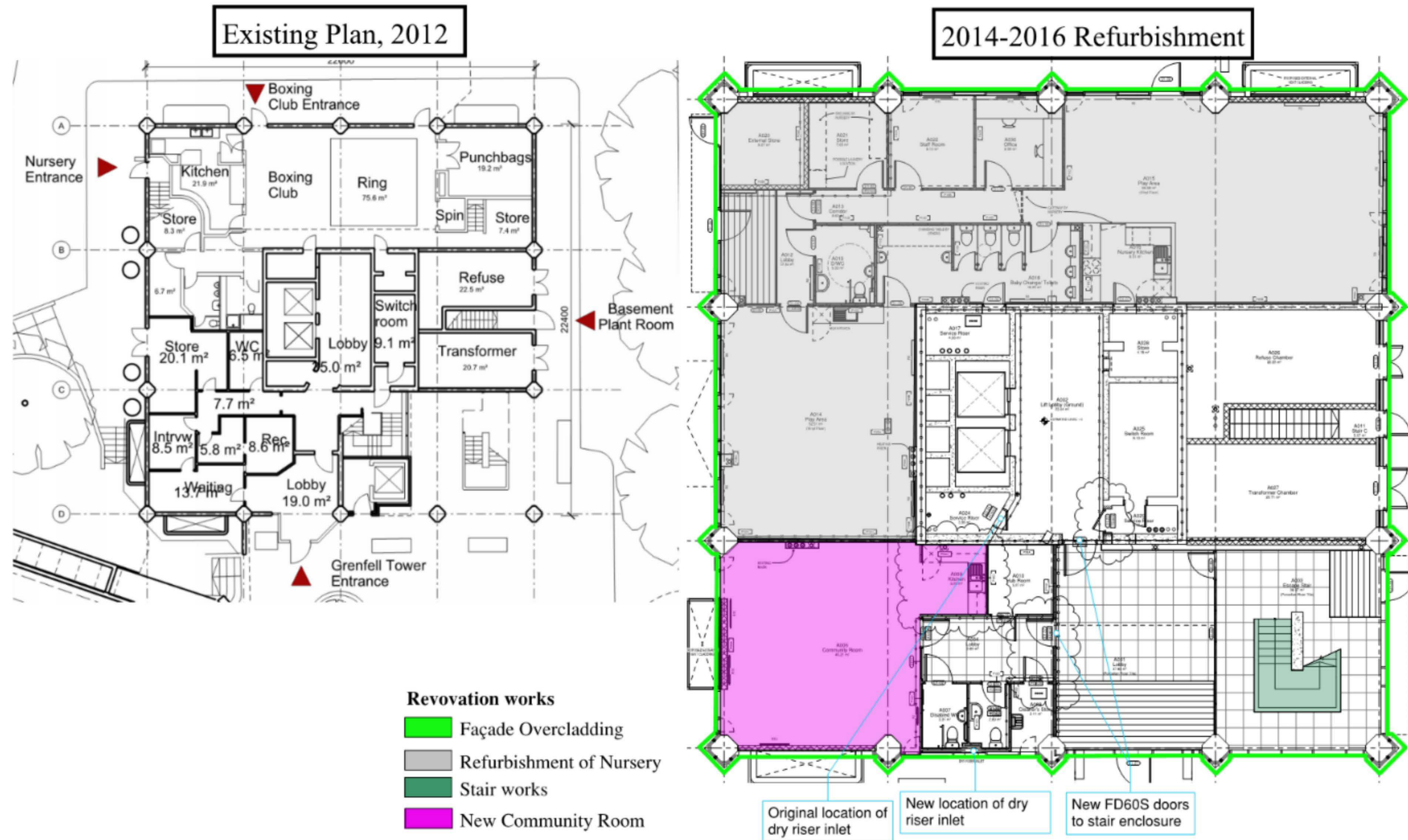


Figure 4.48: Ground level – refurbishment plan and existing 2012 plan (MAX00000879, SEA00003232)

2014-2016 Refurbishment vs original plan- Level 1

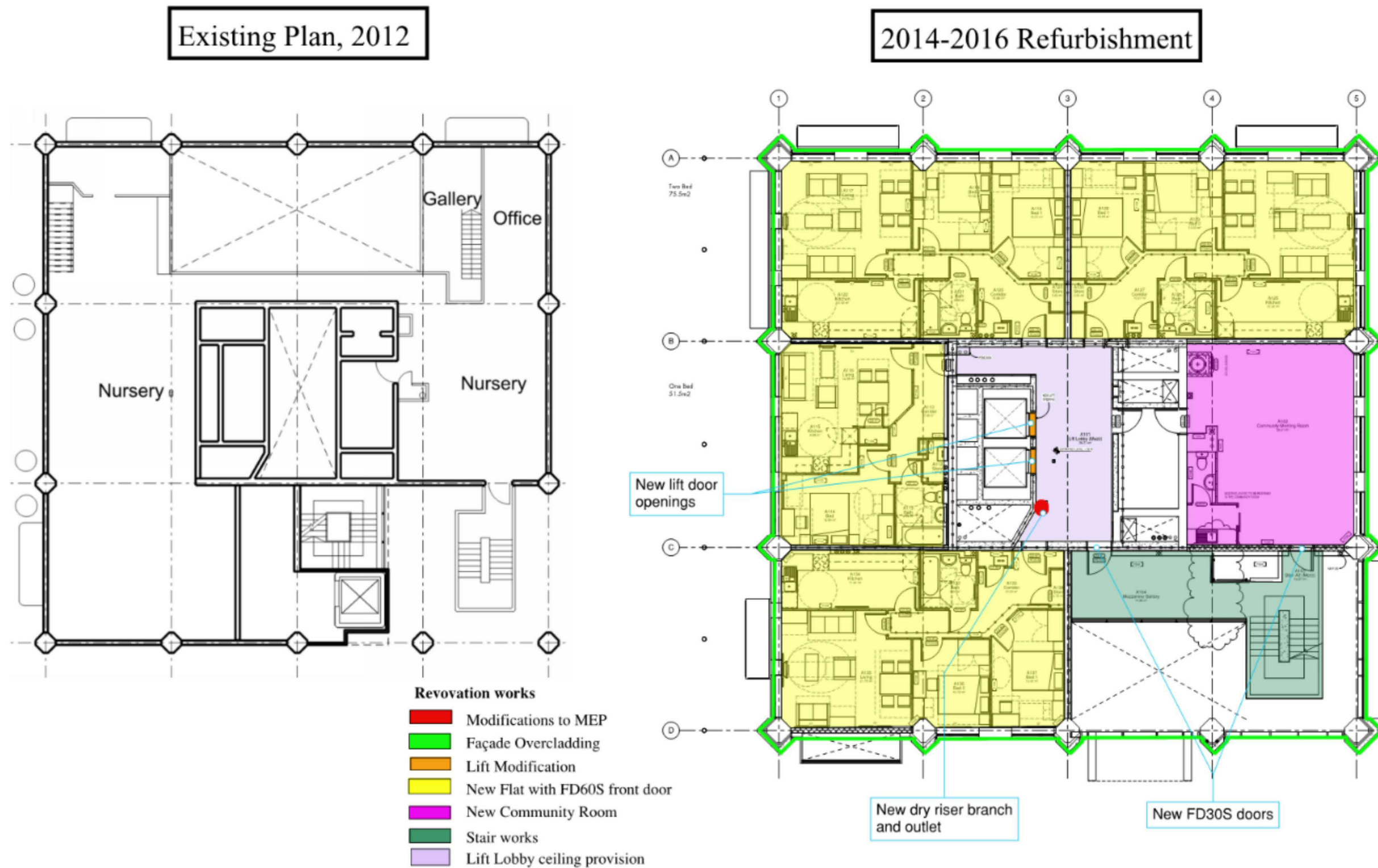


Figure 4.49: Level 1 – refurbishment plan and existing 2012 plan (MAX00000879, SEA00003231)

2014-2016 Refurbishment vs original plan- Level 2

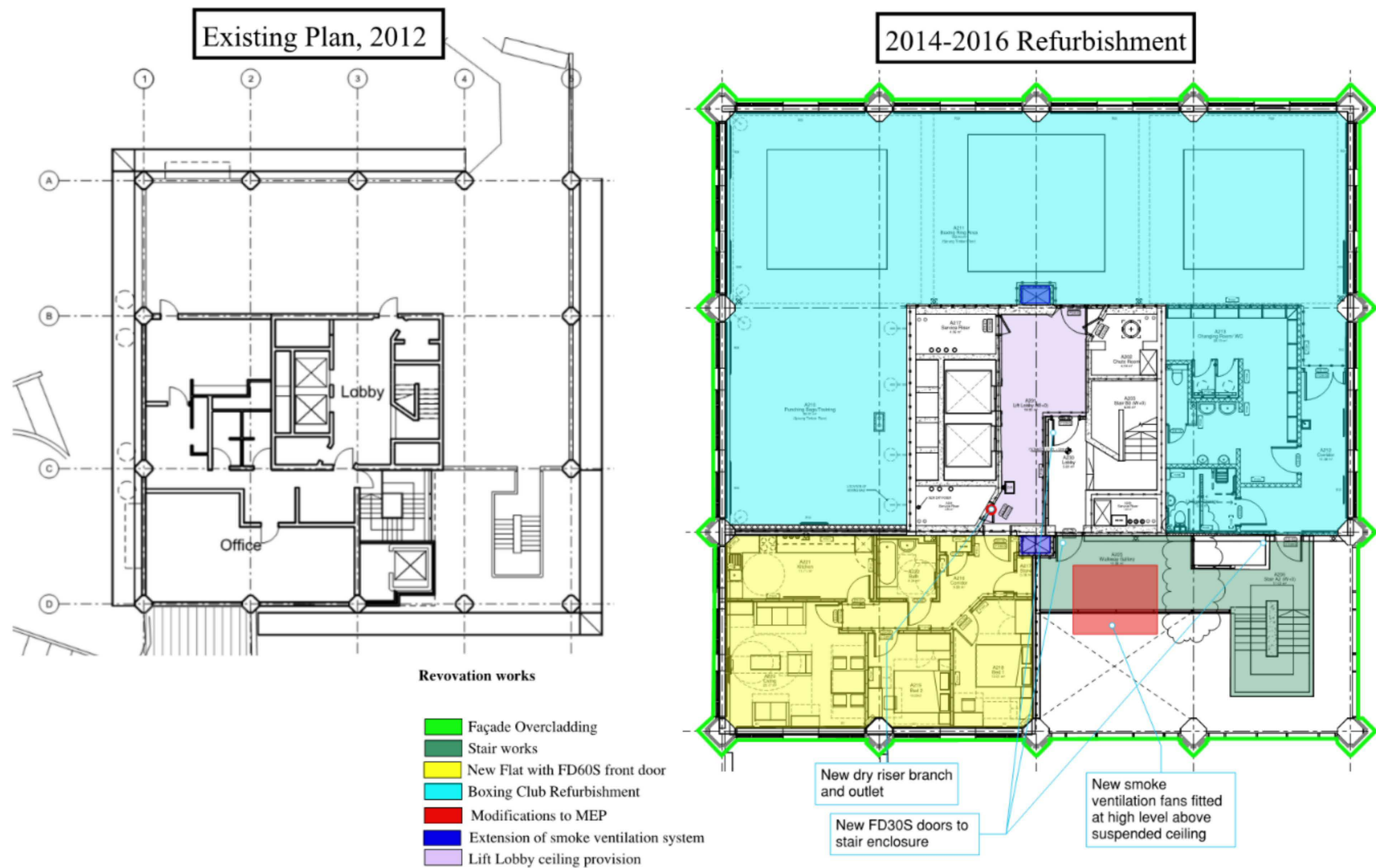


Figure 4.50: Level 2 – refurbishment plan and existing 2012 plan (MAX00000879, SEA00003149)

2014-2016 Refurbishment vs original plan- Level 3

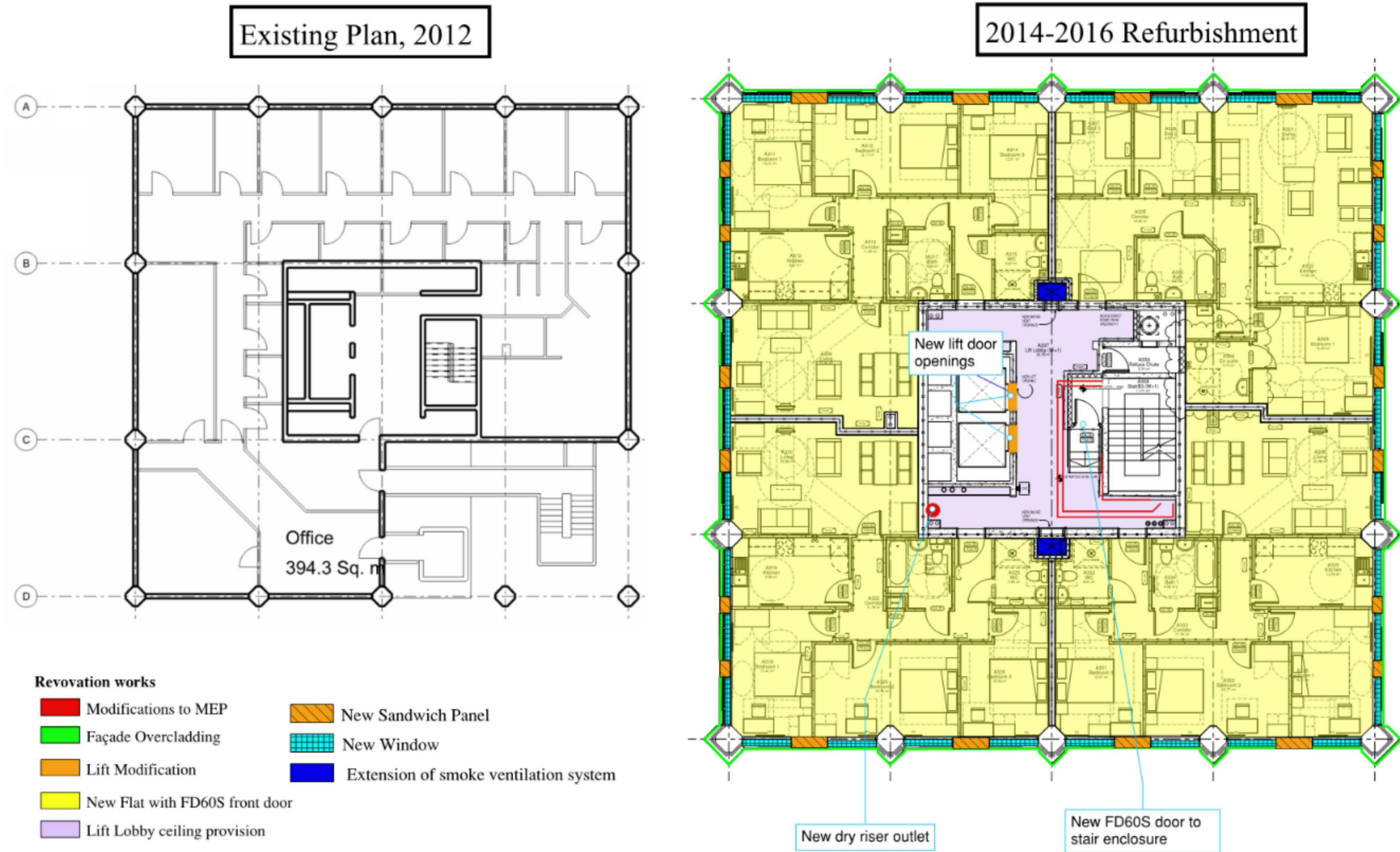


Figure 4.51: Level 3 – refurbishment plan and existing plan (MAX00000879, SEA00003229)

2014-2016 Refurbishment vs original plan - Floors 4 to 23

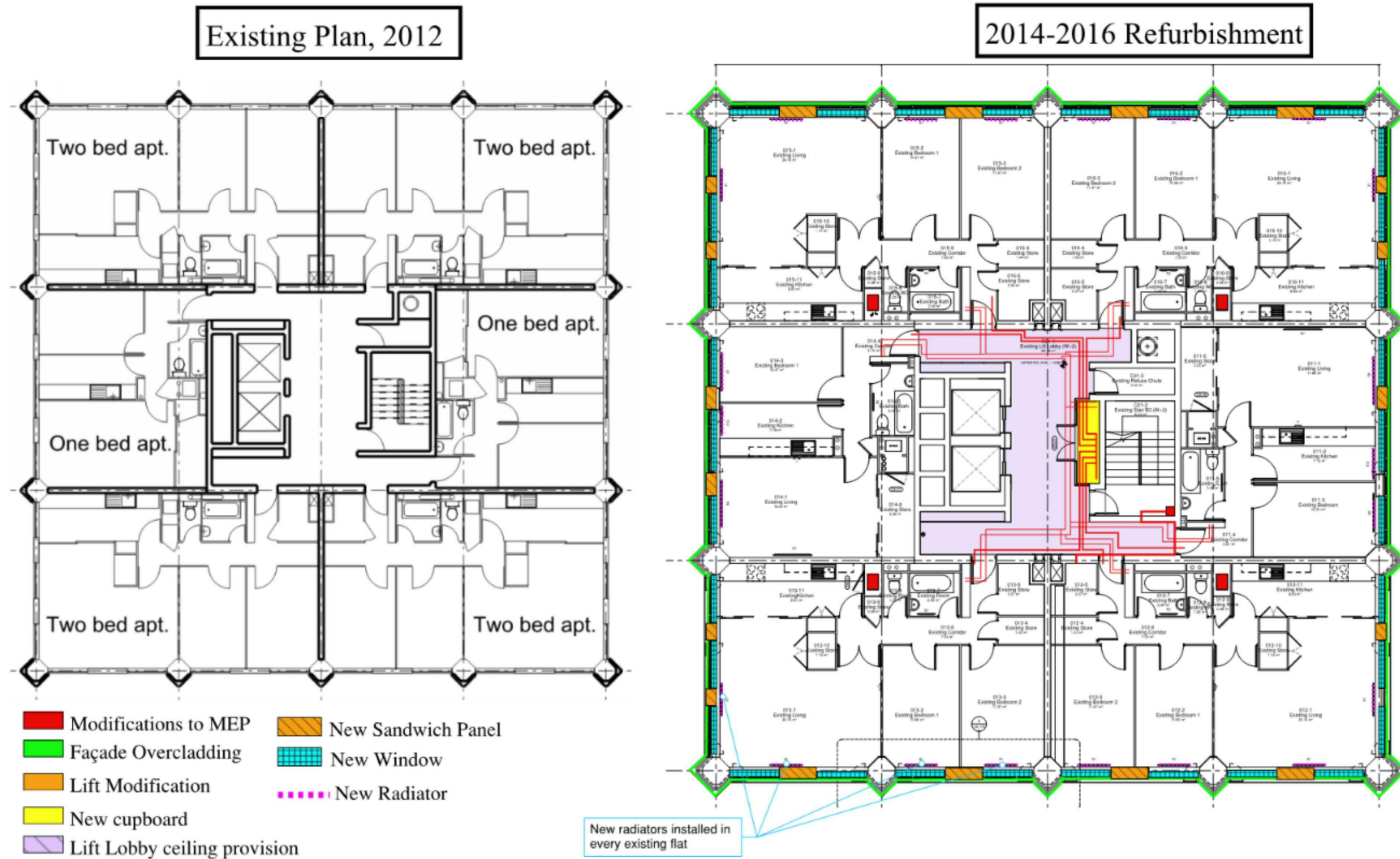
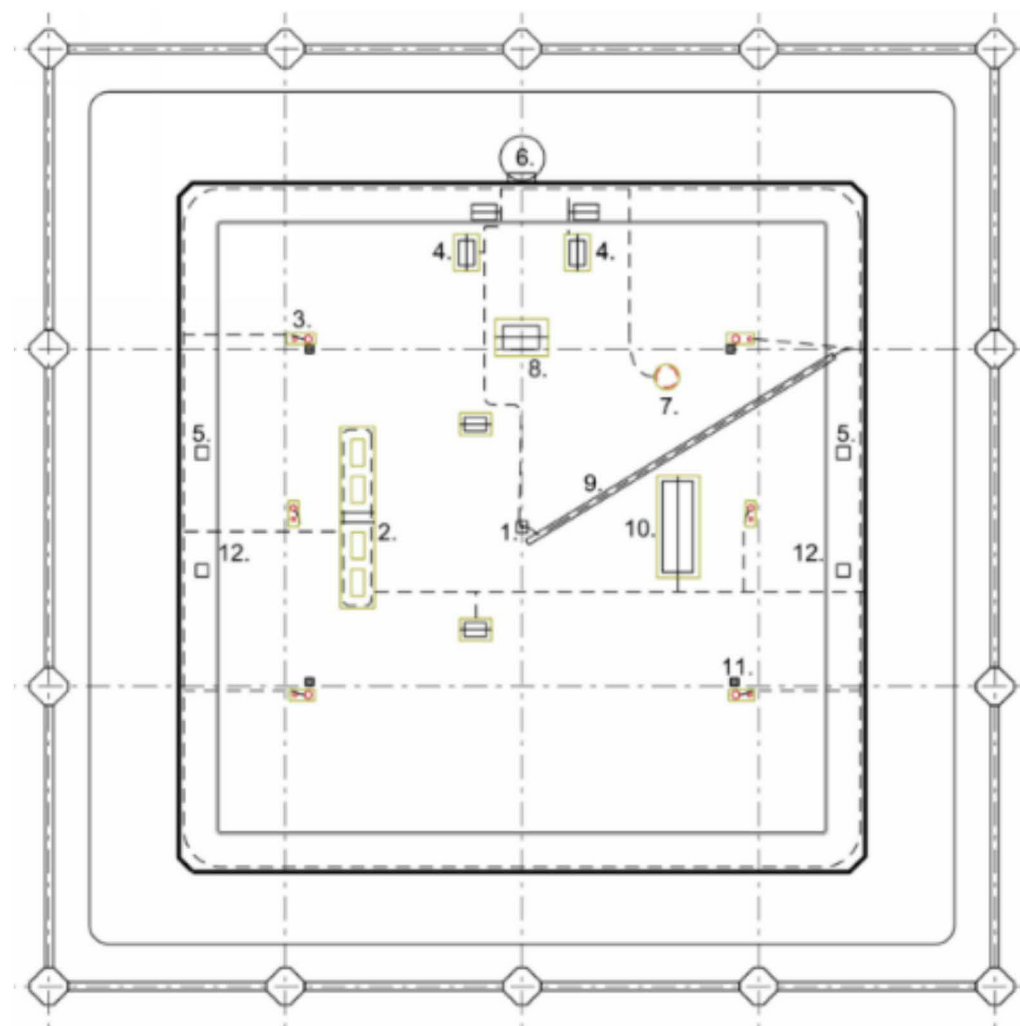


Figure 4.52: Level 4 – 23 typical residential level – refurbishment plan and existing 2012 basement plan (SEA00010474, RYD00000577)

2014-2016 Refurbishment vs original plan- Roof

Existing Plan, 2012



Revovation works

- Modifications to MEP
- Façade Overcladding

2014-2016 Refurbishment

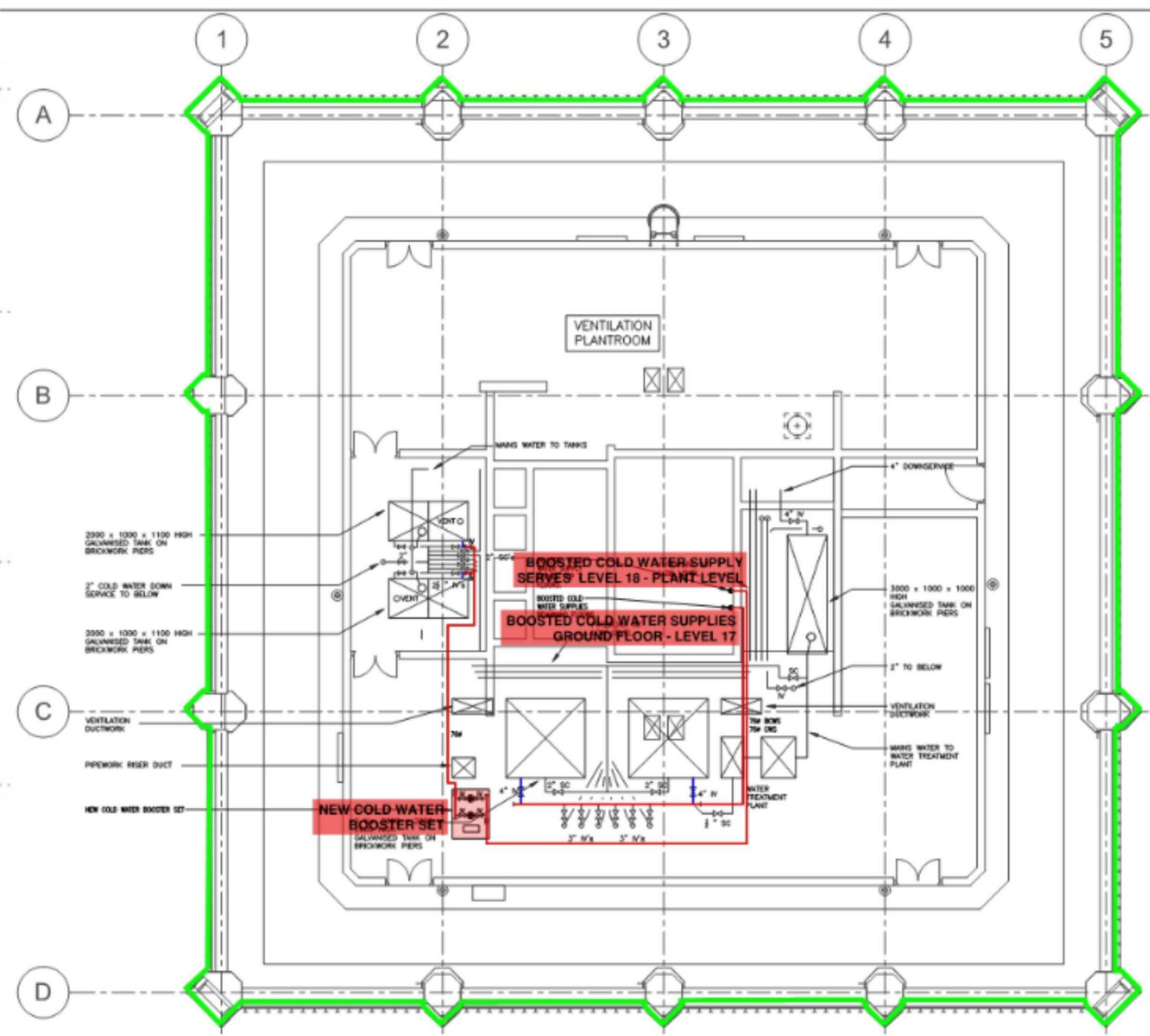


Figure 4.53: Roof level – refurbishment plan and existing 2012 roof plan (MAX00000879, RYD00000577)

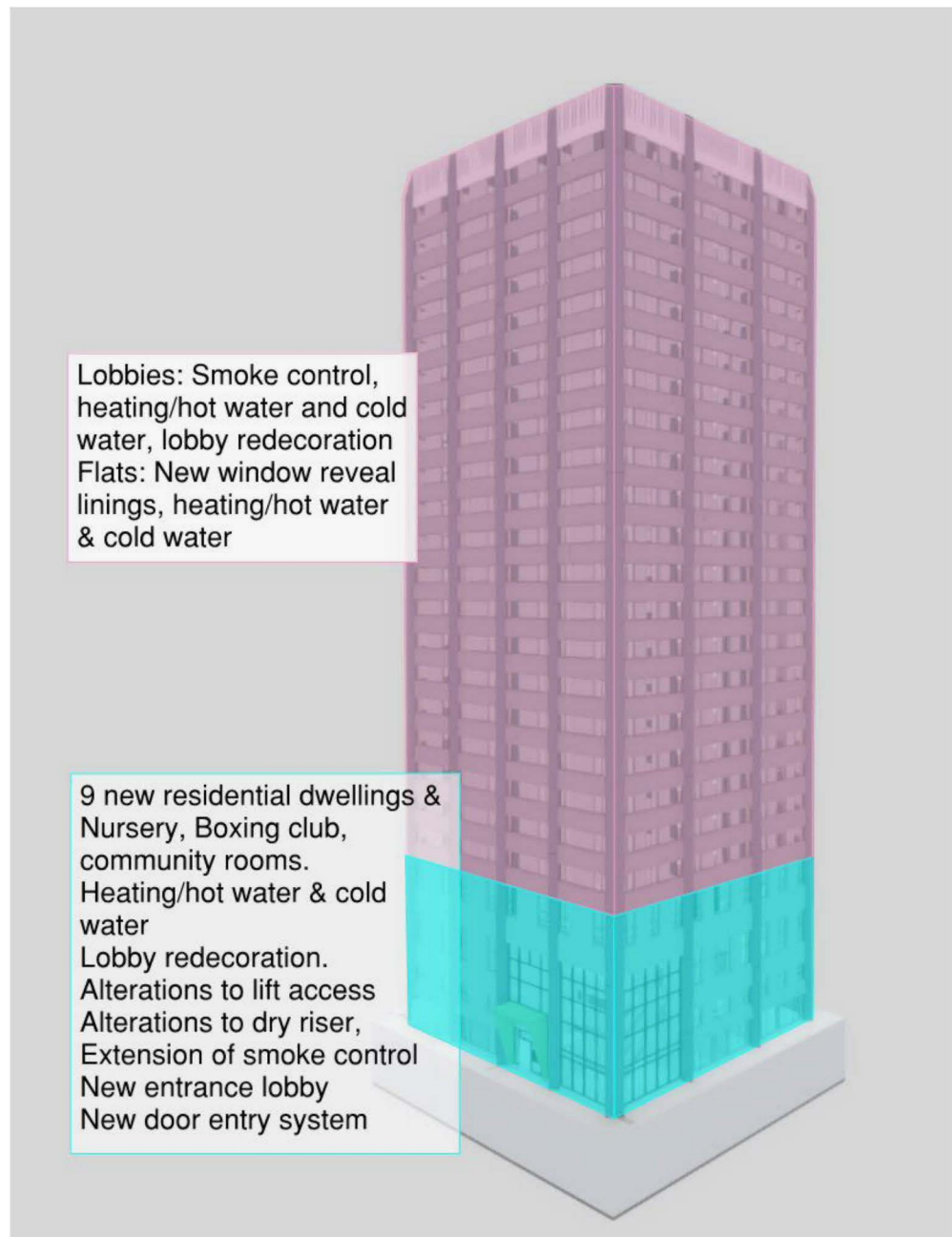


Figure 4.54: Summary of all works undertaken by location in Grenfell Tower shown on 3D model

4.8 Conclusions

- 4.8.1 In this section I have explained my findings from my review of the evidence provided to me regarding key refurbishment projects at Grenfell Tower.
- 4.8.2 I consider these to be substantial works on all levels inside Grenfell Tower, as well as the more obvious external works to the building envelope. These internal and external works took place during the most recent works from 2012-2016, as well as the fire doors work preceding this time period, and the gas works which were underway at the time of the fire.
- 4.8.3 Substantial works have been undertaken in all parts of the building over this time period, including the inside and outside of all individual flats and substantially throughout all of the communal spaces including all protected lobbies and the full extent of the stair core (by means of the gas works).
- 4.8.4 In Appendix D, I present a summary of the relevant legislation, regulations and guidance that was relevant to the works described in this section.
- 4.8.5 In the next phase of my work, I will investigate which of the works described herein would have required specific approval under the Building Act 1984 and the Building Regulations, relevant to 2012-2016.
- 4.8.6 I will also consider if those works could be classified as a “material alteration” under Regulation 4 of the Building Regulations. A “material alteration” is an alteration, which, at any stage of the work, resulted in the building being less satisfactory than it was before in relation to compliance with the requirements of Parts B1, B3, B4 or B5.
- 4.8.7 Such works are controlled by Regulation 4 of the Building Regulations. Regulation 4(1) requires that any building work carried out in relation to a material alteration complies with the applicable requirements of Schedule 1 to the Regulations, while Regulation 4(3) requires that once that building work has been completed, the building as a whole must comply with the relevant requirements of Schedule 1 or, where it did not comply before, must be no more unsatisfactory than it was before the work was carried out.