

**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.**

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**Phase 1 Report – Appendix K**

**Gas supply – fire safety requirements and provisions**

**REPORT OF**

**Dr Barbara Lane FREng CEng**

**Fire Safety Engineering**

**24<sup>th</sup> October 2018**

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<b>Specialist Field</b>	:	Fire Safety Engineering
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<b>On behalf of</b>	:	Grenfell Tower Inquiry
<b>On instructions of</b>	:	Cathy Kennedy, Solicitor, Grenfell Tower Inquiry
<b>Subject Matter</b>	:	To examine the circumstances surrounding the fire at Grenfell Tower on 14 <sup>th</sup> June 2017
<b>Inspection Date(s)</b>	:	6 <sup>th</sup> October, 1 <sup>st</sup> November, 7-9 <sup>th</sup> November 2017

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## **Appendix K– Gas supply – fire safety requirements and provisions**

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## **K1 Introduction**

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### **K1.1 Purpose of Appendix K**

- K1.1.1** This chapter describes the requirements for gas service installations in Grenfell Tower relevant to the Building Act 1984 and Health and Safety at Work Act 1974.
- K1.1.2** I have investigated the gas service installations at Grenfell Tower and the associated compliance of those systems with the current regulations with a particular focus on the provision for Emergency Control as this is relevant to compliance with Part B of the Building Regulations.
- K1.1.3** I was assisted on site by Mr Joe Wade, my colleague from Arup.
- K1.1.4** My assessment of the gas supply systems at Grenfell Tower is based on a review of design and construction documentation and evidence observed during a series of site visits between the 7<sup>th</sup> and 9<sup>th</sup> November 2017.
- K1.1.5** In this chapter, I will also present evidence from witnesses as to the conditions of the gas services during the incident that took place on the 24<sup>th</sup> June 2017, particularly with respect to isolating the gas supply. The gas supply was not isolated until a relatively late stage on 14<sup>th</sup> June 2017.
- K1.1.6** I am aware that the Inquiry has instructed a Gas Service Expert, Mr Rodney Hancox. His instructions are to provide a report, for the purposes of the Inquiry, which addresses the following issues:
- a) The relevant legislation, regulations, guidance and industry practice relevant to gas supply to and within Grenfell Tower, including the measures which ought to have been in place to enable the gas supply to be isolated in the event of a fire.
  - b) The steps taken by the relevant parties to isolate the gas supply to and within Grenfell Tower on or around the night of 14 June 2017 and, in particular, whether the steps taken complied with the relevant regulations, legislation, guidance, industry practice and/or were appropriate in the circumstances.
  - c) The extent to which the presence of gas in the Grenfell Tower contributed to the spread of fire and/or the conditions inside Grenfell Tower on the night of 14 June 2017.
  - d) Insofar as is relevant to the events on the night of 14 June 2017, the design and construction of the gas supplies to and within the Grenfell Tower, including the new gas riser and pipework installed at Grenfell Tower in 2016-2017, and whether the design and construction complied with the relevant regulations, legislation, guidance and industry practice.



**K1.1.7** I intend this appendix to act as a briefing document for the Gas Service Expert, noting that fire safety compliance is relevant to my own expert work.

## **K1.2 Gas services within Grenfell Tower**

**K1.2.1** During our site inspections, we located the gas supplies and traced the pipework to understand how the systems were distributed throughout Grenfell Tower.

**K1.2.2** This was a complex process particularly within the Basement.

**K1.2.3** I also reviewed the following documents relevant to the gas works that took place during the 2012 – 2016 refurbishment:

- a) Max Fordham Employer's Requirements, 28 November 2013 (MAX00006475)
- b) Witness Statement of Stephen Mason, Cadent Gas Ltd (CAD000000004)
- c) Grenfell Tower Mechanical Operation and Maintenance Manual by J S Wright & Co Ltd, which includes Description of Services and 'As Fitted' drawings (RYD00000577).

## **K1.3 Resulting chronology of gas works within Grenfell Tower**

**K1.3.1** Table K.1 presents the chronology of gas works that I have been able to develop based on the information currently available to me.

Table K.1: Chronology of gas works in Grenfell Tower

Gas service	Date	Evidence	Reference
Landlord gas supply for communal heating and water supply to Grenfell Tower and adjacent "finger blocks"	1972 – 1974	<i>The Tower originally had two supplies of gas. The first, a 10" steel service, supplied a communal heating and hot water system in the basement of the tower block.</i>	Witness Statement of Stephen Mason, Cadent Gas Ltd - CAD000000004
	2012 – 2016	<i>The scope of works is limited to providing a new connection from the existing gas system to serve the new boiler plant</i>	RYD00000577

Gas service	Date	Evidence	Reference
Existing tenant gas supply to the residential flats on Levels 4 to 23	1972 – 1974	<i>The second, a 4” steel service, supplied gas for cooking in residential flats on the 4th to the 23rd floors via 6 gas riser pipelines (vertical gas pipes) that were installed when the Tower was built.</i>	Witness Statement of Stephen Mason, Cadent Gas Ltd - CAD00000004
New tenant gas supply to residential flats ending in number 2	Oct 2016 – June 2017	<i>Between October 2016 and June 2017, a third gas supply service and a replacement for one of the existing risers were installed in the Tower, together with associated works.</i>	Witness Statement of Stephen Mason, Cadent Gas Ltd - CAD00000004

## K1.4 Overview of gas services identified within Grenfell Tower

**K1.4.1** The locations of the gas pipes are described in the Statement of Stephen Mason, Cadent (CAD00000004):

*“3. ... The Tower originally had two supplies of gas. The first, a 10” steel service, supplied a communal heating and hot water system in the basement of the tower block. The second, a 4” steel service, supplied gas for cooking in residential flats on the 4th to the 23rd floors via 6 gas riser pipelines (vertical gas pipes) that were installed when the Tower was built. Our records do not stretch back this far but typically the services would be built into service ducts forming the core of the building at the time of construction, similar to lift shafts. Just over 70% of the flats had a live gas supply.”*

**K1.4.2** There are 120 flats on Levels 4 -23 of Grenfell Tower, therefore “just over 70%” of flats would be at least 84 flats in Grenfell Tower.

**K1.4.3** During our site inspections, three (3) no. incoming gas supplies to the Building were identified, as shown in Figure K.1. Each of these gas supplies enter the building at high level on the East elevation of the Basement Level, as follows.

**K1.4.4** The Landlord Gas Supply Entry Point is shown on the east of the basement in Figure K.1. The Landlord Gas Supply is contained within the basement only; this system is described in Section K1.5.

**K1.4.5** The Residential Gas Supply 1 Entry Point and Residential Gas Supply 2 Entry Point are shown on the East elevation of the basement in Figure K.1. These

two gas supplies serve the residential apartments on Levels 4 – 23 of Grenfell Tower, these systems are described in Section K1.6.

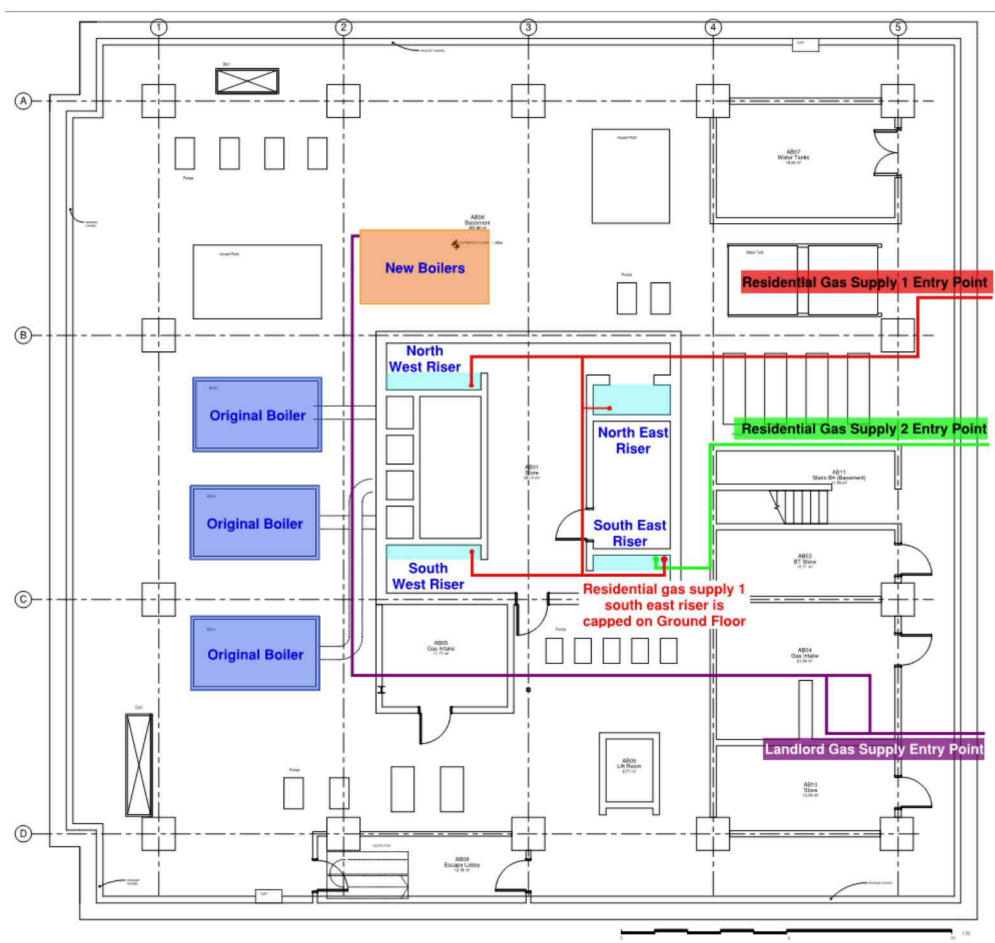


Figure K.1: Incoming gas supplies serving Grenfell Tower (RYD00000577).

## K1.5 Landlord gas supply system (Communal heating and water)

**K1.5.1** The Landlord Gas Supply System, enters Grenfell Tower through the East elevation of the Basement Level; see Figure K.1 and Figure K.2.





Figure K.2: Incoming pipe for Landlord Gas Supply System (approx. 4 – 5m above basement floor)

- K1.5.2** This gas supply serves the new boilers supplying the primary hot water circulation system within Grenfell Tower, as well as the existing boilers, which have been retained to serve the “finger blocks” only – Testerton, Hurstway, and Barandon Walks – 3 and 4 storey linear residential blocks southwest of Grenfell Tower (RYD00000577) (CCL00000028).
- K1.5.3** The gas main and the boilers it supplies are contained within the basement only (RYD00000577). Figure K.2 and Figure K.3 show the primary landlord system components, which are also listed below in order from upstream to downstream valves:
- Low pressure safety valve; reference Figure K.2;
  - Manual isolation valve; reference Figure K.4;
  - Pressure regulator (i.e. pressure reducing valve); reference Figure K.5;
  - Gas meter; reference Figure K.6;
  - Manual isolation valve; reference Figure K.6;
  - Solenoid valve; reference Figure K.7;
  - (3) manual isolation valves for original boilers serving ‘finger blocks’ only; reference Figure K.8 and Figure K.9;
  - Isolation valve for new boilers; reference Figure K.11;
  - Isolation valve and meter to the new boilers; reference Figure K.12.



**K1.5.4** The incoming gas supply enters Grenfell Tower at a high level in the basement – approximately 4 – 5 meters above the finished floor. A low-pressure safety valve, which operates if there is a loss of pressure on the incoming gas main, is installed at this height also, as shown in Figure K.2.

**K1.5.5** The pipework then enters gas intake room 1 in the basement, where it drops to a low level. A manual isolation valve is located at a low level in this room, as shown in Figure K.4. Two pressure-reducing stations are installed in parallel before returning to a single pipe to enter the gas meter; see Figure K.5 and Figure K.6. There is another isolation valve installed after the meter, as shown in Figure K.6. The pipe work leaves the gas intake room 1 via the west wall to the main basement area. At this point, a solenoid valve has been installed that can be used for automatic gas shut off to the landlord system, as shown in Figure K.7. The pipe work then enters gas intake room 2 where there is a header installed with 4 no. take-offs, 3 no. of which go to feed the existing boilers (2 of which were isolated during our site visit), as shown in Figure K.8 and Figure K.9. The fourth take-off is the gas supply to the new boilers, as shown in Figure K.10. A manual isolation valve for the gas pipe work to the new boilers is shown in Figure K.11 as it exits the gas intake room 2. Another isolation valve is provided immediately after the meter to the new boilers, as shown in Figure K.12.

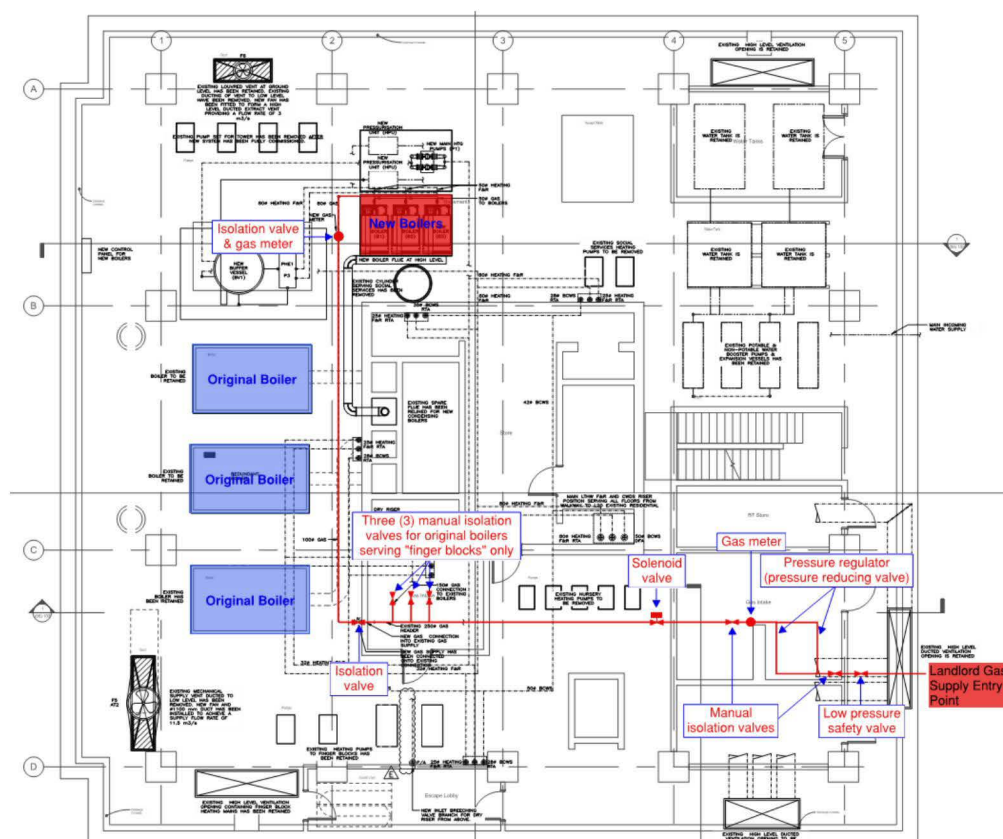


Figure K.3: Landlord system in basement of Grenfell Tower



Figure K.4: Isolation control valve at low level in gas intake room 1



Figure K.5: Pressure reducing valve in gas intake room 1



Figure K.6: Gas meter and manual isolation valve in gas intake room 1



Figure K.7: Solenoid valve





Figure K.8: Distribution header and a take-off in gas intake room 2



Figure K.9: Three (3) original take-offs from the gas main header in gas intake room 2 to the existing boilers





Figure K.10: Take-off for the new boiler gas supply



Figure K.11: Manual isolation valve for the gas pipework serving the new boilers, as it exits gas intake room 2



Figure K.12: Isolation valve and meter for the gas pipework serving the new boilers

## **K1.6 Tenant gas supply (Residential)**

**K1.6.1** During our site inspections, my team identified two (2) no. tenant gas supplies, referred to in this section as Residential gas supply 1 and Residential gas supply 2, which enter Grenfell Tower through the East elevation of the Basement Level; see Figure K.1.

### **K1.6.2 Residential gas supply 1 (original)**

**K1.6.3** Originally, a single gas supply, residential gas supply 1, served all residential flats with gas on Levels 4 to 23. It entered the Basement Level on the East elevation of the building at a high level, shown in Figure K.1 and Figure K.13.

**K1.6.4** I traced the route of residential gas supply 1 to the central core, where it splits into four vertical risers, shown as northeast, northwest, southeast, and southwest risers in Figure K.1. Figure K.14 shows the residential gas supply system 1 entering the northeast riser. Valves were identified at the base of each of the four risers, however these valves were at a high level in the basement and were therefore not readily accessible. Also, it is unknown if these were intended as a service valves or as emergency control valves.

**K1.6.5** I found the gas pipe in the southeast riser (A029 service riser) has been isolated and capped on the ground floor; see Figure K.15.





Figure K.13: Incoming pipe for residential gas supply system 1 entering basement on East elevation of building

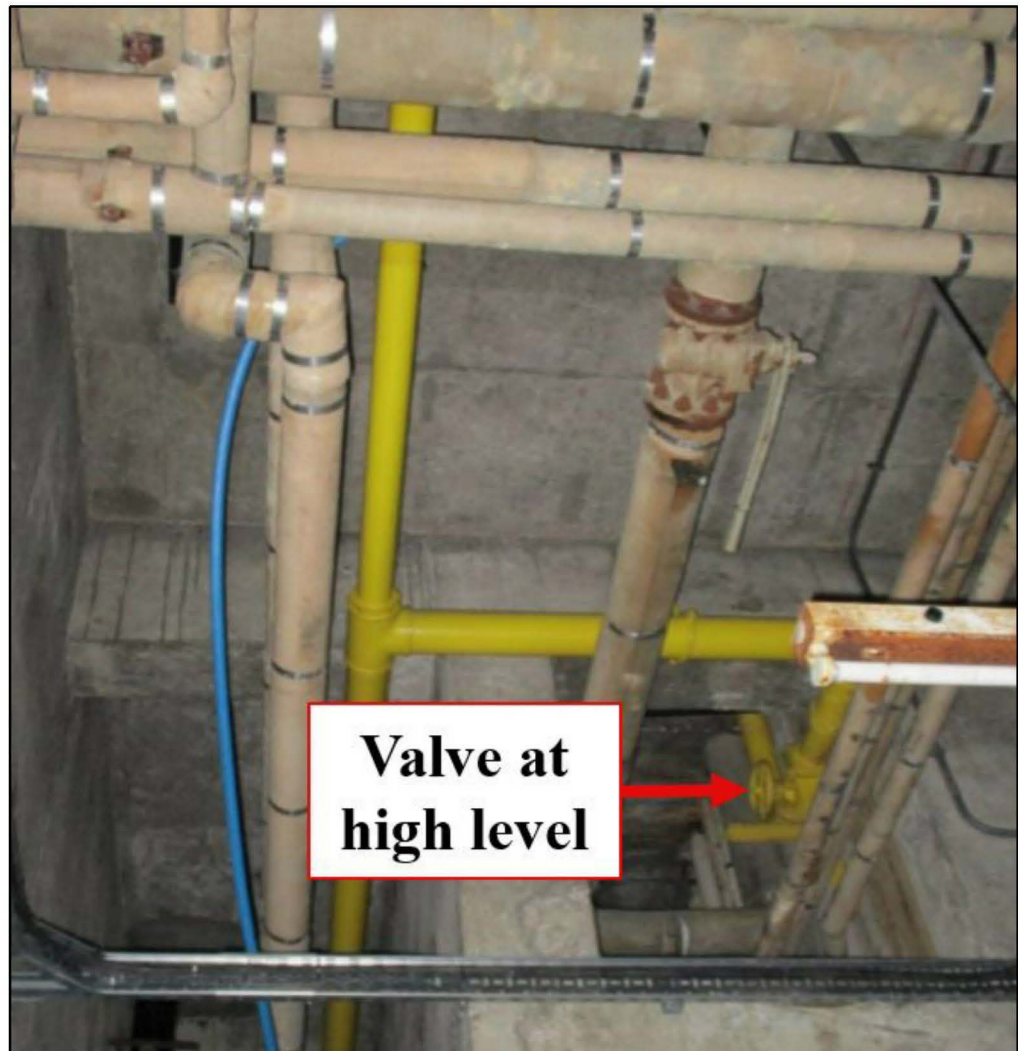


Figure K.14: Residential gas supply system 1 entering the northeast riser

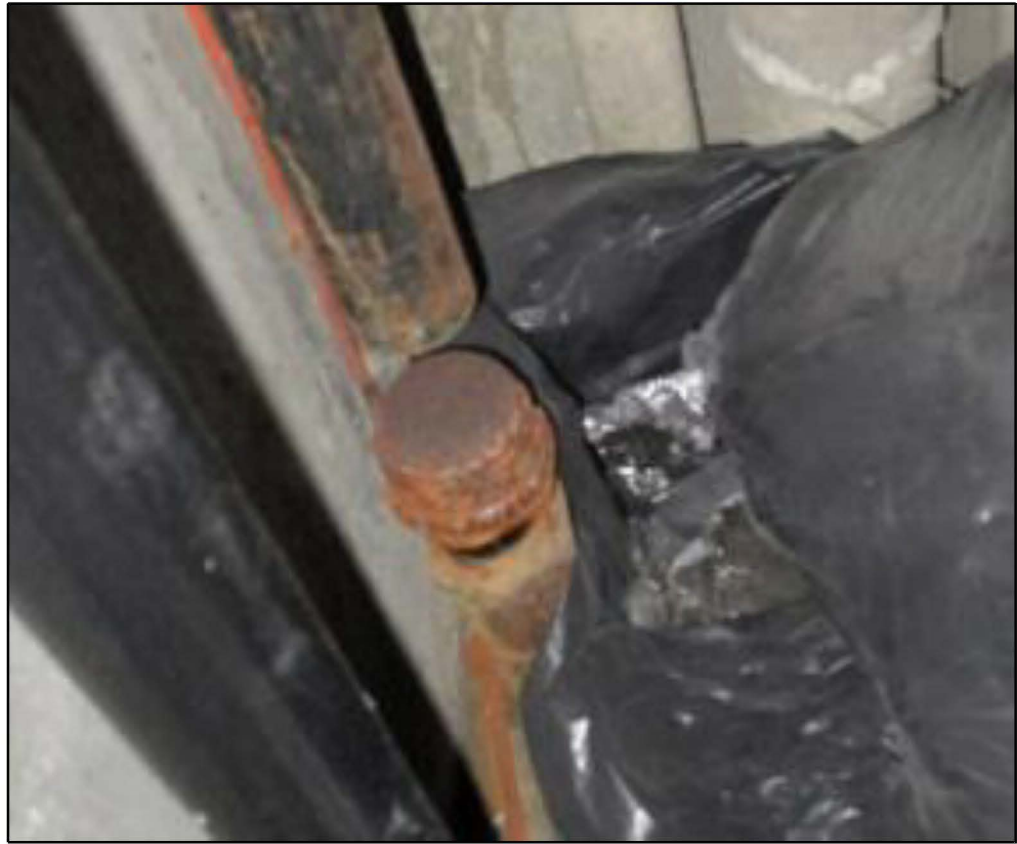


Figure K.15: Residential gas supply system 1 south east riser pipe capped at low level on the Ground Level

- K1.6.6** I have not been able to trace the exact route of the gas pipes between basement and Level 4; this was due to a combination of factors, including no access into the risers or ceiling voids from ground floor to Level 3 during my site inspection.
- K1.6.7** For Levels 4 – 23, I have found the gas pipework has been split into six (6) no. vertical risers with horizontal feeders, one for each of the flats.
- K1.6.8** I identified the location of the original gas riser and gas meter in each flat during my site inspection and these locations are shown in Figure K.16.



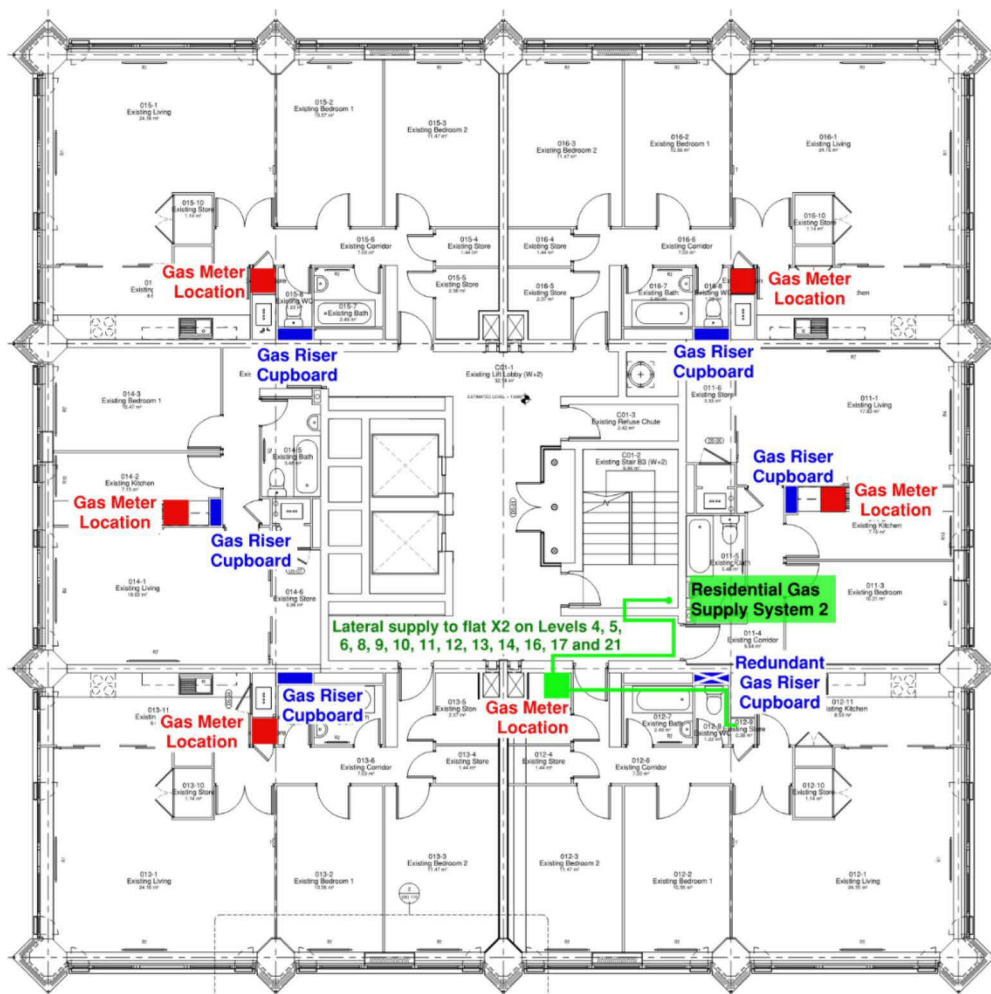


Figure K.16: Tenant gas systems. Levels 4 to 23 typical layout of the gas system serving the residential flats

- K1.6.9** The Flat ‘2’ gas riser cupboard is redundant due to the capped southeast riser on ground floor. Therefore, residential gas supply 1 only served Flats ‘1’, ‘3’, ‘4’, ‘5’, and ‘6’ on Levels 4 – 23 on 14 June 2017.
- K1.6.10** Figure K.17 shows the typical gas meter installation within these flats, which includes an emergency control valve upstream of the meter.
- K1.6.11** The Statement of Stephen Mason of Cadent confirms the location of the emergency controls for the residential gas supply in Grenfell Tower are within the individual flats:

*“Once inside the flat, that pipe would go to the location of the gas meter and terminate at an emergency handle used for cutting off the gas in that individual flat. This handle or Emergency Control Valve (ECV) is the end of the pipework which Cadent owns and operates.” (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004)*



Figure K.17: Typical flat gas meter installation with emergency control valve upstream of meter

**K1.6.12** I have found no evidence this residential gas supply 1 was modified during the 2012 – 2016 refurbishment works. Nor have I found any evidence during my site inspection or investigation of the Max Fordham Employers requirements for MEP Services (MAX00000960) that new gas services or existing gas supplies were modified to provide gas to the 9 new residential apartments on Levels 1 – 3.

**K1.6.13 Residential gas supply system 2**

**K1.6.14** During an inspection by Cadent on the 30<sup>th</sup> September 16 a small gas leak was identified in the southeast riser, which served Flat ‘2’ on certain levels between Levels 4 – 23.

**K1.6.15** Therefore, this riser was decommissioned and a replacement riser to serve these flats was installed. (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004).

**K1.6.16** Cadent’s preferred solution was to install a new gas main, which would rise up the outside of Grenfell Tower and enter each flat, as required. However, KCTMO rejected this solution because they were concerned with the aesthetics and the warranty for the cladding. (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004).



**K1.6.17** The original riser location was rejected due to insurmountable issues related to access. Excerpts from the witness statement of Stephen Mason are shown below:

*“9. The new replacement scheme involved designing and installing a new vertical gas pipe (riser) and new horizontal gas pipes (laterals). This would allow gas to be supplied from the street up to each of the residential floors of the Tower and into each of the residential properties that required it.*

*...*

*18. Any option for the installation of an external riser (generally Cadent’s preferred option) was discounted following Simon Boyle’s discussions held with KCTMO. This was because the Tower had recently undergone a major refurbishment which involved the installation of an entire new façade on the outer skin of the building. KCTMO was concerned about the effect of fixing an external riser on the aesthetics of the Tower’s appearance and the warranty for the cladding.*

*...*

*19. The possibility of replacing the riser in its original location in the utility shaft was discounted due to insurmountable issues related to access. Simon Boyle also surveyed the option for a riser being located in the stairwell running up the centre of Grenfell Tower and this was the proposal that was subsequently surveyed, designed and installed.” (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004).*

**K1.6.18** A new vertical riser, residential gas supply 2, was installed through the southeast riser (Basement Level to Level 2) and the protected stairway (Level 2 to 22) to serve Flat ‘2’ on Levels 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17 and 21.

**K1.6.19** Residential gas supply 2 enters the basement on the East elevation of the building at a high level, shown in Figure K.1 and Figure K.18. An isolation valve is provided at this location (blue valve shown in Figure K.18), however this valve was at a high level in the basement and was therefore not readily accessible.



Figure K.18: Incoming pipe for residential gas supply 2 entering basement on east elevation of building with inaccessible isolation valve

- K1.6.20** During my site inspection, my team traced this gas pipe to the southeast riser in the central core in the basement, as shown in Figure K.1. This pipe runs vertically from the Basement Level to Level 2 through the southeast riser. On Level 2, the gas pipe leaves the southeast riser, enters the Community Meeting Room and then turns and enters the protected stairway; as shown in Figure K.19.



Figure K.19: Residential gas supply system 2 gas piping in Community Meeting Room (Level 2)

- K1.6.21** This gas supply system is then routed through the protected stairway from Level 4 to Level 22, as shown in Figure K.19.



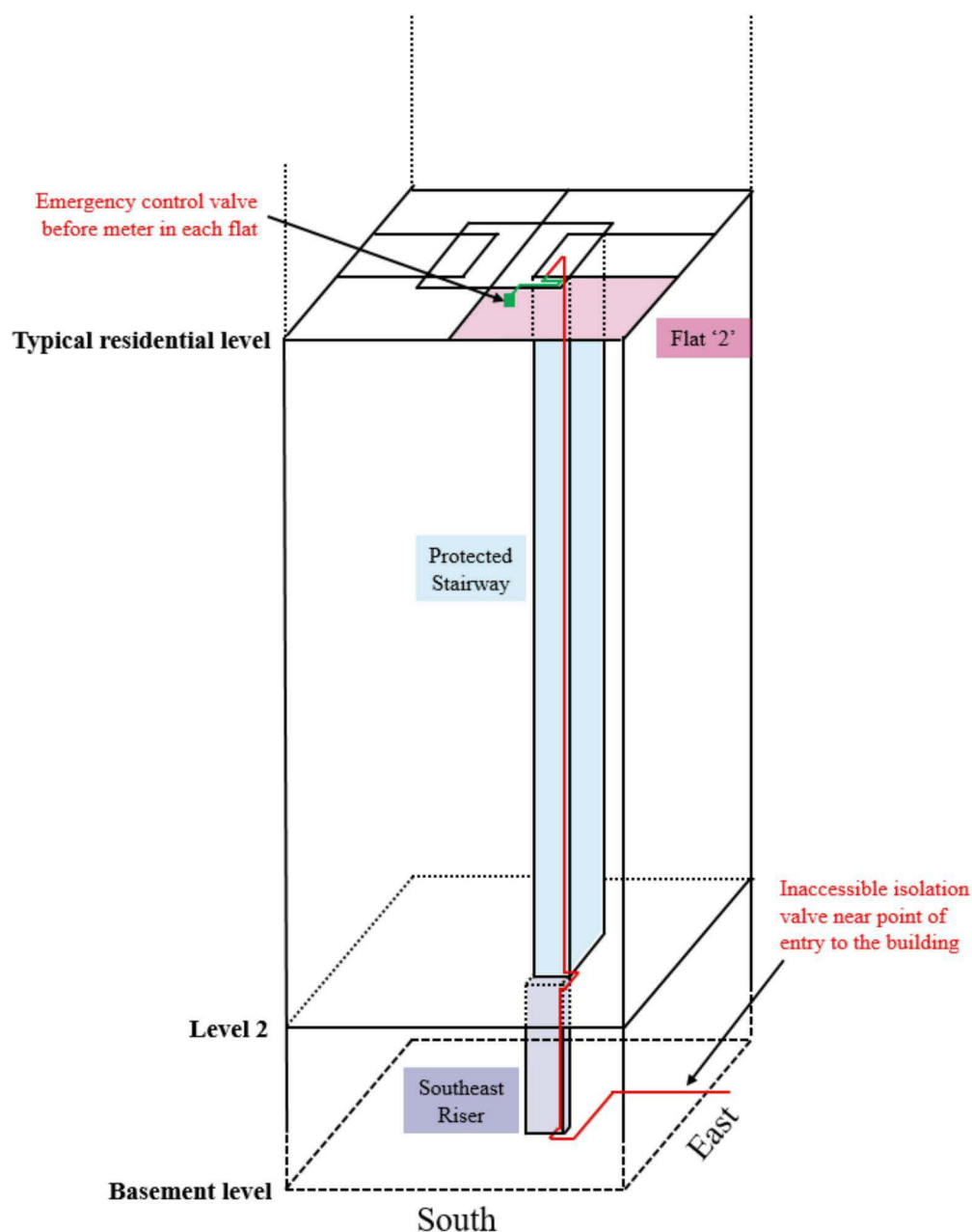


Figure K.20: Distribution of residential gas supply 2

- K1.6.22** I observed that the piping in the protected stairway was enclosed, as shown in Figure K.21, the specific materials used to enclose the pipe were not readily identifiable but appeared to be some form of board.
- K1.6.23** I was not able to access the riser to determine if ventilation was provided for this riser at either high or low level of the riser, within the stair. I explain this in more detail later in this section.



Figure K.21: Residential gas supply 1 runs through protected stairway on Level 2

1.1.1

I observed missing panels on the bottom of the enclosure around Residential gas supply 1 in the protected stairway on Levels 13 and 21, as shown in Figure K.22. It is possible that this was removed during post fire inspections by others. Confirmation is required by the MPS forensic investigation team as to whether this construction was removed after the fire.



Figure K.22: Missing panel from enclosure around Gas Supply 1 in the protected stairway on Levels 13 and 21.

- K1.6.24** Figure K.16 and Figure K.20 show the distribution of residential gas supply 2 from the protected stairway to Flat '2' on a typical residential level, based on observations from our site inspections.
- K1.6.25** I observed that a lateral exposed gas pipe passed through the stair compartment wall into the common lobbies, outside the flats, on Levels 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17 and 21.
- K1.6.26** I inspected one of the gas pipe penetrations on Level 5 and I did not observe any fire stopping at the compartment wall line between the stair and the common lobbies, as shown in Figure K.23.





Figure K.23: Gas pipe penetration through stair compartment wall to Level 5 lift lobby

- K1.6.27** The lateral pipes in the common lobbies ran at ceiling level and entered Flat '2' at the right-hand side of the flat entrance door as shown in Figure K.24 and Figure K.25.
- K1.6.28** I did observe what appears to be some form of seal in some of these pipe penetrations, as shown in Figure K.25, but have not found any evidence related to the materials and relevant fire performance for these seals.

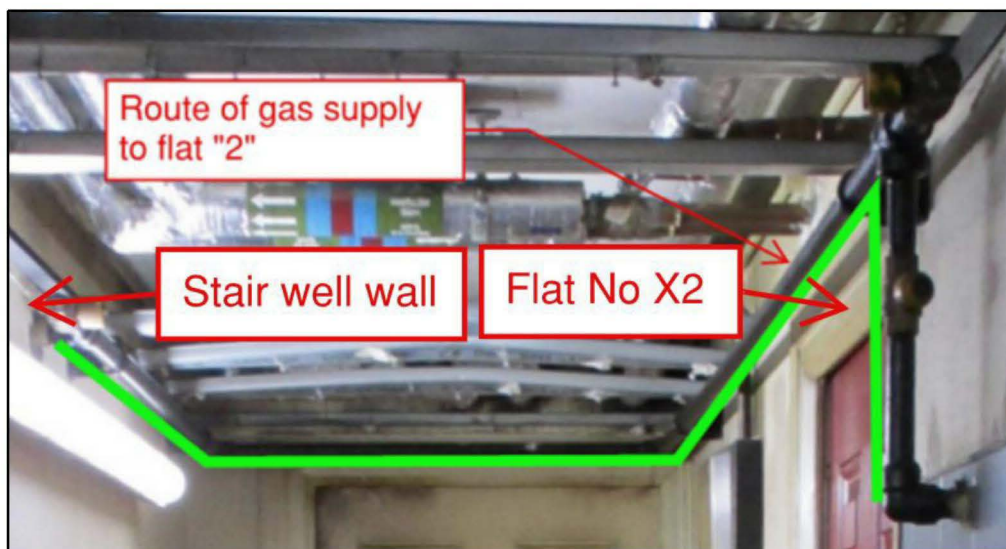


Figure K.24: Resident gas supply system 2 piping in Level 6 lobby

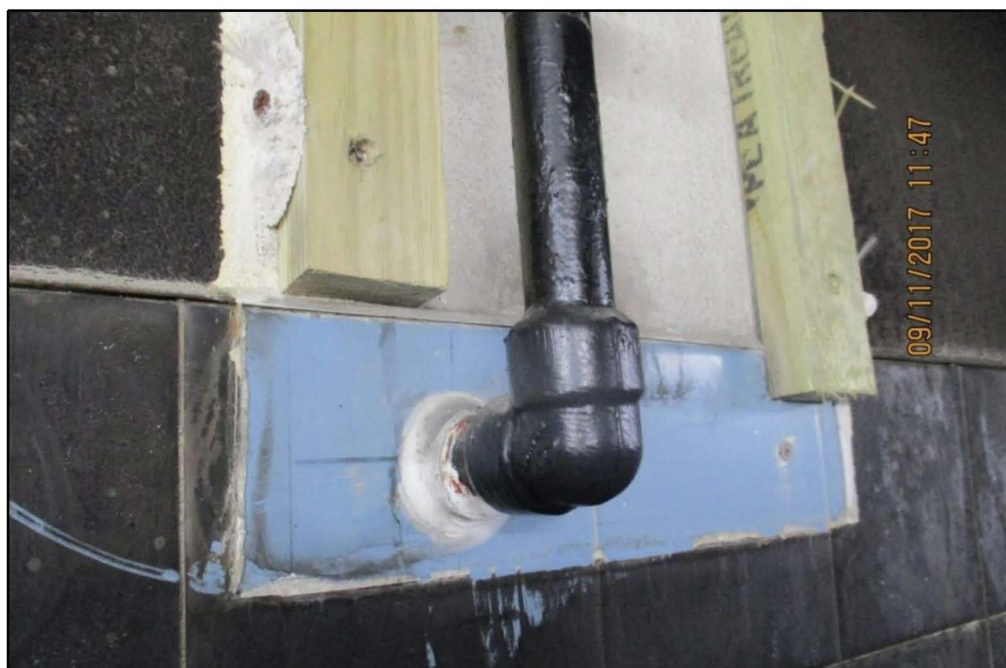


Figure K.25: Gas pipe penetration between Level 5 lift lobby and Flat 22

- K1.6.29** I have reviewed the Statement of Stephen Mason and relevant email correspondence between KCTMO, Carl Stokes (FRA), tRIIO National Grid (gas works principal designer and contractor) regarding the design intention and construction of the gas pipework in the protected stairway and lift lobbies between November 2016 and March 2017 (CST00000335, CST00000365).
- K1.6.30** Based on this information, the design intent was to enclose the gas piping in the stair from Level 2 through to the roof, where it would vent to the outside.
- “16. b. Globe Scaffolding Limited (“Globe”) was contracted to install scaffolding on the 23rd floor... to allow safe access for the installation of ducting around the replacement riser up to the roof vent....”* (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004).
- K1.6.31** The lateral gas piping through the common lobby was intended to be installed below the new ceilings on each level, as stated below:
- “40...agreement to run the riser in the stairwell and the laterals below rather than in the recently lowered ceilings in the communal lobbies.”* (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004).
- K1.6.32** The lateral gas piping through the common lobby was intended to be enclosed on each level within the lobby and under the newly installed ceiling. Therefore, the pipe penetrations through the stair compartment walls were not intended to be fire stopped - to allow the lateral pipe enclosures to be vented into the vertical pipe enclosure in the stairway and then up and out through a roof vent. As observed in Section K1.6.26, I did not observe any fire stopping on site.



**K1.6.33** Note, the following email correspondence from tRIIO National Grid to KCTMO regarding the design intent of these pipe enclosures:

*“The intention is that the boxing will isolate the pipework from the mechanical ventilation in the communal areas. It will be vented directly to the stairwell at one end (which itself is well ventilated) and run to a “dead end” at the point of entry to the individual flats at the other. In case of fire in the stairwell, any smoke will travel along the boxing to a dead end and would be isolated within the boxing. In turn any smoke within the communal area would not get to the stairwell as the boxing would be fire rated.”*  
(CST00000365)

**K1.6.34** There is email correspondence and a letter from Carl Stokes to KCTMO, dated 30 January 2017 (CST00000634), which includes discussion of his views regarding the fire resistance requirements of the pipe enclosure in the stair and the pipe enclosures in the lift lobbies. However, I have not found any evidence that clearly states the applicable requirements proposed by the gas works designer for the works at Grenfell Tower.

**K1.6.35** I have also not found any design or construction documentation that specifies the materials used for these enclosures or their fire performance.

**K1.6.36** Furthermore, from a fire protection perspective, the integrity of the stair compartment wall is dependent on an appropriate installation of the pipe enclosures on either side of the wall. I have not found any evidence relevant to this important construction detail (CST00000335, CST00000365, CST00000336).

**K1.6.37** Further, these gas works were ongoing on 14 June 2017.

**K1.6.38** All gas piping had been installed and tested by this date, but the **enclosures** were still being constructed.

**K1.6.39** The following excerpt from the Statement of Stephen Mason, Cadent describes the condition of the residential gas supply 2 works on the night of the fire:

*“37. The installation of ducting around the new riser had not been fully completed at the time of the fire. The vertical riser in the stairwell had all been ducted from the bottom of the stairwell on floor 2 to the 22nd floor, leaving the 23rd floor to be completed. Only the 5th floor ducting on the laterals in the communal lift area had been completed and preparation work in terms of fitting batons to the walls and ceiling had commenced on floors 6 through to 10.”* (Witness Statement of Stephen Mason CAD000000004).

**K1.6.40** I did observe the ducting of the riser in the protected stairway up to the 22<sup>nd</sup> floor during my site inspections.

**K1.6.41** However, I did not observe any ducting of the laterals on the 5<sup>th</sup> floor during my site inspection; see Figure K.26.



- K1.6.42** I also did not observe any batons for mounting the ducting for the laterals on floors 6 to 10.
- K1.6.43** Therefore, my observations on site are not as described in Stephen Mason's witness statement.



Figure K.26: Lateral gas piping distributed through Level 5 Lobby

**K1.6.44** In summary, residential gas supply 2 in Grenfell Tower included the following on 14 June 2017:

- a) Enclosed gas piping in the protected stairway from Levels 2 – 21. The materials used to enclose this pipe are not currently known. The enclosure in the stair was not completed and may have been open to the protected stairway at Level 23. This was a potential route of smoke spread from lift lobbies into the protected stairway during the fire;
- b) Exposed gas piping in the lift lobbies on Levels 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17 and 21;
- c) Unprotected pipe penetrations between the protected stairway and the lift lobbies on the abovementioned lobbies. These openings were potential routes of smoke spread between levels during the fire;
- d) Sealed pipe penetrations between the abovementioned lift lobbies and Flat '2' on these levels.

**K1.6.45** The Construction (Design and Management) Regulations 2007 places duties on the Client and all Designers and Contractors involved in the project to provide all relevant information about the design and construction. At this stage, I have no evidence to explain how the risks these building works posed were mitigated in the Grenfell Tower, bearing in mind that this was a construction programme within an occupied building.

**K1.6.46** Figure K.13 shows the location of residential gas supply in the protected stairway and the lift lobby, as well as the location of the new gas meter in Flat '2'.

**K1.6.47** The Statement of Stephen Mason, Cadent notes the scope of works included work in the affected flats, such as:

*"33. During the project, some works were undertaken beyond the ECV. These works involved repositioning of gas meters and extending the installation pipework back to the existing meter position to limit the extent of 'network' pipework within individual flats" (CAD00000004).*

**K1.6.48** Figure K.27 shows the gas meter in Flat 22 on Level 5. While this gas meter is unique, it appears all other gas meters serving Flat '2' are typical, as shown in Figure K.28, which appears to be the same meter as observed on Levels 4, 6, 8, 9, 10 during our site inspections.

**K1.6.49** During my site inspections, I and my site inspection team observed multiple burnt out gas meter installations within the flats of Grenfell Tower. It is a matter of expert evidence as to whether and how this would contribute to the fire at such locations. I therefore defer to the appointed Expert Mr Rodney Hancox on this matter.

**K1.6.50** As described in section K1.6.2, the Statement of Stephen Mason of Cadent confirms the location of the emergency controls for the residential gas supply in Grenfell Tower are within the individual flats.



**K1.6.51** The findings of our site inspection of the gas system within the flats is consistent with this statement; an isolating valve was observed upstream of the meter in each flat inspected. If an ECV was switched in a flat, the gas would not continue to be supplied to that particular flat. However, there would still be gas in the pipework unless it was used by an appliance or leaked (and potentially burned off in a gas fire).



Figure K.27: Gas meter in Flat 22 on Level 5





Figure K.28: Typical gas meter installation for Flat '2'

**K1.6.52** According to the Statement of Stephen Mason, Cadent, there were also discussions about replacing the gas risers for residential gas supply 1 serving residential Flats '1', '3', '4', '5', and '6' on Levels 4 – 23, due to concerns that these other risers would “*naturally deteriorate over time*”; refer to the excerpts below:

*“8. Whilst the buy-out’ option was being considered, the second option of a new riser replacement scheme (starting with riser 2) was being developed in parallel, to mitigate the potential failure of the ‘buy-out’ option and address the fact that one riser had already failed and the others would naturally deteriorate over time.*

*41 ... Latterly, discussions included Cadent to a greater degree mainly, about the pace of the work being undertake [sic] and the plan to proactively replace*

*the other risers which would impact flats whose gas supplies had been unaffected by isolation of riser 2.*

- 1.1.2** There were several resident complaints related to *longer term future project to reorganize the gas supply within the Tower.*” (Witness Statement of Stephen Mason, Cadent Gas Ltd (CAD00000004)).

## **K2 Requirements for gas services**

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### **K2.1 Applicable legislation, regulation and guidance**

- K2.1.1** Since my site inspection in November 2017 the Public Inquiry has appointed a Gas Expert, Mr Rodney Hancox.
- K2.1.2** The assessment I present in this section does not include a review of gas safety legislation, regulation and guidance applicable at the time of construction (1972) nor any legislation, regulation or guidance superseded or revoked since that time.
- K2.1.3** My review relates only the legislation, regulation and guidance applicable to recent gas refurbishment works.
- K2.1.4** Where original gas systems were retained, modified or connected to modern gas systems it is a matter of expert evidence as to how the integrated system should be assessed from a compliance perspective.
- K2.1.5** When this analysis has been done, and should it require me to alter my fire safety compliance analysis, I will do that when the evidence is presented to me.
- K2.1.6** My current review is from a fire safety perspective only and considers the provisions of the Statutory Guidance for compliance with the Building Regulations 2010.
- K2.1.7** The original system was modified, during the 2012 – 2016 refurbishment. In particular, the landlord supply to the basement boilers was modified to include new boilers. The Gas Expert needs to determine therefore how this should be considered from a compliance perspective.
- K2.1.8** Table K.2 defines the applicable legislation, regulation and statutory guidance or approved code of practice as applicable for the known gas works undertaken within Grenfell Tower.



Table K.2: Legislation, regulations and guidance in 2012 – 2016

Milestone	Date	Legislation; Regulation; Approved Code of Practice and/or Statutory Guidance
Grenfell Tower construction	1972-1974	Gas Act 1948; Gas Safety Regulations 1972
Refurbishment of landlord gas supply	2012 - 2016	Health and Safety at Work Act 1974; Gas Safety (Installation and Use) Regulations 1998, Approved Code of Practice and Guidance: Safety in the installation and use of gas systems and appliances Health and Safety at Work Act 1974; Pipelines Safety Regulations 1996; A guide to the Pipelines Safety regulations 1996
Residential gas retrofit	2016-2017	Health and Safety at Work Act 1974; Gas Safety (Management) Regulations 1996; IGEM Technical Standards Health and Safety at Work Act 1974; The Dangerous Substances and Explosive Atmospheres Regulations 2002 Building Act 1984, Building Regulations 2010; Approved Document B (2010)

**K2.1.9** Note the following from the Approved Code of Practice: Safety in the installation and use of gas systems and appliances:

*“This Code has been approved by the Health and Safety Executive, with the consent of the Secretary of State. It gives practical advice on how to comply with the law. If you follow the advice you will be doing enough to comply with the law in respect of those specific matters on which the Code gives advice. You may use alternative methods to those set out in the Code in order to comply with the law.*

*However, the Code has a special legal status. If you are prosecuted for breach of health and safety law, and it is proved that you did not follow the relevant provisions of the Code, you will need to show that you have complied with the law in some other way or a Court will find you at fault.”*

## **K2.2 Gas Safety (Installation and Use) Regulations 1998**

**K2.2.1** Compliance with the Gas Safety (Installation and Use) Regulations 1998 is a provision per ADB 2013 Section 2.42 Gas service and installation pipes in protected stairways, Section 4.40 Gas service pipes in protected stair, Section 8.40 Pipes for oil and gas and ventilation ducts in protected shafts.

**K2.2.2** I have therefore included a description of the requirements of these regulations, here.

**K2.2.3** In accordance with Section 53 (1) of the Health and Safety at Work Act 1974, Grenfell Tower is defined as premises:

*““premises” includes any place and, in particular, includes—*

*(a) any vehicle, vessel, aircraft or hovercraft,*



*(b) any installation on land (including the foreshore and other land intermittently covered by water), any offshore installation, and any other installation (whether floating, or resting on the seabed or the subsoil thereof, or resting on other land covered with water or the subsoil thereof), and*

*(c) any tent or moveable structure; ”*

**K2.2.4** The Gas Safety (Installation and Use) Regulations 1998, enacted under the Health and Safety at Work Act 1974 applies to gas fittings, the supply of gas or anything done in respect of gas fitting by virtue of Regulation (3) (a) and (4) at premises used for domestic or residential purposes:

*“(3) Subject to paragraphs (4) and (5) below, these Regulations shall apply to or in relation to gas fittings used in connection with—*

*(a) gas which has been conveyed to premises through a distribution main; or*

*(b) gas conveyed from a gas storage vessel.*

*(4) Save for regulations 37, 38 and 41 and subject to regulation 3(8), these Regulations shall not apply in relation to the supply of gas to, or anything done in respect of a gas fitting at, the following premises, that is to say—*

*(a) a mine or quarry within the meaning of the Mines and Quarries Act 1954(3) or any place deemed to form part of a mine or quarry for the purposes of that Act;*

*(b) a factory within the meaning of the Factories Act 1961(4) or any place to which any provisions of the said Act apply by virtue of sections 123 to 126 of that Act;*

*(c) agricultural premises, being agricultural land, including land being or forming part of a market garden, and any building thereon which is used in connection with agricultural operations;*

*(d) temporary installations used in connection with any construction work within the meaning assigned to that phrase by regulation 2(1) of the Construction (Design and Management) Regulations 1994(5);*

*(e) premises used for the testing of gas fittings; or*

*(f) premises used for the treatment of sewage, but they shall apply in relation to such premises or part thereof used for domestic or residential purposes or as sleeping accommodation.*

*(5) Nothing in these Regulations shall apply in relation to the supply of gas to, or anything done in respect of a gas fitting on—*

*(a) a self-propelled vehicle except when such a vehicle is—*

*(i) hired out in the course of a business; or*

*(ii) made available to members of the public in the course of a business carried on from that vehicle;*

*(b) a sea-going ship;*

*(c) a vessel not requiring a national or international load line certificate except when such vessel is—*

- (i) hired out in the course of a business;*
- (ii) made available to members of the public in the course of a business carried out from that vessel; or*
- (iii) used primarily for domestic or residential purposes;*
- (d) a hovercraft; or*
- (e) a caravan used for touring otherwise than when hired out in the course of a business.”*

**K2.2.5** Therefore, the Gas Safety (Installation and Use) Regulations 1998 applied to any gas works undertaken within Grenfell Tower at any time.

**K2.2.6 Requirements for pipe materials – Regulation 5**

**K2.2.7** Regulation 5 requires the following for gas service pipework:

- “5.— (1) No person shall install a gas fitting unless every part of it is of good construction and sound material, of adequate strength and size to secure safety and of a type appropriate for the gas with which it is to be used.*
- (2) Without prejudice to the generality of paragraph (1) above, no person shall install in a building any pipe or pipe fitting for use in the supply of gas which is—*
- (a) made of lead or lead alloy; or*
  - (b) made of a non-metallic substance unless it is—*
    - (i) a pipe connected to a readily movable gas appliance designed for use without a flue; or*
    - (ii) a pipe entering the building and that part of it within the building is placed inside a metallic sheath which is so constructed and installed as to prevent, so far as is reasonably practicable, the escape of gas into the building if the pipe should fail.”*

**K2.2.8** The following guidance is provided in the Approved Code of Practice: Safety in the installation and use of gas systems and appliances for Regulation 5(2)

*“105 Non-metallic connectors for use with readily movable gas appliances should conform to the appropriate standard. Such hoses, pipes and pipe fittings must be used only for the purpose for which they are designed.*

*106 Appliances or meters may be connected to existing lead piping using suitable fittings, provided that the piping is in a safe condition, e.g. there is no sign of damage.*

*107 Apart from connectors to readily movable appliances such as Bunsen burners, non-metallic (e.g. plastic) pipes should only be used within buildings if sheathed in metal to minimise the risk of gas escaping if the pipe should fail. This requirement does not extend to polyethylene (PE) piping buried in ground beneath a building provided that the piping does not enter the building (but see regulation 19(5)). However, it does apply to that routed in spaces under floors.*



*108 Plastic pipe fittings should not be used to seal pipes within buildings (see also definition of ‘appropriate fitting’ in regulation 2(1)). Although regulation 5(2) applies only to pipes and pipe fittings in buildings, it is recommended that a similar approach be adopted for other premises, e.g. caravans and inland waterway boats. See also regulation 26(2) concerning pipes for flued domestic appliances.”*

**K2.2.9** Therefore, Regulation 5(2) does not allow gas piping and fittings in Grenfell Tower to be made of lead or lead alloy, or be made of non-metallic materials unless it is placed in a metallic sheath to prevent the escape of gas into the building.

#### **K2.2.10 Requirements for emergency control – Regulation 9**

**K2.2.11** Regulation 2 defines:

**“an emergency control**

*“emergency control” means a valve for shutting off the supply of gas in an emergency, being a valve intended for use by a consumer of gas;*

**a primary meter**

*“primary meter” means the meter nearest to and downstream of a service pipe or service pipework for ascertaining the quantity of gas supplied through that pipe or pipework by a supplier;”*

**K2.2.12** Regulation 9 requires the following for emergency control:

*“9.—*

*(1) No person shall for the first time enable gas to be supplied for use in any premises unless there is provided an appropriately sited emergency control to which there is adequate access.*

*(2) Any person installing an emergency control shall ensure that—*

*(a) any key, lever or hand-wheel of the control is securely attached to the operating spindle of the control;*

*(b) any such key or lever is attached so that—*

*(i) the key or lever is parallel to the axis of the pipe in which the control is installed when the control is in the open position; and*

*(ii) where the key or lever is not attached so as to move only horizontally, gas cannot pass beyond the control when the key or lever has been moved as far as possible downwards;*

*(c) either the means of operating the key or lever is clearly and permanently marked or a notice in permanent form is prominently displayed near such means so as to indicate when the control is open and when the control is shut; and*

*(d) any hand-wheel indicates the direction of opening or closing of the control.*

*(3) Where a person installs an emergency control which is not adjacent to a primary meter, he shall immediately thereafter prominently display on or*



*near the means of operating the control a suitably worded notice in permanent form indicating the procedure to be followed in the event of an escape of gas.*

*(4) Where any person first supplies gas to premises where an emergency control is installed, he shall ensure that the notice required by paragraph (3) above remains suitably worded or shall, where necessary, forthwith amend or replace that notice so as to give effect to the provisions of that paragraph.”*

**K2.2.13** The following guidance is provided in the HSE Approved Code of Practice and Guidance “Safety in the installation and use of gas systems” and appliances for Regulation 9

*“149 Whenever a new gas supply is made available for use in premises, an emergency control should also be provided. Where there is a gas meter, the meter control may serve as the emergency control as long as the following conditions are met:*

*(a) Each individual premises (e.g. each house, flat, maisonette, or caravan) using a supply of gas should be provided with an emergency control, whether or not that premises contains a gas meter.*

*(b) The emergency control should be situated as near as is reasonably practicable to the point where the gas supply pipe enters the premises.*

*(c) It should be readily assessable [sic] to all consumers, i.e. gas users, in the premises concerned (e.g. not located in a basement or cellar).*

*(d) A valve located in a meter-room which is normally locked, and accessible only to a landlord, gas supplier, gas transporter and/or emergency services for example, cannot act as an ‘emergency control’.*

*(e) An emergency control should be protected against unauthorised operation (i.e. tamper-proof) but if situated in a locked compartment, the occupier(s) of the premises should be provided with keys (see also regulation 13(3)– (4)). In such cases, the emergency service provider should also hold keys where access cannot be ensured for them at all times, e.g. through keys held by the responsible person for the premises.”*

**K2.2.14** Therefore, Regulation 9 requires that gas supplies to each flat within Grenfell Tower were provided with an emergency control and the HSE guidance recommended it be located within the flat as near as reasonably practicable to the point of entry. Regulation 9 requires that gas supplies to the landlord gas supply were provided with an emergency control. The HSE guidance recommends that the emergency control is located as near as practicable to the point of entry to the premises which in Grenfell Tower would be within the basement.

**K2.2.15 Requirements for secondary meters – Regulation 17**

**K2.2.16** Regulation 17 requires the following for secondary meters:

*“17 (1) Any person supplying or permitting the supply of gas through a primary meter to a secondary meter shall ensure that a line diagram in*

*permanent form is prominently displayed on or near the primary meter showing the configuration of all meters, installation pipework and emergency controls.*

*(2) Any person who changes the configuration of any meter, installation pipework or emergency control so that the accuracy of the line diagram referred to in paragraph (1) is affected shall ensure that the line diagram is amended so as to show the altered configuration.”*

**K2.2.17** Therefore, a line diagram for the landlord gas supply system shall be installed at the meter or the emergency control.

**K2.2.18 Requirements for ventilation – Regulation 19**

**K2.2.19** Regulation 19 requires the following for enclosed pipes:

*“19.— (1) No person shall install any part of any installation pipework in a wall or a floor or standing of solid construction unless it is so constructed and installed as to be protected against failure caused by the movement of the wall, the floor or the standing as the case may be.*

*(2) No person shall install any installation pipework so as to pass through a wall or a floor or standing of solid construction (whether or not it contains any cavity) from one side to the other unless—*

*(a) any part of the pipe within such wall, floor or standing as the case may be takes the shortest practicable route; and*

*(b) adequate means are provided to prevent, so far as is reasonably practicable, any escape of gas from the pipework passing through the wall, floor or standing from entering any cavity in the wall, floor or standing.*

*(3) No person shall, subject to paragraph (4), install any part of any installation pipework in the cavity of a cavity wall unless the pipe is to pass through the wall from one side to the other.*

*(4) Paragraph (3) shall not apply to the installation of installation pipework connected to a living flame effect gas fire provided that the pipework in the cavity is as short as is reasonably practicable, is enclosed in a gas tight sleeve and sealed at the joint at which the pipework enters the fire; and in this paragraph a “living flame effect gas fire” means a gas fire—*

*(a) designed to simulate the effect of a solid fuel fire;*

*(b) designed to operate with a fanned flue system; and*

*(c) installed within the inner leaf of a cavity wall.*

*(5) No person shall install any installation pipework or any service pipework under the foundations of a building or in the ground under the base of a wall or footings unless adequate steps are taken to prevent damage to the installation pipework or service pipework in the event of the movement of those structures or the ground.*



*(6) Where any installation pipework is not itself contained in a ventilated duct, no person shall install any installation pipework in any shaft, duct or void which is not adequately ventilated."*

**K2.2.20** The following guidance is provided in the HSE Approved Code of Practice and Guidance for Regulation 19(2) – (6):

*"208 Regulation 19(2)(b) addresses the potential risk of gas leaking from pipework within a cavity in a wall, floor or standing. Such leakage may be difficult to detect and readily lead to the accumulation of an explosive gas/air mixture in the cavity, presenting a considerable hazard to building occupants and others. The protective measures required may include enclosing that part of the pipe which passes through the wall, floor or standing in a gastight sleeve which itself is ventilated to a safe position, preferably to open air. This approach also provides some protection against possible mechanical damage to pipework, e.g. arising from structural movement (see also regulation 19(5)). Any gap between the pipe and sleeve should be sealed with fire-retardant flexible sealant (see standards in the Legislative, normative and informative document list at [www.gassaferegister.co.uk](http://www.gassaferegister.co.uk) – details are in the References section), but at one end only to ensure any leak cannot accumulate in the gap space.*

*209 Shafts, ducts and voids used for accommodation of gas pipework should comply with the appropriate standard. Measures to comply with regulation 19, e.g. void/duct ventilation arrangements, should not impair any provisions for fire/smoke separation in a building – see regulation 20."*

**K2.2.21** Therefore, Regulation 19 requires gas pipework in Grenfell Tower within a cavity in a wall, floor or standing, or within shafts, ducts and voids to be ventilated. The HSE guidance recommends that ventilation of ducts containing gas supply should not impair the provisions for fire/smoke separation in a building.

**K2.2.22 Requirements for fire resistance – Regulation 20**

**K2.2.23** Regulation 20 requires the following for protection of buildings:

*"20. No person shall install any installation pipework in a way which would impair the structure of a building or impair the fire resistance of any part of its structure."*

**K2.2.24** Therefore, any penetrations through fire resisting construction in Grenfell Tower needed to be fire stopped or ducted to maintain the fire resistance required by the Building regulations 2010 in order to comply with Regulation 20.

**K2.2.25 Requirements for marking of pipes – Regulation 23**

**K2.2.26** Regulation requires the following for marking of pipes:

*"23-*



*(1) Any person installing, elsewhere than in a premise or part of premises used only as a dwelling or for living accommodation, a part of any installation pipework which is accessible to inspection shall permanently mark that part in such a manner that it is readily recognisable as part of a pipe for conveying gas.*

*(2) The responsible person for the premises in which any such part is situated shall ensure that the part continues to be so recognisable so long as it is used for conveying gas.”*

**K2.2.27** The following guidance is provided in the HSE Approved Code of Practice and Guidance “Safety in the installation and use of gas systems”

*“221 This regulation does not apply to domestic premises or living accommodation. In all other locations, e.g. commercial premises such as offices, gas pipes accessible to inspection should be colour coded and/ or marked in accordance with the appropriate standard.”*

**K2.2.28** Therefore, Regulation 23 requires that the pipe work outside of flats should be clearly identified.

#### **K2.2.29 Requirements for service pipe valves – Regulation 24**

**K2.2.30** Regulation 2 defines:

**“ a service pipe**

*“service pipe” means a pipe for distributing gas to premises from a distribution main, being any pipe between the distribution main and the outlet of the first emergency control downstream from the distribution main;*

**Primary meter**

*“primary meter” means the meter nearest to and downstream of a service pipe or service pipework for ascertaining the quantity of gas supplied through that pipe or pipework by a supplier; ”*

**K2.2.31** Regulation 24 requires the following for service pipe valves:

*“24.— (1) Where the service pipe to any building having two or more floors to which gas is supplied or (whether or not it has more than one floor) a floor having areas with a separate supply of gas has an internal diameter of 50 mm or more, no person shall install any incoming installation pipework supplying gas to any of those floors or areas, as the case may be, unless—*

*(a) a valve is installed in the pipe in a conspicuous and readily accessible position; and*

*(b) a line diagram in permanent form is attached to the building in a readily accessible position as near as practicable to—*

*(i) the primary meter or where there is no primary meter, the emergency control, or*

*(ii) the gas storage vessel, indicating the position of all installation pipework of internal diameter of 25 mm or more, meters, emergency controls, valves and pressure test points of the gas supply systems in the building.*

*(2) Paragraph (1) above shall apply to service pipework as it applies to a service pipe except that reference therein to “50 mm or more” is to be reference to “30 mm or more”.*

*(3) In paragraph (1)(b) above “pressure test point” means a gas fitting to which a pressure gauge can be connected.”*

**K2.2.32** The following guidance is provided in the HSE Approved Code of Practice and Guidance for Regulation 24:

*“222 This regulation applies where a service pipe has an internal diameter of 50 mm or more, or service pipework has an internal diameter of 30 mm or more, and divides to supply more than one floor or separate areas on one floor. This situation is most often encountered in industrial and commercial premises.*

*223 Where, to comply with regulation 24(1)(a), an isolation valve needs to be installed in the service pipe, the gas transporter must be notified and arrangements made, e.g. for isolation and degassing as necessary, to ensure this can be done safely.*

*224 The system diagram should be prominently displayed at or near to the primary meter, or if there is no such meter, the emergency control. Where gas is supplied from a storage vessel, the notice may alternatively be displayed at or near to that vessel. Depending on the size of the premises, other copies may be held elsewhere, e.g. the security gate or reception area.*

*225 The purpose of the system diagram is to allow anyone, especially the emergency services, to identify and isolate part of the gas system if necessary. Pipes of less than 25 mm do not need to be shown on the diagram but it is recommended that additional information to that specified in regulation 24(1)(a) be included, where significant to the safety of a particular installation, e.g. this might include purge connections. The diagram needs to be updated as necessary.”*

**K2.2.33** Therefore, Regulation 24 requires that an isolation valve is provided on each of the residential gas supplies in Grenfell Tower, upstream of their division to supply more than one floor where the pipe diameter is 30mm or greater due to the pipework being “service pipework”. I did not measure the pipe diameter on site. This measurement is required to confirm whether Regulation 24 is applicable.



**K2.2.34** Regulation 24 also requires a system diagram to be prominently displayed in the building in a readily accessible position to allow the emergency services to identify and isolate part of the gas system if necessary.

## **K2.3 The Pipelines Safety Regulations 1996**

**K2.3.1** In accordance with Regulation 3 (2) and (4) of Pipelines Safety Regulations 1996, the gas service pipework upstream of the emergency controls in Grenfell Tower are defined as pipelines.

### ***“Meaning of “pipeline”***

#### **3.—**

*(1) Subject to the provisions of this regulation, in these Regulations “pipeline” means a pipe or system of pipes (together with any apparatus and works, of a kind described in paragraph (2), associated with it) for the conveyance of any fluid, not being—*

*(a) a drain or sewer;*

*(b) a pipe or system of pipes constituting or comprised in apparatus for heating or cooling or for domestic purposes;*

*(c) a pipe (not being apparatus described in paragraph (2)(e)) which is used in the control or monitoring of any plant.*

*(2) The apparatus and works referred to in paragraph (1) are—*

*(a) any apparatus for inducing or facilitating the flow of any fluid through, or through a part of, the pipe or system;*

*(b) any apparatus for treating or cooling any fluid which is to flow through, or through part of, the pipe or system;*

*(c) valves, valve chambers and similar works which are annexed to, or incorporated in the course of, the pipe or system;*

*(d) apparatus for supplying energy for the operation of any such apparatus or works as are mentioned in the preceding sub-paragraphs;*

*(e) apparatus for the transmission of information for the operation of the pipe or system;*

*(f) apparatus for the cathodic protection of the pipe or system; and*

*(g) a structure used or to be used solely for the support of a part of the pipe or system.*

*(3) For the purpose of sub-paragraph (c) of paragraph (2) a valve, valve chamber or similar work shall be deemed to be annexed to, or incorporated in the course of, a pipe or system where it connects the pipe or system to plant, an offshore installation, or a well.*

*(4) A pipeline for supplying gas to premises shall be deemed not to include anything downstream of an emergency control.*

*(5) In this regulation—*

*“emergency control” means a valve for shutting off the supply of gas in an emergency, being a valve intended for use by a consumer of gas;*

*“gas” has the same meaning as it has in Part I of the Gas Act 1986(2).*

### ***Safety systems***



*6. — The operator shall ensure that no fluid is conveyed in a pipeline unless it has been provided with such safety systems as are necessary for securing that, so far as is reasonably practicable, persons are protected from risk to their health or safety.”*

**K2.3.2** The Pipelines Safety Regulations 1996, enacted under the Health and Safety at Work Act 1974, applies to pipelines (other than pipelines of a kind described in Schedule 1 by virtue of Regulation 4, in particular

*“Schedule 1, 3. A pipeline contained wholly within the premises occupied by a single undertaking.”*

**K2.3.3** Therefore, the Pipelines Safety Regulations 1996 applied to the gas service pipework upstream of the emergency controls installed in each flat in Grenfell Tower as it is a multiple owner / tenant occupied building.

***“Work on a pipeline***

*10 The operator shall ensure that-modification, maintenance or other work on a pipeline is carried out in such a way that its soundness and fitness for the purpose for which it has been designed will not be prejudiced.*

***Arrangements for incidents and emergencies***

*12. the operator shall ensure that no fluid is conveyed in a pipeline unless adequate arrangements have been made for dealing with –*

- (a) an accidental loss of fluid from*
  - (b) discovery of a defect in or damage to: or*
  - (c) other emergency affecting,*
- the pipeline*

***Maintenance***

*13 The operator shall ensure that a pipe line is maintained in an efficient state, in effective working order and in good repair*

***Decommissioning***

*14 – (1) The operator shall ensure that a pipeline which has ceased to be used for the conveyance of any fluids is left in a safe condition.”*

## **K2.4 The Building Regulations 2010**

**K2.4.1** The Building Regulations 2010 do not make requirements with regards to the supply of gas or anything done in respect of gas fitting.

**K2.4.2** However, the statutory guidance Approved Document Part B Vol 2 makes specific recommendations with regard to the location of gas supply within a building in order to comply with Part B1 Means of warning and escape and Part B3 Internal fire spread (structure).

**K2.4.3** Therefore, in addition to the statutory requirements to comply with the Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996, the statutory guidance for compliance with the Building Regulations 2010 makes further specific recommendations.

#### **K2.4.4 Statutory guidance for location of gas service and installation pipes**

##### **K2.4.5** Approved Document Part B Vol 2 (B1) 2.42 states:

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

##### **K2.4.6** Therefore, the residential gas supply system 2 piping conveyed through the protected stairway in Grenfell Tower was permitted to be located within the protected stairway provided that the gas supply system complied with the current Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996.

#### **K2.4.7 Statutory guidance for gas service and installation pipe materials in a protected stair or lift shaft.**

##### **K2.4.8** Approved Document Part B Vol 2 (B3) 8.40 states

*“If a protected shaft contains a stair and/or a lift, it should not also contain a pipe conveying oil (other than in the mechanism of a hydraulic lift) or contain a ventilating duct (other than a duct provided for the purpose of pressurizing the stairway to keep it smoke free; or a duct provided solely for ventilating the stairway).*

*Any pipe carrying natural gas or LPG in such a shaft should be of screwed steel or if all welded steel construction, installed in accordance with the Pipeline Safety Regulations 1996, SI 1996 No 825 and the Gas Safety (installation and Use) regulations 1998, SI 1998 No 2451.”*

*Note: A pipe is not considered to be contained within a protected shaft if the pipe is completely separated from that protected shaft by fire-resisting construction.”*

##### **K2.4.9** Therefore, the Residential gas supply system 2 piping conveyed through the protected stairway in Grenfell Tower was recommended to be screwed or welded steel unless the pipework was completely separated from the protected stairway by 120 fire resistant construction (loadbearing capacity, integrity, insulation). This is addition to the requirements of the Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996.

#### **K2.4.10 Statutory guidance for ventilation of protected shafts conveying gas**

##### **K2.4.11** Approved Document Part B Vol 2 (B3) 8.41 states:

*“Ventilation of protected shafts conveying gas  
A protected shaft conveying piped flammable gas should be adequately ventilated direct to the outside air by ventilation openings at high and low level in the shaft. Any extension of the storey floor into the shaft should not compromise the free movement of air over the entire length of the shaft.*



*Guidance on such shafts, including sizing of the ventilation openings, is given in BS 8313:1997.”*

**K2.4.12** The following guidance is provided in the BS 8313:1997 for ventilation of protected shafts conveying piped flammable gas.

*“12.3 Safety ventilation*

*12.3.1 Ventilation should be provided to dilute any anticipated or reasonably foreseeable leakages of flammable, toxic or corrosive gases to a safe level.*

*Advice on occupational exposure limits of airborne substances hazardous to health is available in Health and Safety Executive Guidance Note EH40 [15]. For flammable gases or vapours small leaks should be diluted below 25 % of the lower flammable limit (sometimes referred to as LFL or LEL). Where it is not reasonably practicable to satisfy the above, see 12.3.4.*

*Where oxidizing gases are being distributed, the ventilation air requirement should be such as to limit the concentration of the leaked oxidizing gas in air to less than 1 % by volume.*

*Natural ventilation is preferred.*

*Pockets in roofs or floors where lighter-than-air or heavier-than-air gases respectively may accumulate should be avoided.*

*The ventilation rates should be based upon the sensitivity of pressure testing and maintenance procedures applied for each service.”*

**K2.4.13** BS 8313:1997 Table 1 shows the provisions for a free ventilation opening for dispersal of small leaks for ducts with a cross-sectional area of “more than 0.05m<sup>2</sup> but not more than 7.5m<sup>2</sup>” to have a minimum free area of 0.05m<sup>2</sup> for each opening.

*“12.3.2 Duct ventilation openings should lead to safe places, preferably the open air. Ducts contained solely within a room or an occupied space and not containing group 3 services may be ventilated within that room provided that the room is ventilated (see also 12.3.3).*

*The free area of such ventilation openings and the distance between them should be based on consideration of the relevant factors which affect air movement, including the location, size and configuration of the duct, on the physical properties including the relative density of the gases or vapours involved on factors influencing the potential magnitude of any leakages. Ventilation openings should be located such that air movement can occur within the duct, e.g. at the top and bottom or at each end, and at intervals along long horizontal ducts.*

*In general, the larger the interval between openings in horizontal ducts, the greater is the need for a vertical component to the duct at one end to generate air movement.”*

**K2.4.14** Therefore, protected shafts conveying piped flammable gas in Grenfell Tower should be adequately ventilated direct to the outside air by ventilation openings at high and low level in the shaft.

**K2.4.15** Statutory guidance for places of special fire hazard



**K2.4.16** Approved Document Part B Vol 2 (B3) 8.12 states:

*“Every place of special fire hazard (see Appendix E) should be enclosed with fire-resisting construction; see Table A1, Item 13. Note: Any such walls and floors are not compartment walls and compartment floors.”*

**K2.4.17** Approved Document B Part B Vol 2 Appendix E defines special fire hazard

*“Places of special fire hazard  
Oil-filled transformer and switch gear rooms, boiler rooms, storage space for fuel or other highly flammable substances and rooms housing a fixed internal combustion engine.”*

**K2.4.18** Approved Document B Part B Vol 2 Appendix A Table A1 includes provisions for fire-resisting construction enclosing places of special fire hazard to achieve 30 minutes’ fire resistance in Loadbearing capacity, Integrity, and Insulation per BS 476 -22, 23, and 24, accordingly.

**K2.4.19** Approved Document B Part B Vol 2 Appendix A B Table B1 includes provisions for any door forming part of the enclosure to a place of special fire risk to be *FD30* in terms of integrity when tested to BS-476-22.

**K2.4.20** Therefore, the main area of the basement of Grenfell Tower which contained boilers was recommended to be enclosed by 30 minutes’ fire resistance construction with *FD30* doors.

**K2.5 BS EN 1775:2007**

**K2.5.1** BS EN 177:2007 states:

*“This standard specifies general recommendations for the design, construction, testing, commissioning, operation and maintenance of installation pipework; pipework between the delivery point of the gas and the inlet connection to the gas appliance.”*

**K2.5.2** This document is referred to in the Gas safety (Installation and Use) Regulations 1998 Approved Code of practice and Guidance issued in 2007, but is not referred to in the 2013 update.

**K2.5.3 Provisions for external means of isolation**

**K2.5.4** BS EN 1775:2007 Gas supply – Gas pipework for buildings – Maximum operating pressure less than or equal to 5 bar – Functional recommendations states:

*“5.5.3 A means of isolation shall be located in an accessible position at or near to the point of entry of a gas pipe into a building. (see also 5.5.4)  
In high rise buildings, this means of isolation shall be located in an accessible position in the pipework outside the building. For public access buildings or commercial buildings, installation of such a means shall be considered.*

*5.5.4 Means of isolation shall always be accessible, as applicable, to the gas distribution system operator, emergency services and the customer. Measures shall be taken, as necessary, to discourage inappropriate use of the means of isolation."*

- K2.5.5** Therefore, a means of isolation should have been provided in an accessible position outside Grenfell Tower for each incoming gas service supplies in order to be compliant with the provisions of BS EN 1775:2007.

## **K2.6 The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002**

- K2.6.1** The Dangerous Substances and Explosive Atmosphere Regulations 2002 regulations are enacted under the Health and Safety at Work Act 1974, referring to workplace safety and requirements to ventilation requirements applicable during construction and maintenance periods.

- K2.6.2** The specific requirements of these Regulations for Grenfell Tower are being dealt with separately by the Public Inquiry's appointed Gas Expert, Mr Rodney Hancox.

## **K2.7 Gas Safety (Management) Regulations 1996**

- K2.7.1** The Public Inquiry has appointed, Rodney Hancox to provide expert services in relation to the relevant legislation, regulations guidance and industry practice relevant to gas supply to and within Grenfell Tower.

- K2.7.2** Mr Rodney Hancox will therefore cover the requirements of these regulations with respect to Grenfell Tower. I have included a short reference only to some of the relevant duties conferred by these regulations here:

- K2.7.3** The Gas Safety (Management) Regulations 1996 are also relevant to the gas supplies within Grenfell Tower. These regulations place specific duties on persons conveying gas:

*"Duties on persons conveying gas*

*3.-( 1 ) No person shall convey gas in a network unless-*

- (a) he has prepared a safety case containing the particulars specified in Schedule 1 and that safety case has been accepted by the Executive; and*
- (b) where any other person is conveying gas in that network, there is a sole network emergency co-ordinator for the network.*

*(2) For the purposes of these Regulations a network emergency co-ordinator is, subject to paragraph (3), a person who has prepared a safety case containing the particulars specified in Schedule 2 and has had that safety case accepted by the Executive.*

- (a) Where a network emergency co-ordinator has given written notice to the Executive and to all persons conveying gas in the network that he no longer intends to act in that capacity, he shall not be the network*



*emergency co-ordinator for the purposes of these Regulations from the time such notice takes effect (which shall not be less than 6 months after it was given).*

*(b) Nothing in these Regulations shall prevent a person who conveys gas in a network from also being the network emergency co-ordinator.”*

**K2.7.4** Duty 9 of the Gas Safety (Management) Regulations 1996 confers a duty on person conveying gas to also keep records:

*“Keeping of documents*

*9 – (1) A person who prepares a safety case pursuant to these regulations shall –*

*(a) ensure that when the safety case is sent to the Executive for acceptance it is notified of an address in Great Britain for the purposes of sub-paragraph (b) to (f) below;*

*(b) keep the accepted safety case and any revision thereof or a copy thereof at that address*

*(c) keep each audit report made by him or a copy thereof at that address;*

*(d) ensure that a record is made of any action taken in consequence of such an audit report and keep that record or a copy thereof at that address*

*(e) ensure that a report is made of every review carried out by him pursuant to regulation 4(3) and ensure that a copy is sent to the Executive*

*(f) keep such report or a copy thereof at that address; and*

*(g) ensure that a record is made of every test carried out pursuant to regulations 5(5) and 10(6) in relation to gas he conveys and keep that record or a copy thereof at that address.*

*(2) Each report and record required to be kept by paragraph (1) shall be kept for a period of 3 years after it has been made, and the safety case and revision shall be kept for so long as it is current*

*(3) It shall be sufficient compliance with paragraph (\*1) for the information in the documents to be kept at the address notified on film or by electronic means provided that the information is capable of being reproduced as a written copy at that address and it is secure from loss or unauthorised interference.*

*(4) Where a person has notified an address pursuant to sub-paragraph (a) of paragraph (1), he may notify to the Executive a different address in Great Britain for the purposes of the provisions referred to in that sub-paragraph, and where he does so references in those provisions and in paragraph (3) where applicable to the address notified shall be construed as the address in the last notification made under this paragraph*

*(5) In this regulation “audit report” means a report made pursuant to the arrangements referred to in paragraph 11 of Schedule 1 or paragraph 4 of Schedule 2 (to the extent that the latter mentioned paragraph relates to arrangements for audit).”*

## K2.8 Institute of Gas Engineers and Managers Standards

**K2.8.1** The Institute of Gas Engineers and Managers (IGEM) is a chartered professional body which publishes technical standards publish technical standards. These include the following standards relevant to Grenfell Tower:

- a) IGEM/G/5 Edition 2 - Gas in multi occupancy buildings
- b) IGEM/UP/2 Edition 3 – Installation pipework on industrial and commercial premises
- c) IGEM/SR/25 Edition 2 – Hazardous area classification of Natural Gas Installations

**K2.8.2** Mr Rodney Hancox, the appointed Gas Expert to the Public Inquiry shall cover the requirements of these standards for the gas supply to and within Grenfell Tower and the compliance of said gas supplies with those standards.

## K2.9 Summary table

Table K.3 Compliance requirements and provisions

Source of Requirement	Report Section	Relevant requirement to Grenfell Tower gas service supplies
Gas Safety (Installation and Use) Regulations 1998	3.1.1	Requirements for pipe materials – Regulation 5 Regulation 5(2) does not allow gas piping and fittings in Grenfell Tower to be made of lead or lead alloy, or be made of non-metallic materials unless it is placed in a metallic sheath to prevent the escape of gas into the building.
		Requirements for emergency control – Regulation 9 Regulation 9 requires that gas supplies to each flat within Grenfell Tower were provided with an emergency control and the HSE guidance recommended it be located within the flat as near as reasonably practicable to the point of entry. Regulation 9 requires that gas supplies to the landlord heating and hot water gas supply was provided with an emergency control. The HSE guidance recommended it is located as near as practicable to the point of entry to the premises which in Grenfell Tower was within the basement.
		Requirements for secondary meters – Regulation 17 A line diagram for the landlord gas supply system shall be installed at the primary meter or the emergency control where secondary meters have been installed.
		Requirements for ventilation – Regulation 19 Gas pipework in Grenfell Tower within a cavity in a wall, floor or standing, or within shafts, ducts and voids are required to be ventilated to address the potential risk of gas leaking from pipework.
		Requirements for fire resistance – Regulation 20 Regulation 20 requires any penetrations through fire resisting construction in Grenfell Tower to be fire stopped or ducted to maintain the fire resistance required by the Building Regulations 2010.
		Requirements for marking of pipes – Regulation 23 Regulation 23 requires that the pipe work outside of flats at Grenfell Tower to be clearly identified.



Source of Requirement	Report Section	Relevant requirement to Grenfell Tower gas service supplies
		<p>Requirements for service pipe valves – Regulation 24</p> <p>Regulation 24 requires that a readily accessible isolation valve is provided on each of the residential gas supplies in Grenfell Tower upstream of their division to supply more than one floor.</p> <p>Regulation 24 also requires a system diagram to be prominently displayed in the building in a readily accessible position to allow the emergency services to identify and isolate part of the gas system if necessary.</p>
The Pipelines Safety Regulations 1996	3.1.2	<p>Work on a pipeline</p> <p>The operator shall ensure that modification, maintenance or other work on a pipeline is carried out in such a way that its soundness and fitness for the purpose for which it has been designed will not be prejudiced.</p> <p>Arrangements for incidents and emergencies</p> <p>The operator shall ensure that no fluid is conveyed in a pipeline unless adequate arrangements have been made for dealing with –</p> <ul style="list-style-type: none"> <li>(a) an accidental loss of fluid from</li> <li>(b) discovery of a defect in or damage to: or</li> <li>(c) other emergency affecting, the pipeline</li> </ul> <p>Maintenance</p> <p>The operator shall ensure that a pipe line is maintained in an efficient state, in effective working order and in good repair.</p> <p>Decommissioning</p> <p>The operator shall ensure that a pipeline which has ceased to be used for the conveyance of any fluids is left in a safe condition.</p>
The Building Regulations 2010	3.1.3	<p>Statutory guidance for location of gas service and installation pipes</p> <p>The gas residential gas supply system 2 piping conveyed through the protected stairway in Grenfell Tower was permitted to be located within the protected stairway if the gas supply system was compliant with the current Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996.</p> <p>Statutory guidance for gas service and installation pipe materials in a protected stair or lift shaft.</p> <p>The residential gas supply system 2 piping conveyed through the protected stairway in Grenfell Tower should be screwed or welded steel unless the pipework was completely separated from the protected stairway by 120-minute fire resistant construction (loadbearing capacity, integrity, insulation). This is in addition to the requirements of the Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996.</p> <p>Statutory guidance for ventilation of protected shafts conveying gas</p> <p>Protected shafts conveying piped flammable gas in Grenfell Tower should be adequately ventilated direct to the outside air by ventilation openings at high and low level in the shaft.</p> <p>Statutory guidance for places of special fire hazard</p> <p>The main area of the basement of Grenfell Tower containing boilers should have been enclosed by 30 minutes' fire resistance construction with FD30 doors.</p>
BS EN 1775:2007	3.14	<p>Provisions for external means of isolation</p> <p>A means of isolation should have been provided in an accessible position outside Grenfell Tower for each of the incoming gas service supplies.</p>

## K3 Site Observations regarding the gas services at Grenfell Tower and their compliance status

**K3.1.1** Table K.3 in Section K2.1 summarises the requirements and provisions of the applicable legislation, regulation and guidance for the landlord gas supply and (2) residential gas supplies.

**K3.1.2** I have provided a summary of observations relative to these requirements and provisions for the landlord gas supply and residential gas supplies in Table K.4. Particular issues of compliance are discussed against each set of Regulations below.

Table K.4: Summary table to show observations relative to Gas Safety (Installation and Use) Regulations 1998, Pipeline Safety Regulations 1996, Building Regulations 2010, and BS EN 1775:2005

Requirement or provision	Landlord System	Residential System 1	Residential System 2
Gas Safety (Installation and Use) Regulations 1998			
Requirements for pipe materials – Regulation 5	The pipe is joined by welding, flanged connections and screwed connections for the mild steel pipework where it could be viewed.	The pipe is joined by welding, flanged connections and screwed connections where it could be viewed.	The pipe is joined by welding, flanged connections and screwed connections where it could be viewed.
Requirements for emergency control – Regulation 9	Requires a responsible person who could provide access to the gas intake room – I have found no evidence that such a person was available during an emergency.	Each flat had its own emergency control valve installed immediately prior to the meter.	Each flat had its own emergency control valve installed immediately prior to the meter.
Requirements for secondary meters – Regulation 17	I have not seen any evidence that a line diagram was provided.	There are no secondary meters installed on the residential system.	There are no secondary meters installed on the residential system.
Requirements for ventilation – Regulation 19	There are no enclosed pipes within the basement on the landlord supply.	No access to the risers during my site inspection, therefore I have not been able to evaluate ventilation provided, if any.	No access to the riser in the stairway during my site inspection, therefore I have not been able to evaluate ventilation provided, if any.  The design intent was to ventilate the riser and the lateral pipes in the lift lobbies, but works were not yet complete.



Requirement or provision	Landlord System	Residential System 1	Residential System 2
Requirements for fire resistance – Regulation 20	There are no enclosed pipes within the basement on the landlord supply.	No access to the risers during my site inspection, therefore I have not been able to evaluate the fire resistance of the enclosure or fire stopping provided, if any.	I observed that the piping in the protected stairway was enclosed, but the materials used to enclose the pipe were not readily identifiable. The lateral pipes in the lift lobbies were not enclosed.  The design intent was to enclose the riser in the stairway and the lateral pipes in the lift lobbies, but works were not yet complete.
Requirements for marking of pipes – Regulation 23	The new landlord pipe work is not immediately identifiable. Identification labels have not been provided in line with BS 1710:2014.	The residential gas supply system 1 was easily identifiable in the basement; it was painted yellow. It is unknown if the pipework was identified above the Basement Level as it was contained within risers.	The tenant residential supply system 2 was not easily identifiable. It had marker tape that was not compliant to BS1710 specification for identification of pipelines and services and was not painted yellow or otherwise identified as containing gas. It is unknown if the pipework was identified above the Basement Level as it was contained within an enclosure in the stairwell.
Requirements for service pipe valves – Regulation 24	Landlord system only supplies Basement Level	The incoming gas supply split into (4) pipes in the basement and risers through the (4) risers in the core of the building. An isolation valve was provided at the entry of each of these pipes into the relevant riser. However, these valves were at a high level in the basement and were therefore not readily accessible.  We have not seen any evidence that a line diagram was provided.	The incoming gas supply was provided with an isolation valve in the basement, but this was located at a high level and was therefore not readily accessible.  We have not seen any evidence that a line diagram was provided.
The Pipelines Safety Regulations 1996			

Requirement or provision	Landlord System	Residential System 1	Residential System 2
Work on a pipe line	The incoming gas supply was provided with an accessible ECV immediately upon entering the building. Therefore, the Pipelines Safety Regulations only apply to the piping before the ECV.	I have not reviewed any evidence relating to work on the gas supply, except for the capping of the south east riser.	This was a new system.
Arrangement for incidents and accidents	The incoming gas supply was provided with an accessible ECV immediately upon entering the building. Therefore, the Pipelines Safety Regulations only apply to the piping before the ECV. It has not yet been confirmed if external isolation valves were present and operable for this service.	Refer to observations relevant to Gas Safety (Installation and Use) Regulations 1998 Regulations 9, 19, 20, and 24. It has not yet been confirmed if external isolation valves were present and operable for this service.	Refer to observations relevant to Gas Safety (Installation and Use) Regulations 1998 Regulations 9, 19, 20, and 24. It has not yet been confirmed if external isolation valves were present and operable for this service.
Maintenance	The incoming gas supply was provided with an accessible ECV immediately upon entering the building. Therefore, the Pipelines Safety Regulations only apply to the piping before the ECV.	The gas risers in Grenfell Tower were subject to periodic inspections in line with Cadent engineering (Witness Statement of Stephen Mason, Cadent Gas Ltd - CAD000000004)	No evidence reviewed regarding maintenance.
Decommissioning	The incoming gas supply was provided with an accessible ECV immediately upon entering the building. Therefore, the Pipelines Safety Regulations only apply to the piping before the ECV.	The south east riser was capped at ground floor level due to a gas leak found during routine maintenance.	No evidence that any pipework was decommissioned.
Approved Document B (2010)			
Statutory guidance for location of gas service and installation pipes	The landlord system only served the basement area.	This gas supply is not routed through the protected stairway in Grenfell Tower.	The design intent was to separate the riser from the stair with fire resisting construction, as described in section K1.6.13.
Statutory guidance for gas service and installation pipe materials in a protected stair or lift shaft.	The landlord system only served the basement area.	This gas supply is not routed through the protected stairway in Grenfell Tower.	The design intent was to separate the riser from the stair with fire resisting construction, as described in section K1.6.13.



Requirement or provision	Landlord System	Residential System 1	Residential System 2
Statutory guidance for ventilation of protected shafts conveying gas	The landlord system only served the basement area	No access to the risers during my site inspection, therefore I have not been able to evaluate ventilation provided, if any.	No access to the riser in the stairway during my site inspection, therefore I have not been able to evaluate ventilation provided, if any.  The design intent was to ventilate the riser and the lateral pipes in the lift lobbies, but works were not yet complete.
Statutory guidance for places of special fire hazard	The basement is separated from the rest of the building. We have not been able to verify the fire resistance of the separation, but basement access is direct from the exterior.	Not a place of special fire hazard.	Not a place of special fire hazard.
BS EN 1775 Gas supply – Gas pipework for buildings			
BS EN 1775 Gas supply – Gas pipework for buildings – Maximum operating pressure less than or equal to 5 bar – Functional recommendations	As Grenfell Tower is a high rise building, isolation is required in an accessible position external to the building.  Additional action on site is required regarding the external means of isolation provided at Grenfell Tower.	As Grenfell Tower is a high rise building, isolation is required in an accessible position external to the building.  Additional action on site is required regarding the external means of isolation provided at Grenfell Tower.	As Grenfell Tower is a high rise building, isolation is required in an accessible position external to the building.  Additional action on site is required regarding the external means of isolation provided at Grenfell Tower.

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## K4 Emergency Control

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### K4.1 External means of isolation

- K4.1.1** Regulation 5 of Gas Safety Regulations 1972, which were applicable at the time of construction of Grenfell Tower required the “*installation of a service valve in a readily accessible position as near as practicable to the boundary of the through or to which the service pipe is laid.*” The location of the service valve should be clearly indicated.
- K4.1.2** These Regulations were subsequently replaced by The Pipelines Safety Regulations 1996 of which Regulation 12 requires the operator to make arrangements for incidences and emergencies.
- K4.1.3** I am aware that Mr Rodney Hancox, the Public Inquiry’s appointed Gas Expert identified external valve pit covers for the gas supply during a site visit on 28<sup>th</sup> February 2018. Further investigation is required, by the appointed Expert, to confirm the presence and operability of any valves within those pits. It has therefore, yet to be fully confirmed, as I currently understand it, if external isolation was provided at Grenfell Tower|. I note also that during the fire of 14<sup>th</sup> June 2017 neither LFB nor Cadent were able to locate an external means of isolation (See Section K7).

### K4.2 Internal means of isolation

- K4.2.1** The requirements for means of isolation from Regulation 9 of the Gas Safety (Installation and Use) Regulations 1998 are detailed in Section K2.2.
- K4.2.2** Regulation 9 requires emergency controls as excerpted in Section K2.2.13.
- K4.2.3** The following guidance is provided in the HSE Approved Code of Practice and Guidance “*Safety in the installation and use of gas systems*” and appliances for Regulation 9:

*“149 Whenever a new gas supply is made available for use in premises, an emergency control should also be provided. Where there is a gas meter, the meter control may serve as the emergency control as long as the following conditions are met:*

*(a) Each individual premises (e.g. each house, flat, maisonette, or caravan) using a supply of gas should be provided with an emergency control, whether or not that premises contains a gas meter.*

*(b) The emergency control should be situated as near as is reasonably practicable to the point where the gas supply pipe enters the premises.*

*(c) It should be readily assessable [sic] to all consumers, i.e. gas users, in the premises concerned (e.g. not located in a basement or cellar).*



*(d) A valve located in a meter-room which is normally locked, and accessible only to a landlord, gas supplier, gas transporter and/or emergency services for example, cannot act as an 'emergency control'.*

*(e) An emergency control should be protected against unauthorised operation (i.e. tamper-proof) but if situated in a locked compartment, the occupier(s) of the premises should be provided with keys (see also regulation 13(3)– (4)). In such cases, the emergency service provider should also hold keys where access cannot be ensured for them at all times, e.g. through keys held by the responsible person for the premises.”*

- K4.2.4** The HSE guidance point (c) recommends that the emergency control is readily accessible to all consumers and not located in a basement.
- K4.2.5** **Landlord gas supply system**
- K4.2.6** Regulation 9 requires that the landlord gas supply was provided with an emergency control.
- K4.2.7** Regulation 9-(1) requires that the emergency control should be an appropriately sited emergency control to which there is adequate access.
- K4.2.8** The HSE guidance point (b) recommends that the emergency control is located as near as practicable to the point of entry to the premises which in Grenfell Tower was within the basement.
- K4.2.9** HSE guidance point (e) requires that if the emergency control is located within a locked compartment, the emergency service provider should also hold keys where access cannot be ensured for them at all times, e.g. through keys held by the responsible person for the premises.
- K4.2.10** There was an ECV located in the basement (refer to Figure K.4) as required by Regulation 9 of the Gas Safety (Installation and Use) Regulations 1998.
- K4.2.11** However, I have found no evidence that keys were available for the emergency services to access the basement to access the ECV for the Landlord system.
- K4.2.12** Therefore, the internal emergency control for the Landlord system was not provided with adequate access.
- K4.2.13** Mr Rodney Hancox has identified, 28<sup>th</sup> February 2018, three pits external to Grenfell Tower which are to be further investigated to confirm if they contained operator isolation valves as required under The Pipeline Safety Regulations 1996 and Gas Safety Regulations 1972 which predate them.
- K4.2.14** **Residential gas supply system 1**
- K4.2.15** Regulation 9 requires that gas supplies to each flat within Grenfell Tower were provided with an emergency control and the HSE guidance

recommended it is located within the flat as near as reasonably practicable to the point of entry.

**K4.2.16** Emergency cut-off valves were provided in each flat close to the point of entry to the flat as detailed in K1.6.

**K4.2.17** I have found no evidence they were used during the fire.

**K4.2.18** As I have explained above, the three pits external to Grenfell Tower require further investigation.

#### **K4.2.19 Residential gas supply system 2**

**K4.2.20** Regulation 9 requires that gas supplies to each flat within Grenfell Tower were provided with an emergency control and the HSE guidance recommended it is located within the flat as near as reasonably practicable to the point of entry.

**K4.2.21** Emergency cut-off valves were provided in each flat close to the point of entry to the flat as detailed in K1.6.

**K4.2.22** I have found no evidence they were used during the fire.

**K4.2.23** The conditions within the lobbies allowing access to the flats are discussed in detail in Sections 14 and 19 of my main report.

**K4.2.24** As I have explained above, the three pits external to Grenfell Tower require further investigation.

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## **K5 Fire separation of gas supplies**

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### **K5.1 Landlord gas supply system**

**K5.1.1** The landlord gas supply system was contained only within the basement therefore the only requirement is separation between the basement and the rest of the building

**K5.1.2** Boiler rooms are listed as places of special fire hazard in ADB 2013 Appendix E.

**K5.1.3** ADB 2013 8.12 states that every place of special fire hazard (see Appendix E) should be enclosed with fire-resisting construction; see Table A1, Item 13. Note: Any such walls and floors are not compartment walls and compartment floors.

**K5.1.4** It is not clear whether the doors to the basement meet the requirement of Table A1, which, for places of special fire hazard, would require 30 minute fire resisting construction.



## **K5.2 Residential gas supply system 1**

**K5.2.1** As described in Section K1.6.2, residential gas supply system 1 enters four risers in the basement. I have not been able to trace the exact route of the gas pipes between basement and Level 4. However, I know the gas pipe running in the southeast riser was capped at the ground floor. For Levels 4 – 23, the gas pipework has been split into six (6) no. vertical risers with horizontal feeders, one for each of the flats.

**K5.2.2** The Gas Safety (Installation and Use) Regulations 1998, Regulation 20 requires:

*“20. No person shall install any installation pipework in a way which would impair the structure of a building or impair the fire resistance of any part of its structure.”*

**K5.2.3** Therefore, where each of the residential gas supply 1 pipes penetrate the compartment floors, some form of fire protection is required – either by fire stopping the pipe at each level or by enclosing the pipe in a protected shaft separated by 120-minute fire resisting construction (loadbearing capacity, integrity, insulation) per Approved Document Part B Vol 2 Table A2.

**K5.2.4** I was not able to access the residential gas supply 1 risers during my site inspections to evaluate their construction and have not found any evidence detailing their construction.

## **K5.3 Residential gas supply system 2**

**K5.3.1 Separation from the protected stair.**

**K5.3.2** As described in Section K1.6.13, Residential gas supply system 2 ran within the protected stair.

**K5.3.3** Therefore, the provisions of Approved Document Part B Vol 2 (B1) 2.42, excerpted in Section K2.4.5 above, for Residential gas supply system 2

**K5.3.4** Approved Document Part B Vol 2 (B3) 8.40 is also relevant, and excerpted in Section K2.4.8, above.

**K5.3.5** Therefore, the residential gas supply system 2 piping conveyed through the protected stairway in Grenfell Tower was recommended to be screwed or welded steel unless the pipework was completely separated from the protected stairway by 120-minute fire resisting construction (loadbearing capacity, integrity, insulation). This is addition to the requirements of the Gas Safety (Installation and Use) Regulations 1998 and the Pipelines Safety Regulations 1996,

**K5.3.6** The works to fire separate the riser from the stair were ongoing on the 14<sup>th</sup> June 2017. At this time the riser was enclosed within the stair from the 4<sup>th</sup> floor to the 22<sup>nd</sup> floor. The enclosing works were reportedly not complete on

the 23<sup>rd</sup> floor (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD00000004). I have not currently verified the status of the works on the 23<sup>rd</sup> floor.

- K5.3.7** Because the laterals (where provided) pass out from the stair enclosure and were not fire-stopped by design (ADB 2013 Section A2.4.2), the compartmentation of the stair must be maintained through the enclosure to the laterals and connecting securely to the enclosure within the stair.
- K5.3.8** I have not been able to establish whether the enclosure provided within the stair would meet the requirement for 120-minute fire resisting construction.
- K5.3.9** Based on my understanding of the design intent and my observation of one of the pipe penetrations, the compartmentation to the stair was not maintained at the point where the lateral gas pipes (where provided) pass from the stair into the lobbies at the time of the fire.
- K5.3.10** I will update my opinion in the event evidence to the contrary becomes available.
- K5.3.11** **Ventilation of the enclosure containing the gas riser**
- K5.3.12** Approved Document Part B Vol 2 (B3) 8.41 is relevant, and excerpted in Section K2.4.11, above.
- K5.3.13** Guidance is provided in the BS 8313:1997 for ventilation of protected shafts conveying piped flammable gas, excerpted in Sections K2.4.12 and K2.4.13, above.
- K5.3.14** Therefore, protected shafts conveying piped flammable gas in Grenfell Tower were recommended to be adequately ventilated direct to the outside air by ventilation openings at high and low level in the shaft.
- K5.3.15** As set out in Section K1.6.13, the proposed design was to ventilate the riser enclosure at the roof and the enclosure laterals were meant to be ventilated only by connection to the main riser enclosure. It is not clear whether the design provided ventilation at the base of the riser as is required by Health and Safety Executive Guidance Note EH40 [15].
- K5.3.16** As described in Section K1.6.13 of this Appendix, I did not observe any ducting of the laterals on any level.
- K5.3.17** I have been unable to verify whether ventilation openings were provided at high and low level within the enclosure containing the gas riser in the protected stair, and if provided, whether these openings meet the requirements of Health and Safety Executive Guidance Note EH40 [15].



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## K6 Observations

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### K6.1 Landlord system

#### K6.1.1 Pipe Materials

**K6.1.2** The service pipework is mild steel; it is unknown if it is medium or heavy grade. The pipe is joined by welding, flanged connections and screwed connections where it could be viewed.

**K6.1.3** The original installation pipe work downstream of the meter is mild steel; it is unknown if it is medium or heavy grade. The pipe is joined by welding, flanged connections and screwed connections where it could be viewed.

**K6.1.4** The pipework that was installed to the new boilers is a Geberit Mapress system. This is joined by compressing the couplings where it could be viewed.

#### K6.1.5 Line diagrams

**K6.1.6** Regulation 17 of the Gas Safety (Installation and Use) Regulations 1998 requires a line diagram to be installed in permanent form prominently displayed on or near the primary meter and on or near all emergency controls connected to the primary meter.

**K6.1.7** No permanently displayed line diagrams were found in the gas intake room that contained the emergency control and the landlord gas meter.

#### K6.1.8 Marking of pipes

**K6.1.9** The new landlord pipe work is not immediately identifiable as it is stainless steel Mapress (Manufactured by Geberit); refer to Figure K.12. Identification labels have not been provided in line with BS 1710:2014.

### K6.2 Residential gas supply 1

#### K6.2.1 Pipe Materials

**K6.2.2** The service pipework is mild steel; it is unknown if it is medium or heavy grade. The pipe is joined by welding, flanged connections and screwed connections.

#### K6.2.3 Marking of pipes

**K6.2.4** The residential gas supply system 1 was easily identifiable in the basement where the pipework was painted yellow. It is unknown if the pipework was identified above the Basement Level as it was contained within risers.

## **K6.2.5 Maintenance**

**K6.2.6** The gas risers in the tower were subject to periodic inspections in line with Cadent engineering procedures (principally T/PM/LC/21). The most recent survey had been completed on the 30<sup>th</sup> September 2016 where a gas leak was identified on one of the risers. The gas supply to this riser was cut off in accordance with Cadent's procedures. (Witness Statement of Stephen Mason, Cadent Gas Ltd CAD000000004).

**K6.2.7** This is line with our site inspection that identified the southeast riser had been capped at the ground floor (see Figure K.15) and a new gas supply, residential gas supply 2, was installed.

## **K6.3 Residential gas supply 2**

### **K6.3.1 Pipe Materials**

**K6.3.2** The service pipework is mild steel; it is unknown if it is medium or heavy grade. The pipe is joined by welding, flanged connections and screwed connections where it could be viewed.

### **K6.3.3 Marking of pipes**

**K6.3.4** The residential gas supply system 2 was not easily identifiable. It had marker tape that was not compliant to BS1710 specification for identification of pipelines and services and was not painted yellow. It is unknown if the pipework was identified on above the Basement Level as it was contained within an enclosure in the stairwell.



Figure K.29: Residential gas supply 1 pipe markings in basement



## **K7 Gas supply during the course of the fire**

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- K7.1.1** The gas supply to Grenfell Tower was not isolated finally until approximately 23:30 on 14 June 2017 (CAD000000002).
- K7.1.2** The gas supply could not be isolated by LFB because they were unable to locate or access isolation valves in the basement. (MET00005756). The provision and location of valves is described in Sections K1.5 and K1.6. It is important to note that the tenant gas supply isolation valves were at a high level and were therefore not accessible.
- K7.1.3** It was not possible for Cadent to access the basement during the fire, due to the risks of falling debris and risk of collapse of the building (MET00005756).
- K7.1.4** Therefore, Cadent isolated the supplies to the building by excavating and isolating each supply at a remote location (CAD000000002)
- K7.1.5** Prior to isolation of the gas, gas fires continued to burn on several floors of Grenfell Tower. These could not be extinguished because of the risk of explosions (MET00005404).
- K7.1.6** The problems caused by the continued supply of gas to Grenfell Tower are set out in Section 19.
- K7.1.7** A timeline of the principal events leading to isolation of the gas supply to Grenfell Tower is provided in Table K.5.

Table K.5: Timeline of events associated with the gas supply to Grenfell Tower on 14 June 2017.

Time	Event	Reference
02:17	Message from Incident <i>"CU8 First request for dangerous structure engineer, gas and electricity board and local authority liaison officer"</i>	LFB00000003
03:22	Emergency Call received by Cadent.	CAD00000002
03:30	Cadent First Call Operative (FCO) dispatched.	CAD00000002
03:48	Cadent FCO arrival on site, confirmed with LFB.	CAD00000002
05:10	Cadent staff start to ascertain where gas mains are situated. Cadent instructed by LFB to standby.	CAD00000002
07:45	LFB confirmed that they wanted the gas supply isolated. Cadent established that they were unable to get close to the building to isolate the fire valves, it would therefore be necessary to physically isolate the gas network away from the building.	CAD00000002
08:10	<i>Codon Gas[sic] former National Grid. Will isolate 3 separate locations that will isolate building Grenville Tower [sic] and 1 other building.</i>	AC Roe, MET00005404
08:50	Cadent explains the isolation plan to LFB - estimate gas off 19:00-20:00 <i>Plan was to excavate and isolate the gas mains at three separate locations: The first isolation site was at Testerton Walk (4" gas main); the second was at Grenfell Road (180mm gas main); and the third was at the rear of Blechynden Street (12" / 15" gas main).</i>	CAD00000002
09:29	<i>Cadent could not locate service valves due to restrictions and debris at the base of the building.</i>	CAD00000002
12:20	<i>Access to the isolation sites agreed and granted by LFB.</i>	CAD00000002
15:30	<i>Gas authority are now digging up the road to isolate the supply to the building. There are 3 supplies to the building resulting in 3 areas to be dug up.</i>	AC Ellis, MET00005756
15:50	<i>Cadent instructed by LFB to retreat from the basement due to concerns about the safety of the building.</i>	CAD00000002
16:00	<i>Excavation of 4" and 180mm gas mains successfully completed. Repair teams working on the 12" main excavation instructed to retreat from the site.</i>	CAD00000002
16:15	<i>AC Ellis instructs SM Andrew Williams to assess if the gas supply can be shut down in the basement.</i>	AC Ellis, MET00005756
16:50	<i>SM Williams reports that they gained access to the basement, however due to the tactical withdrawal they were unable to shut off the gas supply.</i>	AC Ellis, MET00005756
17:50	<i>AC Ellis agrees for Gas authority to continue working within the hazard area to isolate supply to Grenfell Tower. The rationale [sic] for this is that the remaining fires in the tower are mainly gas fed fires. These will not go out until gas is isolated. Extinguishing these before gas is isolated will lead to possible gas explosion hazard which could in turn lead to building damage/collapse. To make this as safe as possible a system of safety officers and spotters will be implemented to actively monitor the building and to give warning of any signs of collapse so that gas workers and LFB safety staff can retreat to a place of safety.</i>	AC Ellis, MET00005756
17:53	<i>SM Andrew Williams instructed to reattempt gaining access to basement to knock off gas supply</i>	AC Ellis, MET00005756



Time	Event	Reference
18:20	<i>LFB declare building unsafe - Repair teams working on the 12" main instructed to retreat again</i>	CAD00000002
18:30	<i>Update was provided in relation to gas board, a risk assessment had been carried out in relation to the area they were working and it had been agreed that they could continue with works, it was hoped that they should be finished in approximately 30 minutes</i>	AC Ellis, MET00005756
19:35	<i>SM Andrew Williams reported unable to knock off gas supply in basement as the gas authority would not enter the basement following their risk assessment. Fire crews not able to knock off without there assistance due to a complex piping system.</i>	AC Ellis, MET00005756
20:00	<i>Isolation of 4" and 180mm mains confirmed.</i>	CAD00000002
20:15	<i>LFB request to access basement to operate valves - Tony Day undertook risk assessment and instructed Jason Allday not to enter building due to safety concerns. Jason Allday offered to advise and direct LFB if they decided to enter building.</i>	CAD00000002
21:10	<i>Confirmation back to the AC is that currently there are fires on floors 10,11,13 and 15, these are believed to be gas fires where the supply has still not yet been isolated.</i>	AC Ellis, MET00005756
21:20	<i>12" gas main located and discovered to be a 15" gas main. Decision made to use 12" equipment to isolate the 15" main to achieve temporary isolation until the 15" equipment arrived ONST [on site].</i>	CAD00000002
21:30	<i>There are still pockets of fire on multiple floors caused by the gas still supplied to the building, LFB are confident that these will go out once the supply has been isolated, all of this information has been fed back to Gold.</i>	AC Ellis, MET00005756
23:30	<i>Temporary Isolation of 15" gas main achieved.</i>	CAD00000002

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## K8 Problems caused by continuing supply of gas

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- K8.1.1** The principal issues caused by the continued supply of gas to Grenfell Tower were:
- a) Continuing fires within the building on multiple floors (MET00005756);
  - b) Re-ignition of other materials on floors by the gas fires (MET00005756);
  - c) Risk of explosion (MET00007693);
  - d) LFB were at risk from fires re-igniting below the floors on which they were working (MET00005257);
  - e) LFB had to commit resources to dealing with the effects of gas fires (MET00005257);
  - f) I have explained the condition in the stairs and the lobbies in Section 14 of my main report.

- K8.1.2** Descriptions of the problems encountered by LFB due to gas fires are listed below:

**K8.1.3** Ellis MET00007693

Soon after that meeting at 13:25 hrs I went for another walk of the incident to check our progress and I received an update from Rick OGDEN that they had just about cleared the hose on the staircase so they could start moving up and this is when we started to realise we had gas fed fires on many floors in the building. We had gas fed fires on the 10th floor, floors 5, 6, 7 and 8 had jets working — in other words working fires on those floors so straight away you have five floors of fire there before we have even got above the 12th floor which would have been a massive challenge on any day.

Our main issue now with the fires, right up to the stage I left, were that most of the remaining fires in the building were gas fed fires. Where boilers or cookers had been destroyed by the fire, you literally had a gas pipe sticking up with a flame coming out of it in the middle of a room and it would be a desolate room with nothing else left to burn but just the gas flame burning in the middle of the room. We could not knock those fires out because that would cause a gas explosion hazard so the only way forward was to isolate the gas. To facilitate this I committed a crew into the basement to see if we could isolate the gas in the basement as there were some isolation valves in there but that was just at the same time as reports of quite a few really loud banging noises in the building were heard and we thought maybe a few floors are going. Because of this I ordered an evacuation of all personnel from the building and then we were out for some time while we methodically assessed the stability of the building. In the interim the Gas board started digging up the road in three separate places to isolate the various gas supplies to the building. We did try to commit crews again into the basement to isolate the gas but the gas board at this stage and following the previous evacuation of the building did not want to commit staff to the basement of the building.



#### K8.1.4 Graham MET00005257

*Another factor that impeded progress was the Gas main alight in most flats, the inability to turn this off meant that I had to tie crews up covering existing floors that we had partially extinguished. At one point received confirmation that the gas had been dug up in the street and it was off, I moved the bridgehead up to seven only to have to return it to 4, 20 minutes later as the gas was not off it then re-ignited fires below the bridge head.*

#### K8.1.5 Ogden MET00007657

Frustration from the fire fighters was shown as they were struggling to progress further up the buildings. This was due to several reasons including that each floor had so many individual fires on that these were taking time to out and causing heavy smoke making it difficult to see. The gas mains were still on and were alight. There were issues with having the gas supply to the cut off in the area. This prolonged the situation and kept the fire alight in the building. There was gas supply to each flat in the building that I am aware of. There were five water hoses on each floor. It became apparent the stairs were becoming