

# **GRENFELL TOWER INQUIRY**

## **Final Report of**

**Rodney Denver Hancox B.Sc., C.Eng, MIGEM**

## **Gas Engineering**

Report of:	Rodney Hancox
Specialist Field:	Gas Engineering
Instructing Solicitor:	Cathy Kennedy
Prepared for:	Grenfell Tower Inquiry
Inspection Dates:	28 <sup>th</sup> February 2018 & 30 <sup>th</sup> May 2018

## CONTENTS

Topic	Paragraphs
Introduction	1 - 15
Outline of the Gas Infrastructure surrounding, to and within Grenfell Tower	16 - 62
Instruction No. 1 - 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.	63 – 177
Instruction No. 2 - 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.	178 – 223
Instruction No. 3 - The extent to which the presence of gas in the Tower contributed to the spread of fire and/or the conditions inside Grenfell Tower on the night of 14 June 2017.	224 -259
Instruction No. 4 - In so far 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 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.	260 – 448
Supplementary Instruction - Consider Issue No.6 – Inspections, in the Inquiry’s List of Issues in so far as the questions relate to the inspection of the gas infrastructure at Grenfell Tower on and before 30 <sup>th</sup> September 2016.	449 – 466
Recommendations	467 – 479
Summary	480 - 492

Appendices	
1	Brief Career Profile for Rodney Hancox B.Sc., C.Eng., M.I.G.E.M.
2	Standards, HSE Guidance Documents, Legislation etc. Referenced when Preparing the Report for The Inquiry.
3	Initial Design Drawing of Replacement Riser {TRI000000263}
4	HS(L)56 – Safety in the Installation and Use of Gas Systems and Appliances 4 <sup>th</sup> Edition
5	IGEM/G/5 Edition 2 – Gas in Multi-occupancy Buildings
6	Safety Advice for Emergency Services Attending Gas Escapes



7	Extract from IGE/TD/4 Edition 1 - Services to Multi-storey Buildings
8	Simon Boygle's 1 <sup>st</sup> Survey Report {CAD000000054}
9	Simon Boygle's 2 <sup>nd</sup> Survey Report {CAD000000038}
10	Updated Boxing/Ventilation Requirements {TRI0000001206}
11	Extract from BS 6891 – Specification for the installation and maintenance of LP gas installation pipework $d \leq 35\text{mm}$ on premises.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **Introduction**

1. I, Rodney Denver Hancox, have been employed in the Gas Industry since graduating in 1970. In that time I have specialised in gas distribution activities. I have also been involved in gas metering, installation pipework and technical training.
2. As an operational Gas Engineer between 1975 and 1983 I managed a number of gas incidents in the field, including fires on gas mains. As an Area Planning Engineer I designed new and replacement gas networks and was a member of the Area Emergency Control Team. As Operations Engineer at British Gas Eastern Region HQ, I undertook a “staff officer” role and I was a member of the Region’s Major Incident Emergency Control Team as and when required.
3. Over the last 23 years, since leaving Transco, I have written Gas Safety Cases and associated procedures, compliant with the Gas Safety (Management) Regulations 1996, for various aspiring Gas Transporters and Local Authorities and Housing Trusts which own Private Gas Networks. In addition, I have audited the Safety Case and associated procedures of an Independent Gas Transporter (IGT). My CV is attached as Appendix 1.
4. I am an active member of the Institution of Gas Engineers and Managers (IGEM). IGEM is the professional engineering institution supporting individuals and businesses working in the global gas industry. Its core role is to encourage the highest standards of professional competence amongst individuals working in gas. It delivers technical training and develops technical standards that are recognised around the world.
5. I chair the panel responsible for drafting and updating IGEM/G/5 Edition 2 – Gas in Multi-occupancy Buildings. My involvement in other IGEM panels is detailed in Appendix 1.
6. My instructions are to provide a report, for the purposes of the Inquiry, which addresses the following issues:

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- 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 Tower contributed to the spread of fire and/or the conditions inside Grenfell Tower on the night of 14 June 2017.
  - d) In so far 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 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.
7. The Inquiry has published a list of issues on which its investigations will focus. Issue number 6 relates to inspections. In the light of observations on site and information disclosed to the Inquiry I was asked, after I was given the above instructions, to consider Issue No.6 – Inspections, in the Inquiry’s List of Issues in so far as the questions relate to the inspection of the gas infrastructure at Grenfell Tower on and before 30<sup>th</sup> September 2016.
8. In preparing the advice contained in this report, I do not consider myself to be qualified in the field of law. My observations are based on my practical experience of the relevant legislation and my long-standing working relationships with other professional gas engineers including individuals who either are or have been employed by the Health and Safety Executive.
9. In preparing this report I have considered various documents. Where I have taken information from documents disclosed to the Inquiry such as witness statements and items of correspondence, I have cited the Inquiry reference in brackets within the body of the report. Standards, HSE Guidance Notes and various items of legislation

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

which I have considered are listed in Appendix 2. I have quoted from them in the body of the report, where appropriate.

10. In preparing this report, I understand that my duty is to assist the Inquiry on matters within my expertise. I have complied, and will continue to comply, with that duty. I am aware of the requirements of Part 35 of the Civil Procedure Rules (CPR 35) and the supporting Practice Direction 35 (PD 35), and of the Civil Justice Council Guidance for the Instruction of Experts in Civil Claims 2014.
11. I confirm that I have exercised reasonable skill and care in preparing this report.
12. I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer. Where, in my experience, a range of opinions on any matter exists amongst gas engineering professionals, I have summarized the range of opinion, while clearly giving my opinion along with the reasons for it. I have also identified any assumptions that I have made in reaching my conclusions.
13. Moreover, particularly in the case of guidance and the content of standards, I have set out only the key issues that, subjectively, I consider might be most relevant to the Inquiry. Accordingly, before relying on these Parts of this report in relation to any significant findings of the Inquiry, reference should be made to the full copies of the standards, legislation and guidance, as amended at the relevant time.
14. I am in receipt of an occupational pension from the National Grid, now Cadent Gas Ltd, Pension Scheme. I confirm that I have no conflict of interest of any kind, other than any which I have already set out in this report. I do not consider that any interest which I have disclosed affects my suitability to give expert evidence to the Inquiry on any issue on which I have given evidence and I will advise the Inquiry if, between the date of this report and the Inquiry hearings, there is any change in circumstances which affects this statement.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

15. I reserve the right to alter my opinions and conclusions in the light of any further information of which I am currently unaware. Under such circumstances, I recognize, and will comply with, my obligation to inform the Inquiry.

**Outline of the Gas Infrastructure surrounding, to and within Grenfell Tower**

16. Before addressing my instructions I will describe the gas infrastructure surrounding, entering and within Grenfell Tower.
17. In response to a request for further information, on 25<sup>th</sup> October 2018 Cadent Gas Ltd disclosed a plan giving an overview of the gas distribution system in West London {CAD00003006}. The plan shows the Low Pressure Mains in red and the locations of the Pressure Reduction Installations which feed gas from the Medium Pressure Network into the Low Pressure Network. It is reproduced as Figure 1 below.
18. Cadent Gas Ltd has disclosed a screenshot of its network plans for the area surrounding Grenfell Tower {CAD00000423} and a copy of the network plans forwarded electronically from site during the morning of 14<sup>th</sup> June 2017 {CAD00000551}. I have obtained a copy of the network plans of the surrounding area, applicable at that time. It shows the same information more clearly and it is also reproduced below as Figure 2:



<b>Report of:</b>	<b>Rodney Hancox</b>
<b>Specialist Field:</b>	<b>Gas Engineering</b>
<b>Prepared for:</b>	<b>Grenfell Tower Inquiry</b>



**Fig.1 – West London LP Gas Distribution Network with Pressure Reduction Installations (PRIs)**



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

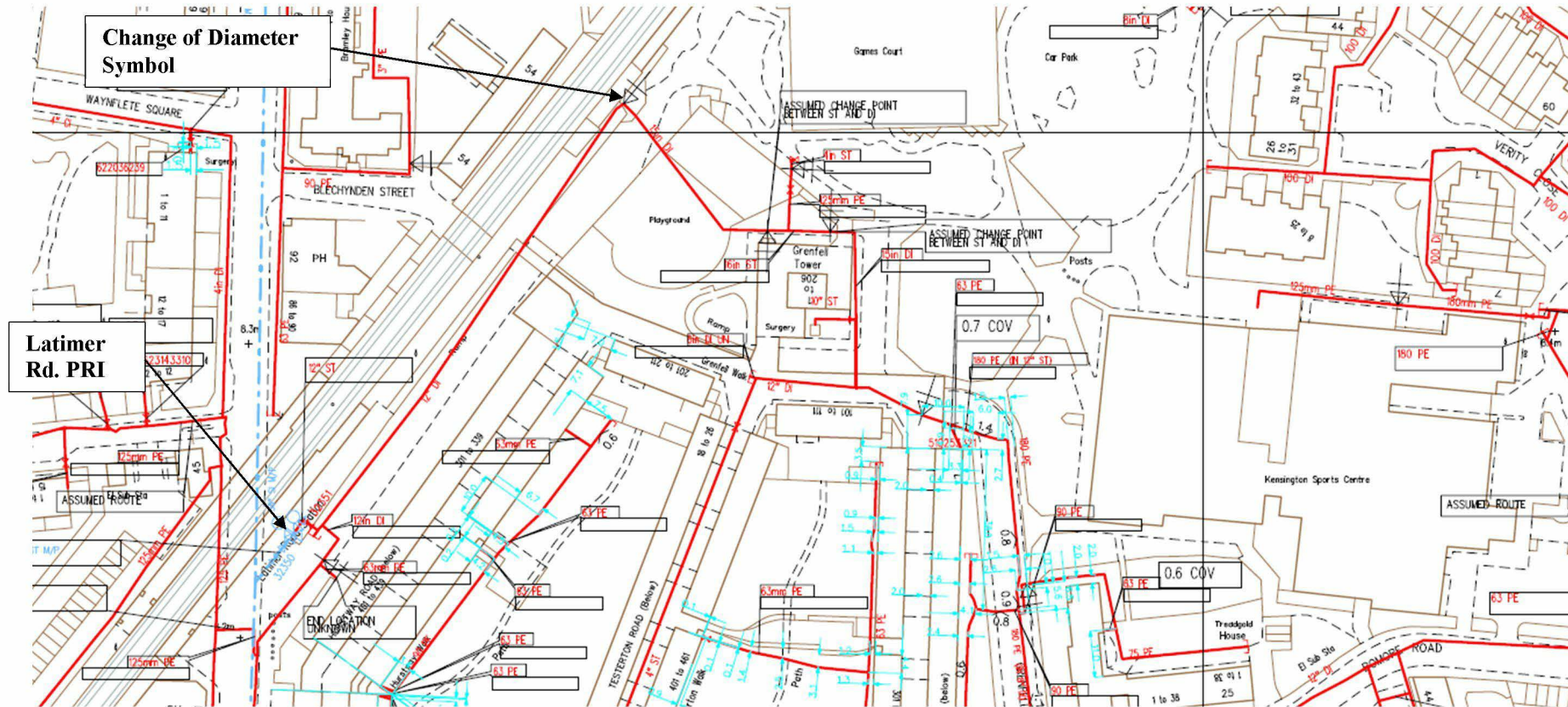


Fig. 2 – Extract from Cadent Gas Ltd's Network Plan of the Area Surrounding Grenfell Tower as at 14<sup>th</sup> June 2017

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

19. The principal source of gas for the local Low Pressure system is the Latimer Road Pressure Reduction Installation (PRI) which is located in a pit in Station Walk near to its junction with Bramley Road.



**Fig. 3 – Covered Pit for Latimer Road Pressure Reduction Installation**

20. Pressure Reduction Installations farther afield have been marked on Figure 1 above which is a plan of the West London Low Pressure Gas Network.
21. It will be noted from Figure 2 that the plan indicates that the Low Pressure gas main emanating from the Latimer Road Pressure Reduction Installation is 12" diameter. It is shown as changing diameter to 15" close to a bend to the north west of the Tower. The significance of this observation will be discussed in paragraphs 185 to 187 below.
22. It will also be noted that the plan only shows a single service/pipeline entering the Tower.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

23. I am indebted to Dr Barbara Lane and her team who carried out a thorough survey of the site between the 7<sup>th</sup> and 9<sup>th</sup> November 2017 and who included the results in Section C2 of Appendix C {BLAR00000018} and Appendix K of her report {BLAS00000032}. I was able to confirm many of the details contained there in when I visited the site on 28<sup>th</sup> February and 30<sup>th</sup> May 2018. I am also indebted to Corgi Technical Services, who have undertaken an investigation on behalf of the Metropolitan Police Service. Their report consists of:

- Witness statement of Kevin Winship {MET00016757}, since amended by {MET00039915};
- Associated appendices {MET00016753}, {MET00016754}, {MET00016755}, {MET00016759}, {MET00016760}, {MET00016761}, {MET00016762}, {MET00016763}, {MET00016764}, {MET00016765}, {MET00016771} & {MET00016772}.

I have used these source documents to back up my own observations and I confirm that I have not relied upon them alone.

24. During my visit to Grenfell Tower on 30<sup>th</sup> May I was accompanied by an official Metropolitan Police photographer. A schedule of the photographs he took in the form of camera disc/photograph number and location has been presented to the Inquiry {MET00016081}. Each of the photographs taken has been submitted to the Inquiry and each one has been allocated a reference number in the Relativity database. Unfortunately, the allocated reference numbers do not follow the sequence in which the photographs were taken. Consequently, I have produced the following table should any reader wish to follow up what I observed at any particular location during my visit.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Location of Photographs	Relativity Reference – MET000
Outside Building	16626, 16567,
Roof	16690, 16595, 16609
Floor 23	16674, 16603, 16657, 16541, 16686, 16699
Floor 22	16600, 16728, 16633, 16711
Flat 3 – Floor 22	16583, 16519, 16570, 16639, 16575, 16608
Floor 21	16724, 16652, 16549, 16551, 16646, 16649, 16552, 16642, 16710, 16544, 16528, 16708, 16752
Floor 20	16641, 16727
Floor 19	16529, 16729, 16680
Floor 18	16656, 16533
Floor 17	16579, 16545, 16516, 16740, 16718, 16591, 16645, 16517, 16668, 16592, 16546, 16640, 16644
Floor 16	16749, 16623, 16518, 16716, 16666, 16542, 16555, 16704, 16687, 16746, 16590, 16698, 16733
Flat 2 – Floor 16	16719, 16622, 16562, 16715, 16678
Flat 5 – Floor 16	16593, 16683, 16621, 16688, 16553, 16557, 16627
Floor 15	16664, 16616, 16598
Flat 5 – Floor 15	16566, 16643, 16681, 16548
Floor 14	16684, 16692, 16580, 16610, 16594, 16696, 16556, 16658, 16625, 16691
Flat 5 – Floor 14	16592, 16589, 16717, 16585, 16615, 16702, 16604, 16520, 16673, 16538
Floor 13	16714, 16676, 16560, 16748, 16750, 16662, 16737, 16607, 16539, 16665, 16697
Flat 5 – Floor 13	16550, 16564, 16554, 16667, 16629, 16693, 16730
Floor 12	16731, 16654, 16606, 16612, 16532, 16712, 16634, 16617, 16569, 16713, 16659, 16671, 16655,
Floor 11	16531, 16747, 16559, 16706, 16578, 16745, 16689, 16527, 16561, 16568, 16522, 16547
Floor 10	16624, 16638, 16576, 16525, 16679, 16735, 16725, 16636, 16675, 16526, 16536, 16720
Floor 9	16571, 16661, 16722, 16630, 16669, 16701, 16647, 16741, 16523, 16709, 16672, 16743, 16677, 16705
Floor 8	16663, 16577, 16685, 16628, 16734, 16620, 16543, 16632, 16605, 16618, 16658, 16650
Floor 7	16723, 16619
Floor 6	16682, 16726, 16613, 16700, 16584, 16540, 16586, 16563, 16744, 16635, 16670
Floor 5	16599, 16751, 16736, 16588, 16648, 16695, 16653, 16534, 16535, 16651, 16742
Floor 4	16524, 16597, 16521, 16596, 16587, 16631, 16721, 16574, 16581, 16530, 16614
Floor 2	16637, 16738
Floor 1	16732, 16703, 16565, 16739
Ground Floor	16601, 16707, 16602, 16537, 16660, 16611, 16573, 16582

**Table 1 – Schedule of Photographs taken on 30<sup>th</sup> May 2018 by Location and Relativity Reference Numbers**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

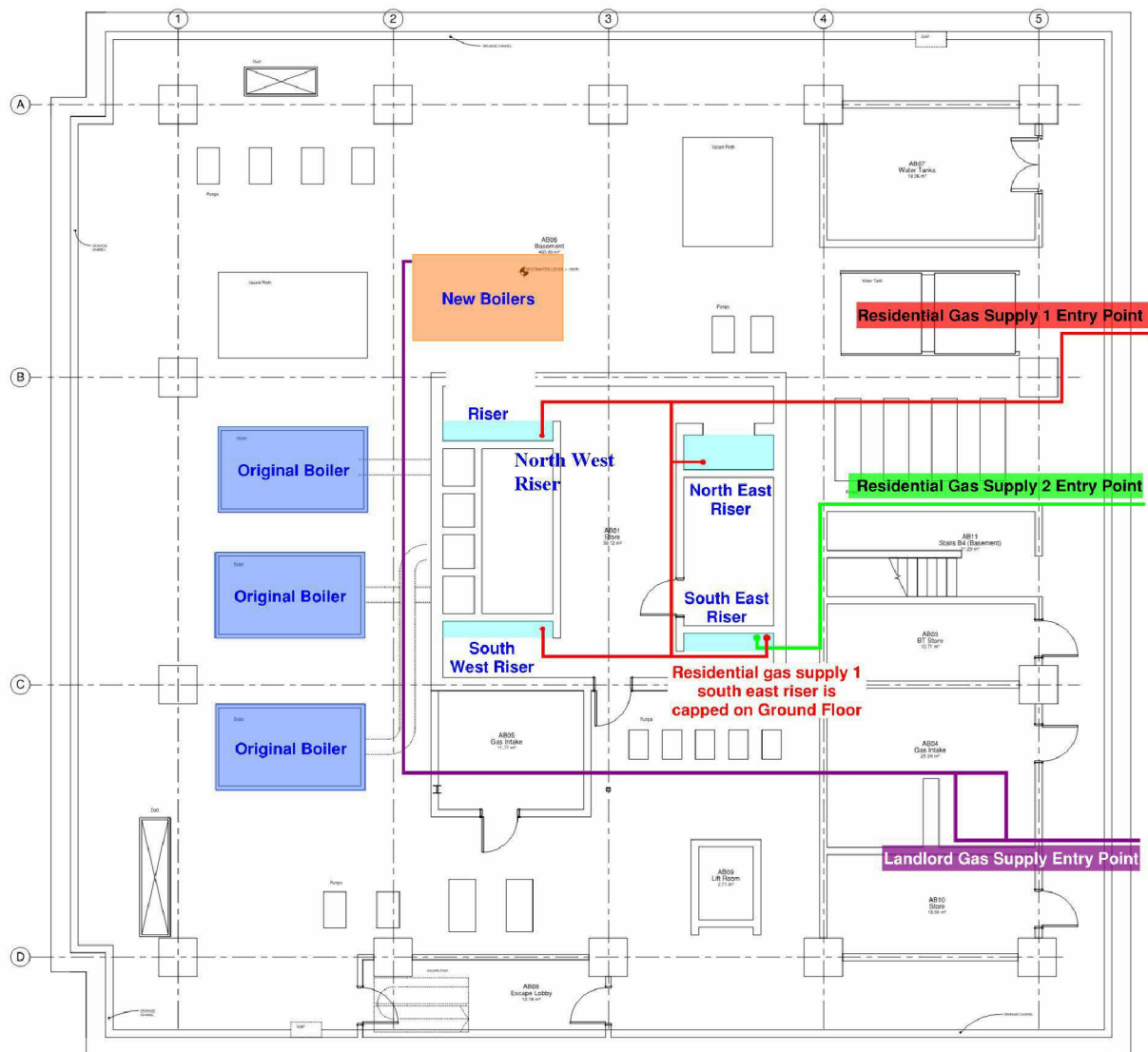
25. Steve Mason of Cadent Gas Ltd., states in his witness statement {CAD000000004} that the Tower originally had two supplies of gas. The first, a 10” steel service, supplied a communal heating and hot water system in the basement of the tower block. The second, a 4” steel “service”, supplied gas for cooking in residential flats on the 4th to the 23rd floors. The “service” supplied 6 risers (vertical gas pipes) in all. These gas risers were installed when the Tower was built. Cadent Gas Ltd has not been able to find records relating to their installation and so they are unable to state precisely when those supplies were installed and commissioned. (See Figure 4 below for a plan of the gas pipes in the basement.)
26. Steve Mason goes on to say in his witness statement that the gas risers in the Tower were subject to periodic inspections in line with Cadent’s engineering procedures (principally T/PM/LC/21). The most recent survey had been completed on the 30 September 2016 and the survey report document has since been disclosed to the Inquiry {CAD000000031}. A small gas leak due to corrosion was identified on one of the risers, which in {CAD000000031} was identified as riser 6<sup>1</sup> and as a result this riser was isolated in accordance with Cadent’s procedures. This operation was completed on 1 October 2016.
27. It appears from information contained in {CAD000000031} and {CAD000000020} that initially it was assumed that flats ending in 1 were also affected. This assumption proved to be unfounded.
28. With respect to the 20 flats potentially supplied from riser 6, 13 used a gas supply for cooking.
29. For the purposes of this report and for consistency with Dr Barbara Lane’s report, I will refer to
- a) The 10” service supplying the boilers in the basement as “The Landlord Supply”;

---

<sup>1</sup> For digital record purposes and as recorded on {CAD000000031} Cadent Gas Ltd split the Grenfell Tower risers into 9 segments. The pipe supplying flats ending in a 2 and running from the ground floor to the top floor was designated “riser 6”. The riser “r2” went from the basement to the ground floor and, at the time was understood to split into riser 6 and riser 7 which supplied flats ending in a 1.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

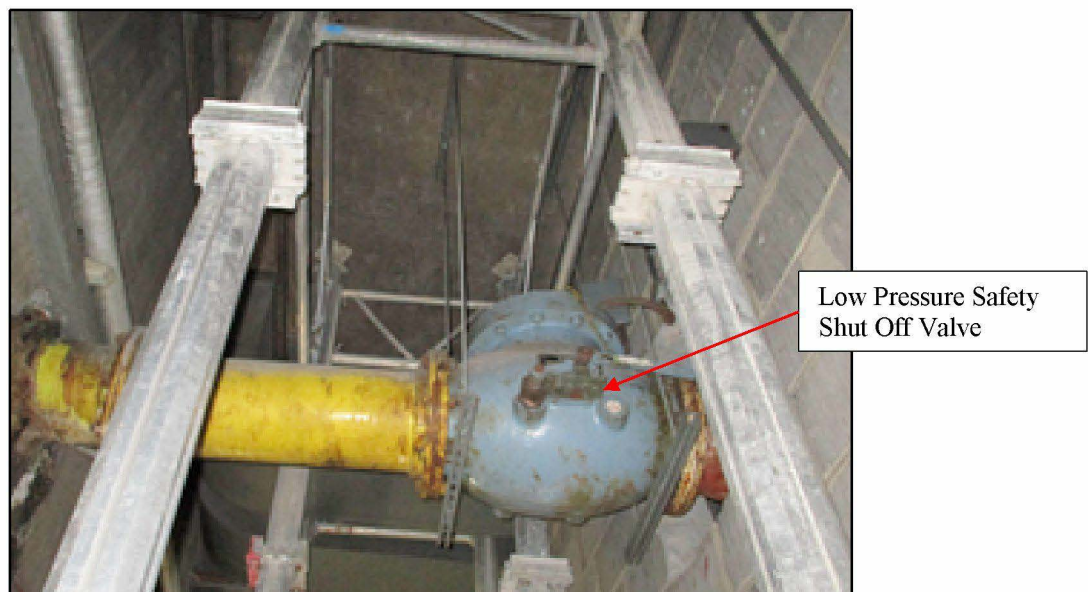
- b) The 4" steel service/network pipeline supplying the 5 original risers to flats with numbers ending in 1, 3, 4, 5 and 6 on the 4th to the 23rd floors as "Residential Supply No.1";
- c) The 90mm PE/3" & 2" steel service/network pipeline supplying the new replacement riser to flats with numbers ending in 2 on the 4th to the 23rd floors as "Residential Supply No.2".



**Fig.4 Gas Services/Network Pipelines at Basement Level  
Serving Grenfell Tower {RYD00000577}**

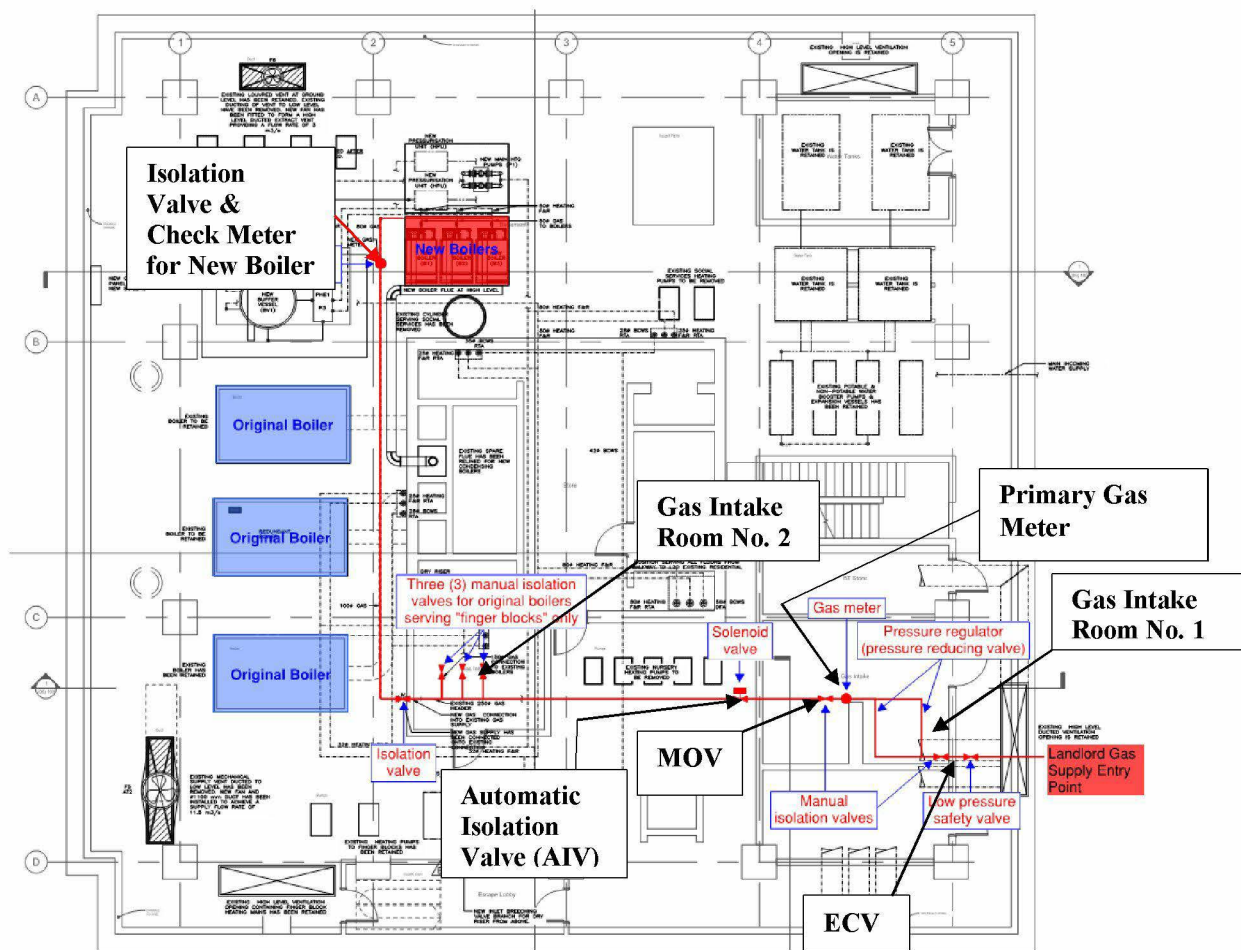
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**The Landlord Gas Supply System**

30. The Landlord Gas Supply System, enters Grenfell Tower through the east elevation of the basement level; see Figures 4, 5 and 6. This gas supply served the new boilers supplying the primary hot water circulation system within Grenfell Tower, as well as the existing boilers, which I am given to understand had been retained to serve the “finger blocks” only – Testerton, Hurstway, and Barandon Walks and which are 3 and 4 storey linear residential blocks southwest of Grenfell Tower {RYD00000577} {CCL00000028}.



**Fig. 5 – Landlord Supply Service Entry with Low Pressure Safety Valve at High Level**

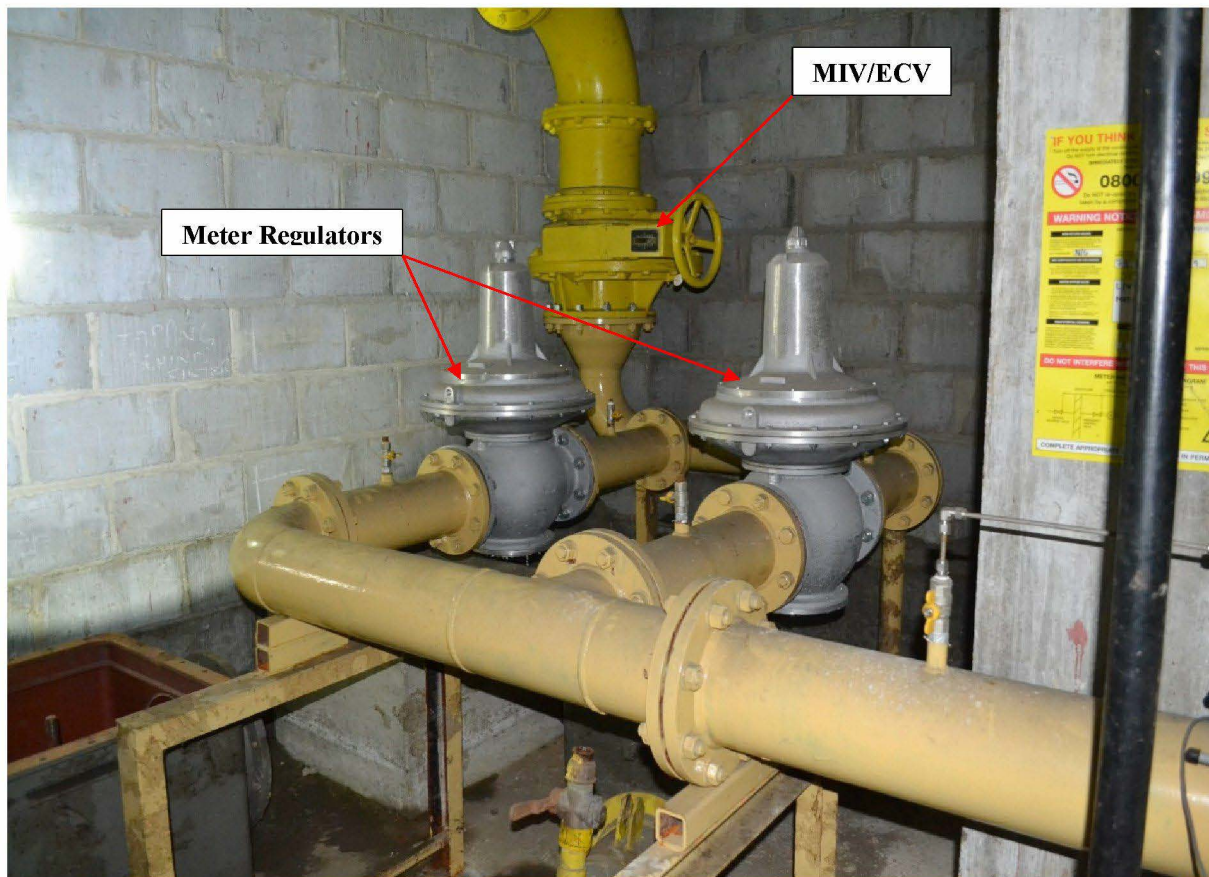




**Fig.6 – Landlord System in Basement**

31. The gas service and the boilers it supplies are contained within the basement only. {RYD00000577} shows the primary landlord system components.
32. Cadent Gas Ltd's incoming gas service 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 5.
33. 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 7 and which I regard as the Landlord's Emergency Control Valve (ECV). At this point ownership of the installation passes from Cadent Gas Ltd, the Gas Transporter, to the Meter Asset Manager Energy Assets Ltd.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 7 – Meter Inlet Valve (MIV)/Emergency Control Valve (ECV) & Meter Regulators**

34. The meter installation comprises two pressure regulators which are installed in parallel before returning to a single pipe to enter the rotary gas meter; see Figures 7 and 8. Another isolation valve, the Meter Outlet Valve, is installed after the meter, see Figure 9.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 8 – Inlet to Rotary Gas Meter {CAD00002995}**



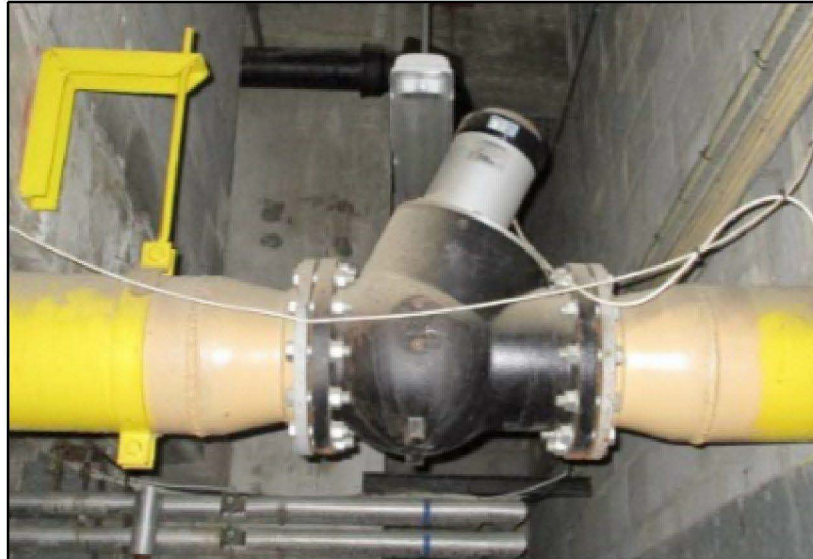
**Fig. 9 – Rotary Gas Meter and Meter Outlet Valve**

35. The pipework exiting the Meter Outlet Valve and running to the boilers is installation pipework and it is the responsibility of the Landlord.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

36. The pipe work leaves the gas meter room via the west wall to the main basement area. At this point, an Automatic Isolation Valve (AIV) has been installed that can be used for automatic gas shut off to the landlord system, see Figure 10.



**Fig. 10 – Automatic Isolation Valve (AIV)**

37. I note from paragraph 49 of the position statement made to the Inquiry on behalf of J S Wright & Co Ltd {JSW00001883} that the operation of the Automatic Opening Vent System (AOV) in smoke control mode is described, as follows:

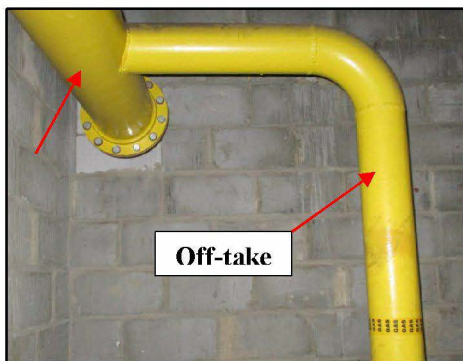
- a) *The fans begin to operate; and*
- b) *Simultaneously, all dampers close or remain closed (depending on their position while the system was operating in environmental mode) and the dampers on the floor where smoke had been detected open. In smoke control mode, the AOV system is intended to only have dampers open on the floor where smoke has been detected; and*
- c) ***The entire gas supply to the building is cut off by the signal from the Building Management System panel which in turn drops the existing gas solenoid valve<sup>2</sup> to the site; and***
- d) *An automated emergency message is sent to the off site remote monitoring company, Tunstall, to inform them of the presence of fire at Grenfell*

<sup>2</sup> See the annotation of Automatic Isolation Valve (AIV) in Figure 6. See also Figure 10.  
01/10/2019

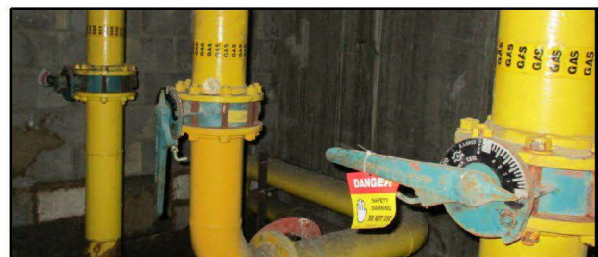
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*Tower. Tunstall would then contact the appropriate emergency services.*

38. From paragraphs 52 -56 of the position statement and the associated exhibits, {JSW00001884}, it is clear that J S Wright & Co. Ltd was only engaged to undertake works on the “Landlord’s Gas Supply System”.
39. The statement that the “entire gas supply to the building is cut off” is factually incorrect. For the avoidance of doubt, it is only the gas supply to the boilers which is cut off when the AIV is operated.
40. The pipe work then enters a room where there is a header installed with 4 no. off-takes, 3 no. of which go to feed the existing boilers (2 of which have been observed to be isolated), as shown in Fig11 and Fig 12. The 4<sup>th</sup> off-take is the gas supply to the new boilers, see Figure 13. A manual isolation valve for the gas pipe work to the new boilers is shown in Fig. as it exits the room. Another isolation valve is provided immediately before the check meter to the new boilers, see Figure 15.



**Fig11: Distribution header and an off-take in gas intake room 2**



**Fig 12: Three (3) original off-takes from the gas main header in gas intake room 2 to the existing boilers**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 13 – Off-take for the new boiler gas supply**



**Fig. 14: Manual isolation valve for the gas pipework<sup>3</sup> serving the new boilers, as it exits gas intake room 2**

<sup>3</sup> Note the use of press fit jointed stainless steel pipe, which is permissible for use at pressures less than 100 mbar as per IGEM/UP/2 Edition 3 – Installation Pipework on Industrial and Commercial Premises.  
01/10/2019



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

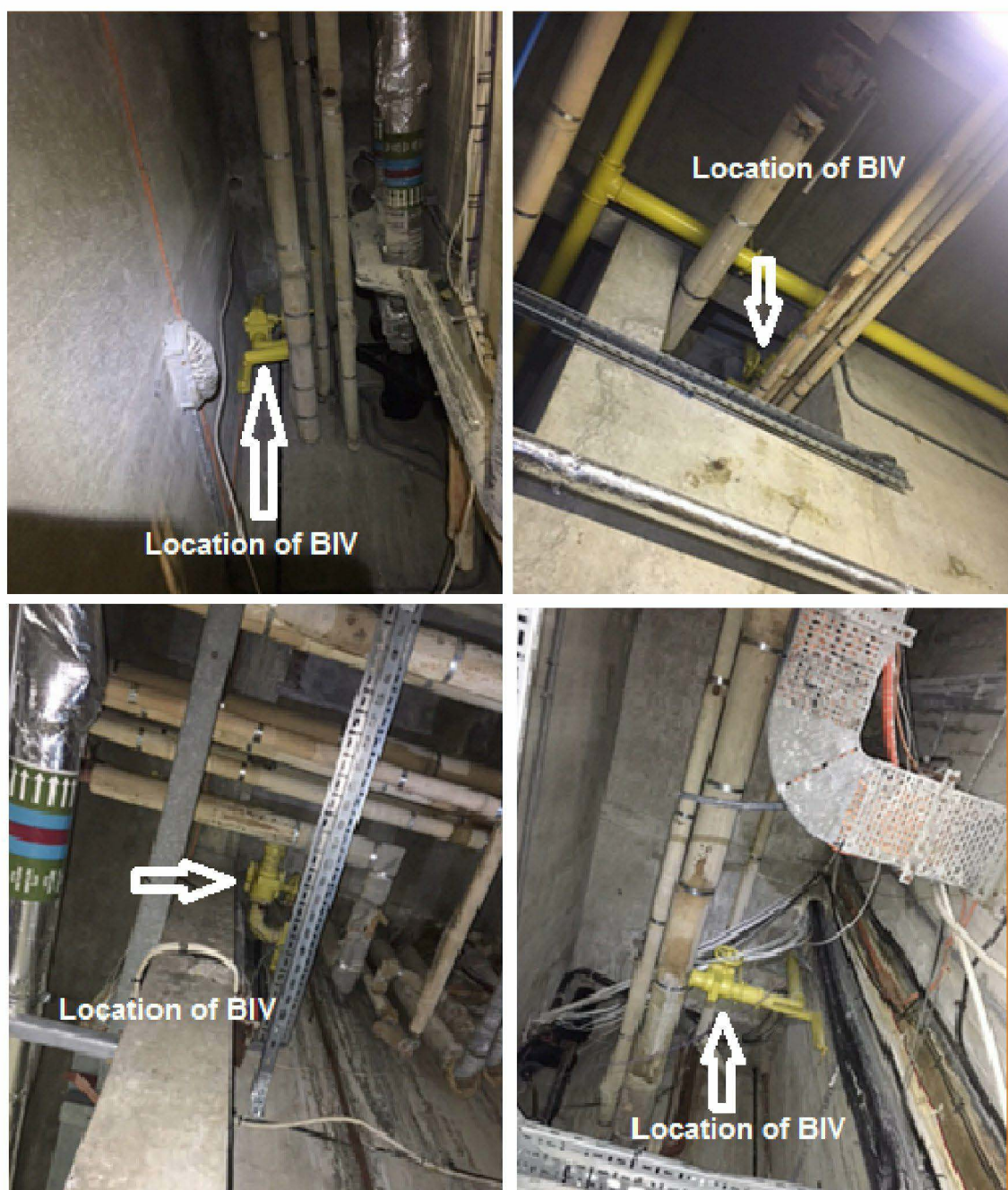


**Fig. 15 – Check Meter & Isolation Valve for New Boiler**

#### **“Residential Gas Supply No.1”**

41. Originally, a single 4” screwed steel 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.
42. The route of Residential Gas Supply No.1 has been traced to the central core, where it splits into 4 vertical risers, shown as northeast, northwest, southeast, and southwest risers in Figure 4. Riser or Branch Isolation Valves (BIV) were identified at the base of each of the (4) four risers. However, these valves were at a high level in the basement and in the absence of a fixed ladder or similar to each of them were therefore not readily accessible for use in an emergency.
43. Cadent Gas Ltd’s survey report of 30<sup>th</sup> September 2016 {CAD00000031} includes photographs of each of the 4 Branch Isolation Valves. James Harrison attached better quality photographs as Exhibit JAH13 to his witness statement to the Inquiry {CAD00002993} and {CAD00002985} respectively). The photographs from {CAD00002993} are as follows:

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Figures 16: BIVs at High Level {CAD00002993}**

44. Initially and as recorded in {CAD00000031} and {CAD00000020}, it was understood that between the basement and the ground floor, the south east riser (riser 2 in {CAD00000031}) split into two. One riser then supplied gas to flats on the 4<sup>th</sup> to the 23<sup>rd</sup> floor with numbers ending in 1 (riser 7 in {CAD00000031}) and the other riser supplied gas to flats on the 4<sup>th</sup> to the 23<sup>rd</sup> floor with numbers ending in 2 (riser 6 in {CAD00000031}). The original riser 6 serving flats ending in the number 2 in the



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

south east of the building was observed to have been isolated and capped on the ground floor; see Figure 17.



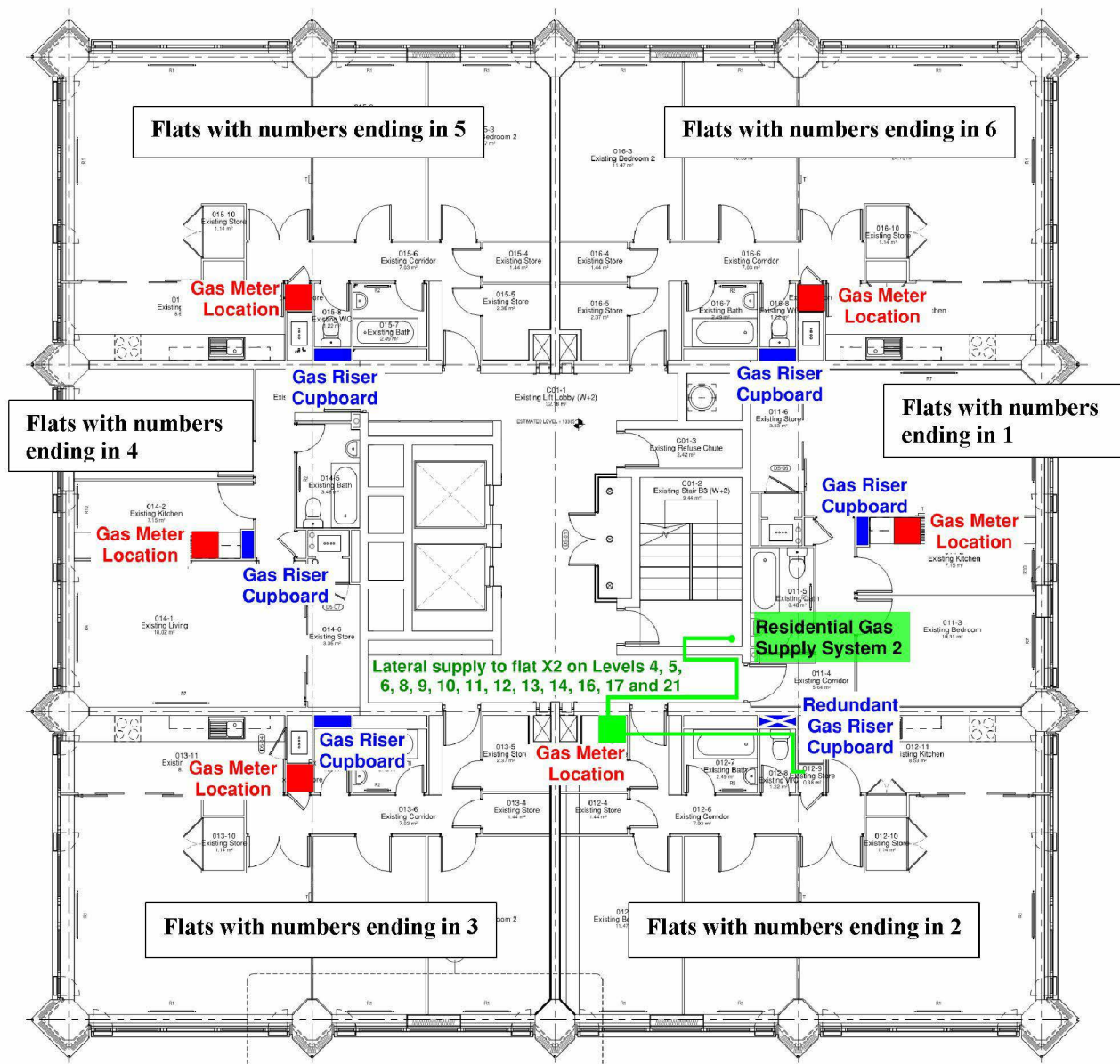
**Fig. 17 - : Capped riser pipe at low level on the Ground Floor**

45. Dr Lane's team were unable to trace the exact route of the gas pipes between the 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 their site inspections. I encountered similar restrictions when I visited site on 28<sup>th</sup> February 2018.
46. CORGI Technical Services Ltd were engaged by the Metropolitan Police Services (MPS) to investigate the gas infrastructure at Grenfell Tower and to present a report on their findings. The witness statement of Kevin Winship, Technical Safety Manager, {MET00016757}, Revised Summary Report {MET00016759} and Examination Logs including {MET00016760}, {MET00016762}, {MET00016763} and {MET00016771} have been made available to the Inquiry. From the examination logs it can be seen that they were able to establish the following:
- The 3 inch diameter North East Riser rose to Flat 11 on the 4<sup>th</sup> floor where it split into 2 x 2" risers supplying gas to flats ending in 1 and 6 all the way up to the 23<sup>rd</sup> floor;
  - The 3 inch diameter South West Riser rose to Flat 14 on the 4<sup>th</sup> floor where it split into 2 x 2" risers supplying gas to flats ending in 3 and 4 all the way up to the 23<sup>rd</sup> floor;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- The 2 inch diameter North West Riser rose all the way up to the 23<sup>rd</sup> floor supplying gas to flats ending in 5 from the 4<sup>th</sup> floor upwards;
  - The 2 inch diameter South East Riser originally rose all the way up to the 23<sup>rd</sup> floor supplying gas to flats ending in 2 from the 4<sup>th</sup> floor upwards. It was seen to have been capped at the ground floor;
  - From the 4<sup>th</sup> floor upwards each of the original gas risers were of 2 inch diameter up to the bottom of floor 14 at which point the diameter of the each of the risers reduced to 1½ inch diameter. The 1½ inch diameter risers then rose to the bottom of the 21<sup>st</sup> floor at which point they reduced to 1 inch diameter to supply gas to the 21<sup>st</sup>, 22<sup>nd</sup> and 23<sup>rd</sup> floors.
47. I note that James Harrison in his witness statement {CAD00002985} states in relation to the Branch Isolation Valves that “*One of these BIV had already been isolated on the 30<sup>th</sup> September 2016..*”. To my mind this statement indicates that Cadent Gas Ltd accept that the flats ending in the number 1 were not supplied from the South East Riser as originally implied by the September 2016 survey report {CAD00000031}.
48. The location of the original gas riser and gas meter in each flat on floors 4 – 23 as observed during site inspections are shown in Figure 18 below.

Report of: **Rodney Hancox**  
Specialist Field: **Gas Engineering**  
Prepared for: **Grenfell Tower Inquiry**



**Fig 18 - Tenant gas systems. Levels 4 to 23 typical layout of the gas system serving the residential flats**

49. The flat '2' gas riser cupboard is redundant due to the capped riser on the ground floor (see Figure 17). Therefore, on 14 June 2017, residential gas supply 1 only served flats ending in numbers '1', '3', '4', '5', and '6' on levels 4 – 23.
50. Figure 19 shows a typical gas meter installation within these flats, which includes a meter inlet valve upstream of the meter. It performs the role of emergency control valve (ECV). This ECV is intended to be used by the consumer to isolate the gas supply entering their dwelling in the event of an emergency.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

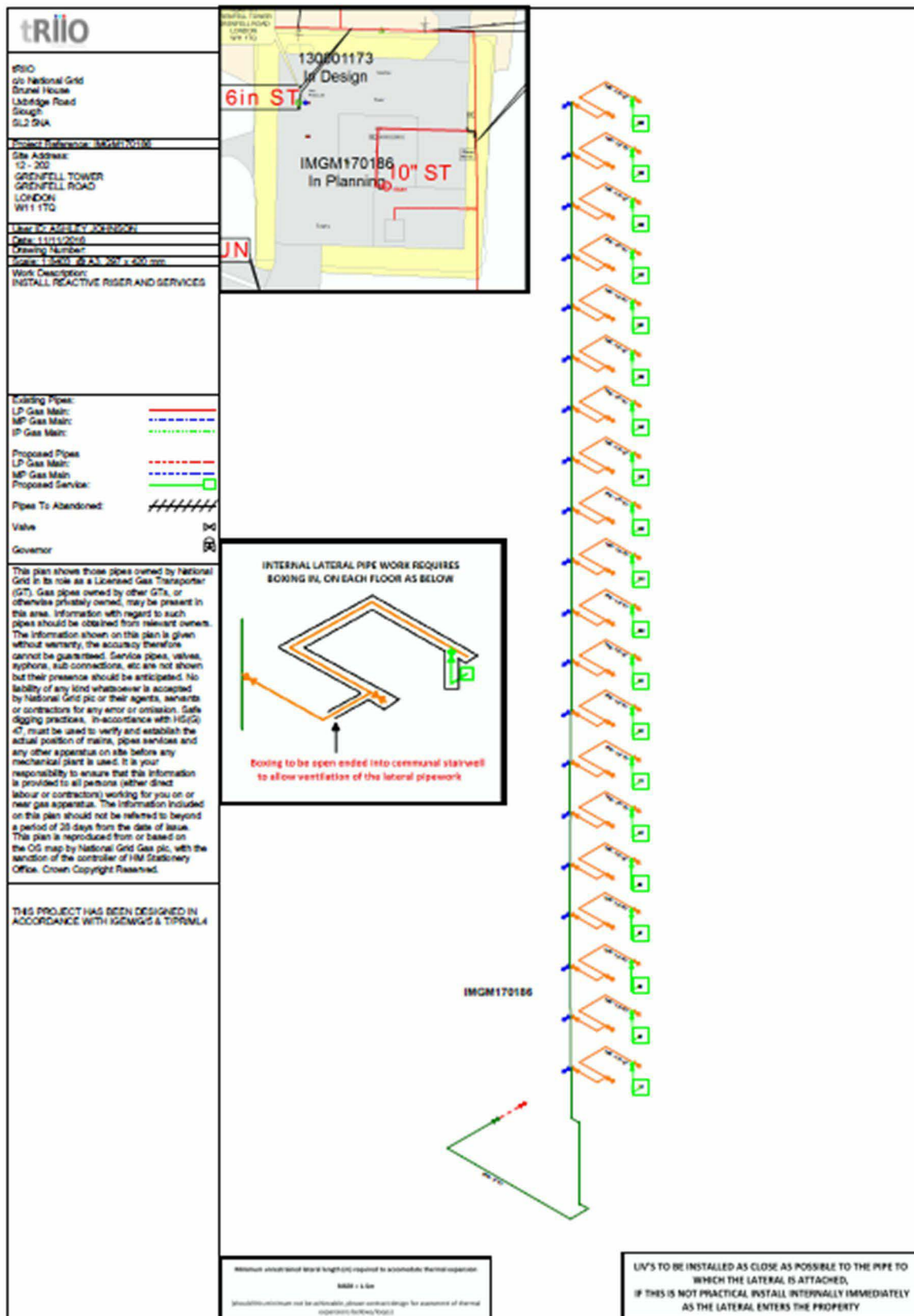


**Fig. 19 – Typical Gas Meter Installation served by Residential Supply No.1**

**“Residential Gas Supply No.2”**

51. Following an inspection by Cadent on the 30<sup>th</sup> September 16 {CAD00000031}, gas leaks were identified in flats 22 and 32. This riser was decommissioned and a replacement riser, referenced in this report as Residential Gas Supply No.2, has been installed to serve those flats ending with the number 2.
52. I understand from Stephen Mason’s witness statement {CAD00000004} that the initial design was drawn up by tRIIO Design Team in November 2016. The replacement riser (Residential Gas Supply No.2) was to be located in the stairwell and laterals were to be installed in the communal lift lobbies to supply gas to the flats. This is shown diagrammatically in the following drawing, Figure 20 – {TRI000000263}. This drawing is reproduced at A3 size as Appendix 3 to this report.

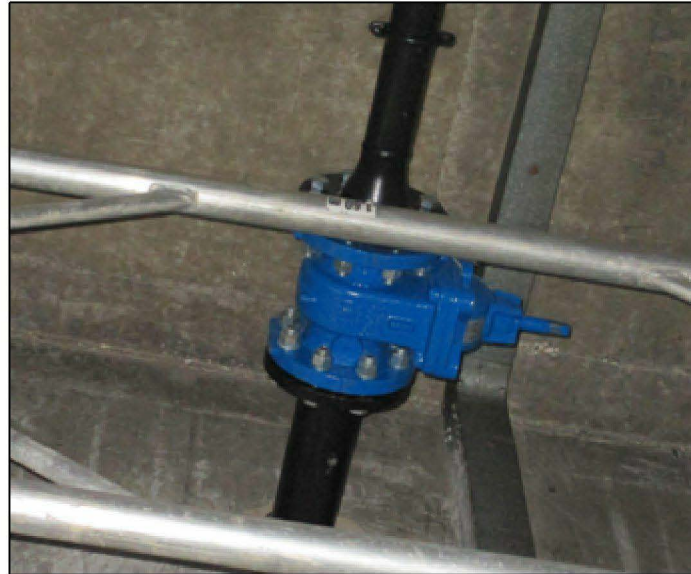
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 20 – Initial Design Drawing of Replacement Riser {TRI000000263}**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

53. The replacement riser, Residential Gas Supply No. 2 enters the basement on the east elevation of the building in 4" steel at a high level, reducing to 3" steel as shown in Figure 21. An inlet isolation valve (IIV) is provided at this location (blue valve shown in Figure 21). It is noted that this valve is at a high level in the basement.



**Fig. 21 – IIV of Residential Gas Supply 2**

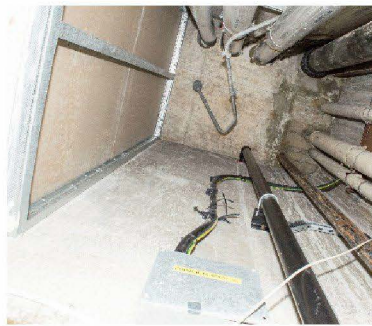
54. This gas pipe has been traced to the southeast riser duct in the central core in the basement, as shown in Figure 4. It runs vertically from the basement level to Level 2 through the southeast utilities shaft, which, by any stretch of the imagination, is not ventilated in accordance with Section 12 of BS 8313.
55. For the southeast utilities shaft to have complied with paragraph 8.41 of Approved Document B2 of the Building Regulations and hence Section 12 of BS 8313, there would have had to have been ventilation openings at high and low level leading to a safe space, preferably to outside air. In addition, the minimum free ventilation area of each opening would have been  $0.05 \text{ m}^2$  ( $500 \text{ cm}^2$  or  $50,000 \text{ mm}^2$ ). No such ventilation openings were in evidence.



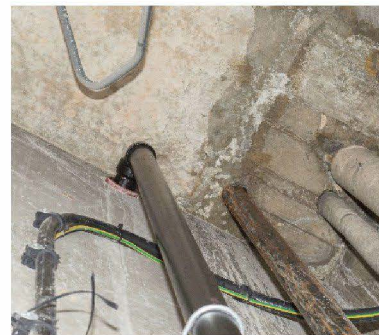
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**{MET00016602} – Riser entering utilities shaft at ground floor.**



**{MET00016573} – Riser going up utilities shaft**



**{MET00016582} – Riser exiting utilities shaft at 2<sup>nd</sup> floor**

**Fig. 22 Riser in Utilities Shaft**

56. On Level 2, the gas pipe leaves the southeast riser duct, enters the windowless storeroom adjacent to the Community Meeting Room and then turns and enters the protected stairway (see Figure 20).

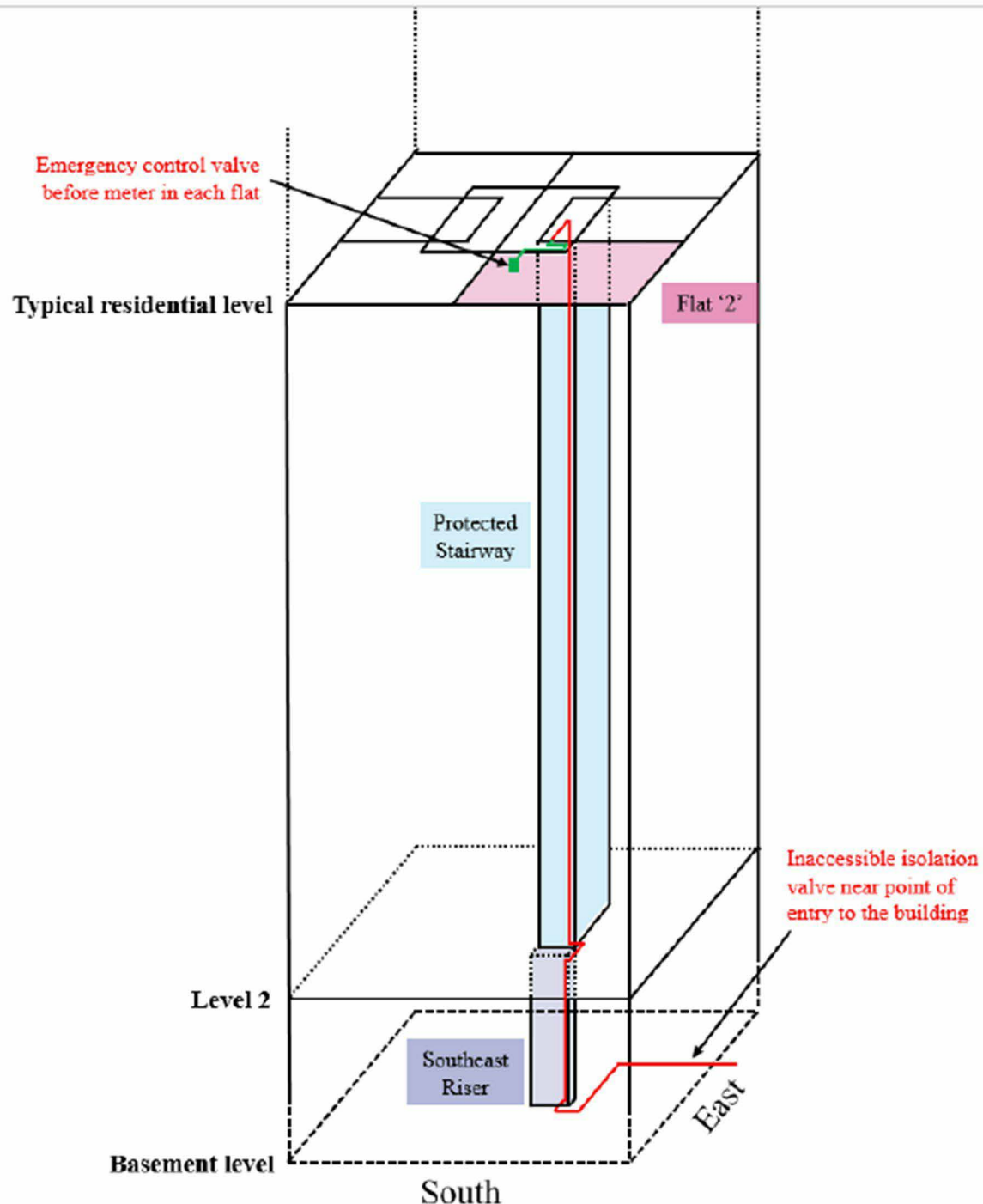


**Fig. 23 - Residential gas supply system 2 gas piping in storeroom adjacent to the Community Meeting Room (Level 2) and below Protected Stairway {MET00016703}**

57. This gas supply system is then routed through the protected stairway to Level 23, as shown in Figure 20. See also Figure 24 below.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

58. In order to assist the reader in following paragraphs 53 – 57 above, I have reproduced Figure K20 from Dr Barbara Lane's report below:



**Fig. 24 – Figure K20 from from Dr Barbara Lane's Report**

59. 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 25 below.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 25 – Lateral in Lobby prior to boxing in {TRI000001431}**

60. As not all flats ending with the number 2 used gas. As at 14<sup>th</sup> June 2016 laterals were only installed on the 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup> and 21<sup>st</sup> floors. On those floors where laterals were not installed, the Branch Isolation Valve in the stairwell was plugged off.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Configuration of pipework in stairwell where lateral installed to supply gas to flat “2”  
{CAD00001896}**

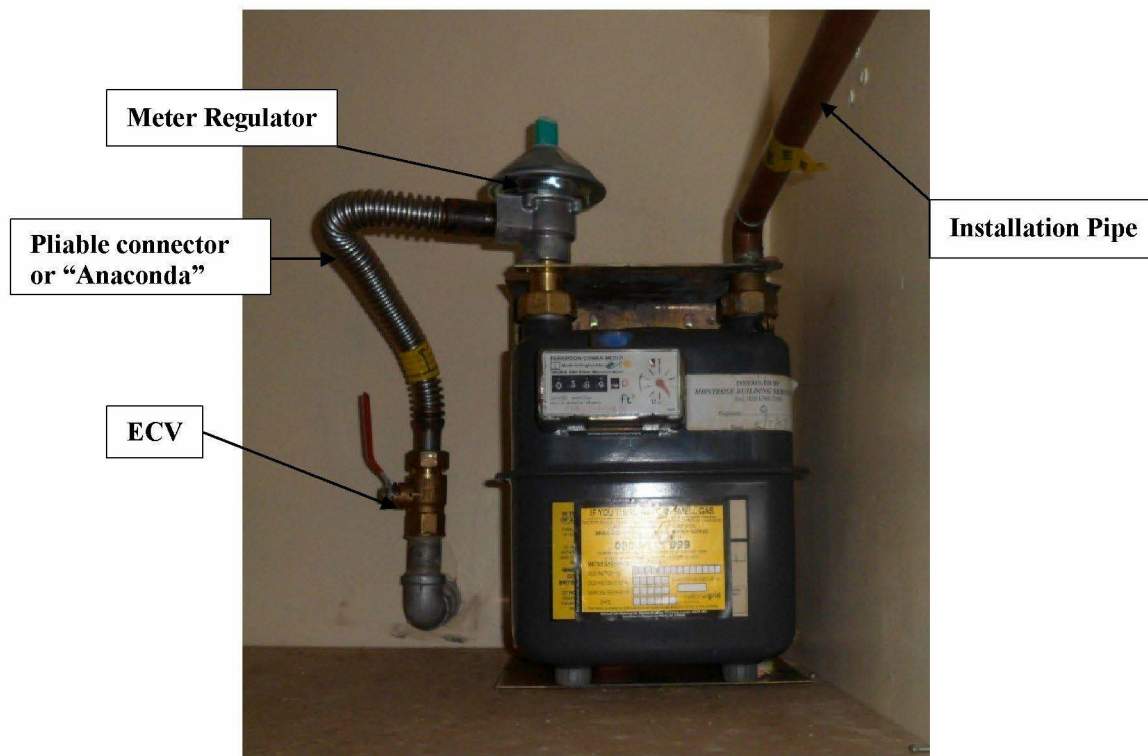


**Configuration of pipework in stairwell where flat “2” did not require a new gas supply.  
{TRI000001462}**

**Figure 26 – Configuration of pipework in stairwell**

61. The gas meters within flats ending with the number “2” were repositioned immediately on the inside of the lobby wall in a cupboard adjacent to the sole means of escape from the flat. Copper installation pipe was then run to the old meter position and connected to the flat’s existing installation pipework. See Figure 27.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 27 – Typical Repositioned Gas Meter Installation**

62. The design was subsequently updated in March 2017 to include ducting (boxing-in) of the riser in the stairwell. See paragraphs 327 – 448 below for a detailed review of the initial and revised designs. Boxing in of the pipework in the lobbies and the stairwell was still in progress on June 14<sup>th</sup> 2017.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

**Instruction No.1 - 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.**

63. Please see Appendix 2 for a list of the legislation, regulations, standards and guidance I have referenced in this report.

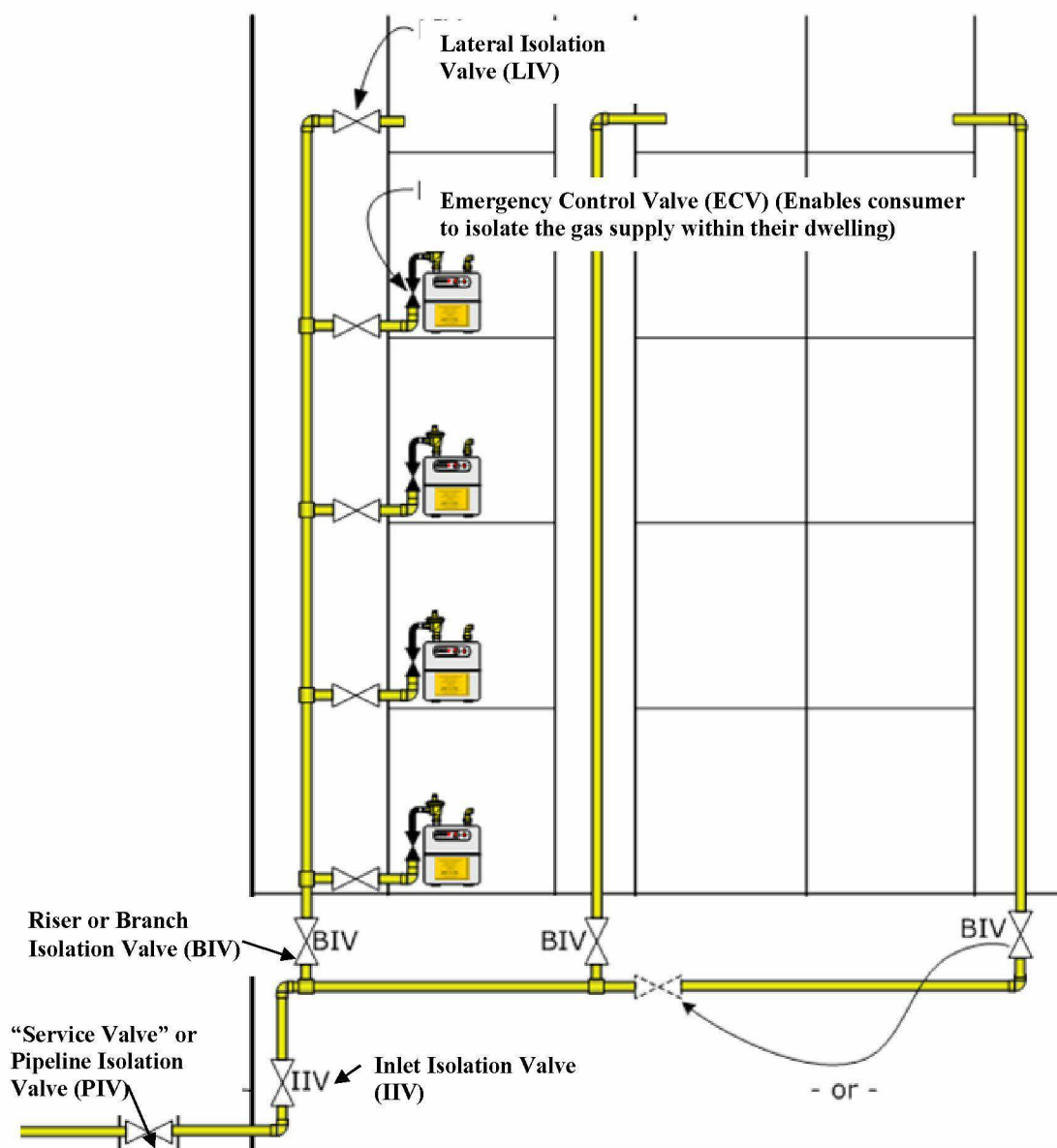
### **A. Regulatory Position during 1972 - 1974**

64. I understand from a chronological account provided to the Inquiry by the Royal Borough of Kensington and Chelsea (RBKC) that the building is said to have been designed in 1967, and that construction took place between 1972 and 1974. I also understand that the Inquiry does not have any information concerning the date of the installation of the original gas infrastructure into and through the building in this three year time frame.
65. From the legislative point of view the date of 1<sup>st</sup> December 1972 is important as it was on that date that the Gas Safety Regulations 1972 (SI 1972/1178) came into force. These regulations, which were very prescriptive, were made by the Secretary of State for Trade and Industry under Section 67 of the Gas Act 1948. They applied throughout the United Kingdom and except for the Inner London Boroughs were wholly new. In the Inner London Boroughs, such as the Royal Borough of Kensington and Chelsea (RBKC), they took the place of certain provisions of the London Gas Undertakings Regulations 1954 which had been made under the London Gas Undertakings Act 1939.
66. A copy of the London Gas Undertakings Regulations 1954 has been located at the National Archives (POWE 29/643). They were very prescriptive. Regulation 3 specified amongst other things, that where a service was of an internal diameter of 2 inches or more, a service valve complying with a detailed specification in Appendix A of the Regulations shall be installed in a position outside but as near as practicable to the boundary of the property.
67. The Gas Safety Regulations 1972 contained 53 regulations in total. They covered the following topics:

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Citation, interpretation including definitions (Regulations 1 – 2);
  - Installation of service pipes (Regulations 3 – 16);
  - Installation of meters (Regulations 17 – 33);
  - Installation of installation pipes (Regulations 34 – 43);
  - Installation of gas appliances (Regulations 44 – 46);
  - Use of Gas (Regulations 47 – 48);
  - Removal, disconnection, alteration, replacement, and maintenance of gas fittings etc (Regulations 49 -52);
  - Penalties (Regulation 53).
68. For buildings such as Grenfell Tower, Regulation 5 of the Gas Safety Regulations 1972 required a “service valve” to be installed in a readily accessible position as near as practicable to the boundary of the premises. A “service valve” is defined in Regulation 2(1) as being a valve inserted in the service pipe outside of the building for shutting off the supply of gas.
69. Regulation 52 of the Gas Safety Regulations 1972 placed the responsibility for keeping all service valves in proper working order on to the Area Gas Board i.e. North Thames Gas Board, which later became North Thames Region of the British Gas Corporation.

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Fig. 28 – Diagrammatic Representation of Valves in Multi-occupancy Buildings**

70. The Gas Safety Regulations 1972 also required a “meter control valve”, which is now termed an Emergency Control Valve (ECV), to be fitted at the end of the service as near as practicable to the gas meter. No other valve between the service valve and meter control valve was mentioned in the regulations.
71. The Gas Safety Regulations 1972 were prescriptive. The following regulations are of particular relevance to the installation of the original gas infrastructure serving the flats in Grenfell Tower and they are discussed in response to Instruction No. 4 below. Those regulations are:

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*Regulation 7(2) – Where a service pipe is installed so as to pass through any wall or is installed so as to pass through any floor of solid construction –*

- a) The service pipe shall be enclosed in a sleeve and*
- b) The service pipe and sleeve shall be so constructed and installed as to prevent gas passing along the spaces between the pipe and the sleeve and the sleeve and the wall or floor and so as to allow normal movement of the pipe.*

*Regulation 7(3) – No service pipe shall be installed in an unventilated void space.*

*Regulation 8 – All service pipes installed shall be constructed of material which is inherently resistant to corrosion or shall be protected against corrosion externally and, unless there is no risk of internal corrosion, internally.*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **B. Standards & Recommendations Position 1972 - 1974**

72. Notwithstanding that the relevant legislation discussed above was very prescriptive and not goal setting, there were a number of British Standards and Recommendations of the Institution of Gas Engineers published at the time in support of compliance with legislation.
73. In January 1962 the Institution of Gas Engineers, the forerunner of IGE, published its second printing of Communication 563 – Recommendations for the laying of steel gas service pipes. This document was supplementary to B.S. Code of Practice 331.101 (Gas Service Pipes). The version of B.S. Code of Practice 331.101 (Gas Service Pipes) which was current in 1972 had been published in 1957. It was intended that Communication 563 would give more detailed information on the practical aspects of B.S. Code of Practice 331.101 (Gas Service Pipes).
74. One recommendation contained within Communication 563 was that any service pipe of 2" diameter or more should contain a service valve outside of the building located as near as practicable to the boundary of the property. In addition, it should be fitted with a surface box and cover; see Figure 28 above.
75. A second recommendation was that
- “Facilities should be provided for the disconnection of each branch pipe at a position adjacent to the rising service pipe, such position to be readily accessible to the Gas Undertaking’s personnel.”*
- In current terminology this recommendation was calling for the installation of Branch Isolation Valves (BIV); see Figure 28 above.
76. Communication 563 was updated in 1973 and the updated document became the first edition of IGE/TD/4. Section 6.5 of IGE/TD/4 Edition 1 addresses the installation of service valves. It stated that a service valve should be fitted where one or more of a number of conditions were met. The conditions included the following, which applied to Grenfell Tower:
- a) Service diameter of 2" or more
  - b) Common service supplying two or more primary meters.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

In addition, section 7 addresses multi-occupancy buildings. Paragraph 7.1.3.5 states that a service valve should be fitted in the service pipe and paragraph 7.2.3 states that a valve should be fitted in an accessible position on every lateral. In current terminology this later requirement was calling for the installation of Lateral Isolation Valves (LIV); see Figure 28 above.

77. The British Standard Code of Practice 331.101 (Gas Service Pipes) specifies that where the service is of 2" diameter or greater or where there are special circumstances e.g. block of flats, a service valve should be fixed in the service pipe outside, but as near as practicable to, the property boundary and should be fitted with a surface box and cover.
78. Additionally, British Standard. Code of Practice 331.101 states that in blocks of flats facilities should be provided for the disconnection of the branch to each installation at a position adjacent to the junction of the branch i.e. a LIV should be fitted (see Figure 28 above).
79. From the above it can be seen that irrespective of whether the gas infrastructure supplying the flats in Grenfell Tower was installed prior to, on or after 1<sup>st</sup> December 1972, accessible service valves were required to be installed in the original services outside of the building as near as practical to the boundary of the premises and kept in proper working order, both from a legislative and standards point of view.
80. From a standards perspective depending on when the gas infrastructure was installed, either accessible BIVs or LIVs should have been installed.
81. There is no mention either in the regulations or standards applicable at the time for the valve which is now termed the IIV. Hence there was no requirement for an IIV to be installed.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

### **C. Regulatory Position as at 2016**

82. The current legislative, regulatory and standards position or framework relating to the gas industry as a whole, and which was also applicable in 2016, is very different from that which was in place during the period 1972 – 1974. Following the passing of the Health and Safety at Work Act in 1974 there has been far more health and safety legislation and associated guidance which has to be followed. The break-up of British Gas and the introduction of competition into the distribution, metering and supply of natural gas has also generated a whole new regulatory and standards regime. The United Kingdom's involvement in the development of European and International standards has also been a contributory factor to the changed regulatory and standards position.
83. I understand the legislative, regulatory and standards hierarchy of gas engineering requirements is as follows:
- a) Primary Legislation, such as
    - Gas Act
    - Health and Safety at Work Act
    - Civil Contingencies Act
  - b) Secondary Legislation, such as
    - Pipelines Safety Regulations
    - Gas Safety (Installation and Use) Regulations
    - Gas Safety (Management) Regulations
    - Construction (Design and Management) Regulations
    - Dangerous Substances and Explosive Atmospheres Regulations
    - Management of Health and Safety at Work Regulations
  - c) Approved Codes of Practice, such as

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- HSE Series such as HS(L)56, HS(L)80, HS(L)81, HS(L)138 and HS(L)153
  - Building Regulations Approved Documents
- d) British (BS) and Gas Industry Technical Standards (GIS), such as
- British Standards such as BS 6400 – 1: Specification for installation etc. of gas meters with maximum capacity  $\leq 6\text{m}^3/\text{hr}$  – Low Pressure
  - Institution of Gas Engineers and Managers (IGEM) such as IGEM/G/5 – Gas in Multi-occupancy Buildings;
  - GIS material standards such as GIS/V7 Part 3 - Technical Specification for Distribution Valves. Part3 - Brass Valves and associated fittings for pressure not exceeding 5bar.
- e) Company Procedures, Work Instructions and specifications.

#### **Primary Legislation, Secondary Legislation & Approved Codes of Practice**

84. The supply and transportation of gas is covered by the Gas Act 1986 as amended subsequently by the Gas Act 1995 and the Utilities Act 2000. For the purposes of this report, all subsequent references to the Gas Act are references to the Gas Act 1986 as amended.
85. Amongst other things, Section 9 of the Gas Act, requires Gas Transporters (GTs), such as Cadent Gas Ltd, to develop and maintain an efficient and economical pipeline system for the conveyance of gas. In addition, paragraph 15 of Schedule 2B<sup>4</sup> – The Gas Code – is entitled “Maintenance etc. of service pipes”. Paragraph 15 (1) reads as follows:

*A gas transporter shall carry out any necessary work of maintenance, repair or renewal of any service pipe by which gas is conveyed by him to a consumer's premises, whether or not the service pipe was supplied and laid at the transporter's expense.*

---

<sup>4</sup> The original Gas Code was updated and designated Schedule 2B as one of the amendments introduced by the 1995 Gas Act.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

86. Before discussing the Regulations in force in 2016, I believe it would be beneficial to outline some of the changes which occurred in the intervening period.
87. In 1984 the first set of Gas Safety (Installation and Use) Regulations were enacted. They addressed pipes, fittings, meters and apparatus designed for use by consumers of gas. A consequential effect was the revoking of the sections of the Gas Safety Regulations 1972 which dealt with meters, installation pipes, gas appliances and the use of gas and amendments to some of the remaining regulations.
88. The Gas Safety (Installation and Use) Regulations 1984 were updated in 1994. The 1994 regulations were replaced by the Gas Safety (Installation and Use) Regulations 1998 which are discussed in detail in paragraphs 105 to 118 below. The 4<sup>th</sup> Edition of the HSE Approved Code of Practice HS(L)56 – Safety in the Installation and Use of Gas Systems and Appliances was the version current in 2016. The regulations have been reproduced in HS(L)56 and a copy of the 4<sup>th</sup> edition has been attached as Appendix 4 of this report.
89. In 1996 the Pipeline Safety Regulations were enacted. They revoked the Gas Safety Regulations 1972, which remained after the introduction of the Gas Safety (Installation and Use) Regulations 1984. The Pipeline Safety Regulations 1996 are far less prescriptive than were the corresponding sections of the Gas Safety Regulations 1972 and they can be described as being in “functional form” or as “goal setting”. In particular, for items such as “Service Valves”/Pipeline Isolation Valves (PIV), sleeves, unventilated voids and corrosion protection, no prescription has been provided.
90. For the purpose of this report, the Pipeline Safety Regulations 1996 apply to the underground gas distribution mains outside of Grenfell Tower and the gas “service pipe” or “riser” from the distribution main into and through the building up to and including the ECVs in the individual flats.
91. Regulations 5, 6, 12, 13 and 16 of the Pipeline Safety Regulations 1996 are as follows:

*Regulation 5 - The operator shall ensure that no fluid is conveyed in a pipeline unless it has been so designed that, so far as is reasonably practicable, it can withstand -*



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- (a) forces arising from its operation;*
- (b) the fluids that may be conveyed in it; and*
- (c) the external forces and the chemical processes to which it may be subjected.*

*Regulation 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.*

*Regulation 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.*

*Regulation 13 - The operator shall ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair.*

*Regulation 16 - For the purpose of ensuring that no damage is caused to a pipeline, the operator shall take such steps to inform persons of its existence and whereabouts as are reasonable.*

## **Valves & Plans**

92. In 1996 the HSE published guidance on the Pipeline Safety Regulations in HS(L)81 – Design, Construction and Installation of Gas Service Pipes ACOP at approximately the same time as the regulations were published. HS(L)81's scope was for gas service pipes operating up to 7 bar gauge. Consequently it only covered Regulations 1 – 17<sup>5</sup>. The guidance in paragraph 13 to Regulation 5 – Design, referred to Institution of Gas Engineers standard IGE/TD/4 Edition 3, which included the requirement for a service

---

<sup>5</sup> Regulations 18 – 27 relate to Major Accident Hazard Pipelines which convey dangerous fluids as defined in Schedule 2 of the Regulations. In Schedule 2 natural gas conveyed at a pressure of less than 8 bar absolute is not designated as a dangerous fluid and hence Regulations 18 – 27 do not apply to Grenfell Tower.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

valve. The guidance in paragraph 24 to Regulation 6 – Safety Systems, refers to the requirement for a “service valve” in “services” for multi-occupancy buildings<sup>6</sup>.

93. Regulation 3(5) defines the term “emergency control” as follows:

*"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;*

94. In HS(L)81’s guidance to Regulation 3 – Meaning of a Pipeline, paragraph 10 states that the term “service valve” means a valve (other than an emergency control) for controlling a supply of gas, being a valve:

- a) incorporated in a service pipe; and
- b) intended for use by a supplier or transporter of gas; and
- c) not situated inside a building.

95. In respect of Regulation 13, which is concerned with maintaining a pipeline in an efficient state etc, Cadent Gas Ltd’s policy in relation to the inspection of valves on its networks is contained in its document T/PM/V17 {CAD00002232}. Paragraph 4.6 of that document states that there is no requirement to maintain Service Isolation Valves, valves within multi-occupancy buildings and Emergency Control Valves.

96. See Figure 28 for a diagram illustrating the location of different valves.

97. In respect of Regulation 16 - prevention of damage to the pipeline, both HS(L)81 and HS(L)82 specify the need for Gas Transporters to keep and maintain plans of their apparatus.

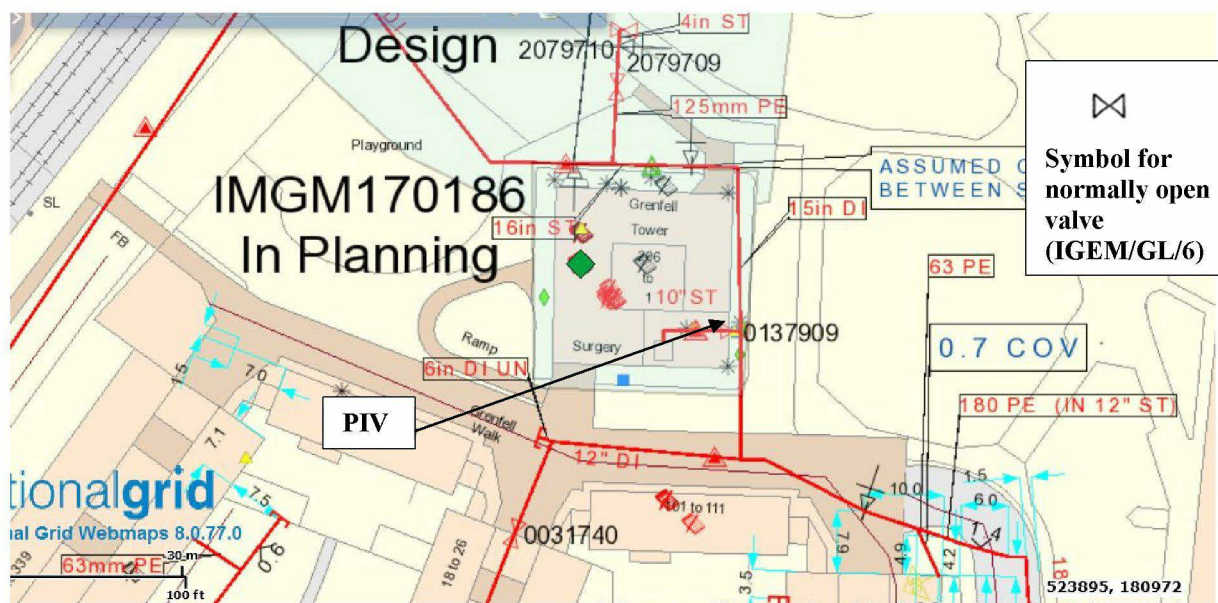
98. For the purposes of this report, I believe the Gas Act and the Pipeline Safety Regulations 1996 require a Gas Transporter, such as Cadent Gas Ltd, to keep Service Valves/Pipeline Isolation Valves (PIV), which are part of the “Service Pipe”, in proper working order and to have accurate graphical records of its services of 2” diameter and above readily available to its emergency personnel and others who need access to them. It has been industry practice for as long as I can remember to record the location of low pressure services of 63mmPE/2” steel diameter or larger and their associated service valves on network plans.

---

<sup>6</sup> HS(L)82, which was also published in 1996, covers all the regulations and schedules in a generic format. The focus of the guidance contained therein is on Major Accident Hazard Pipelines.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

99. Cadent Gas Ltd's network plan of the area as at 14<sup>th</sup> June 2016 {CAD00002174} is as follows:



**Fig. 29 – Cadent Gas Ltd's Network Plan {CAD00002174}**

It can be seen that the plan<sup>7</sup> shows the 10" service for the Landlord's supply including its service valve/PIV. The plan does not show either of the service/network pipelines supplying Residential Supply No. 1 and Residential Supply No.2.

100. As such, it appears to me that Cadent Gas Ltd was not complying with the relevant provisions of the Gas Act and the Pipeline Safety Regulations in respect of the requirement to keep and maintain plans of their apparatus.

### Safety Case

101. Gas Transporters, such as Cadent Gas Ltd, own and operate gas networks which terminate at the consumers' meter control valves/ ECVs. Under the Gas Safety (Management) Regulations 1996 Cadent Gas Ltd is required to have and it has a legal obligation under Regulation 5 to follow, an approved Safety Case. Schedule 1 of the regulations specifies the particulars which should be addressed by the Safety Case.

102. The focus of a Safety Case is the safe flow of gas and dealing with escapes and supply emergencies. Topics addressed in the Safety Case include:

<sup>7</sup> See Figure 2 also.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- a) Standards and procedures;
- b) Risk assessment;
- c) Competence;
- d) Management of contractors;
- e) Communications and liaison with others;
- f) Audit;
- g) Gas escapes and emergencies;
- h) Incident investigation;
- i) Gas supply emergencies;
- j) Discontinuing and restoring supply.

103. The HSE has published HS(L)80 – Guide to the Gas Safety (Management) Regulations 1996. With respect to the guidance relating to the content of the Safety Case, HS(L)80 contains the following paragraph:

*Paragraph 96 - It will be sufficient for the safety case to refer to internal or recognised technical specifications or standards (e.g. BSI, CEN, ISO, or industry publications such as IGE Recommendations<sup>8</sup>) which the gas transporter intends to follow in relation to managing the safe flow of gas through his part of the network, rather than describe them in detail.*

Consequently, I would expect a Gas Transporter's procedures as declared in its Safety Case to be at least consistent with current IGEM standards.

104. A Gas Transporter's compliance with its Safety Case is policed by the Gas and Pipelines Unit of the Health and Safety Executive's Hazardous Installations Directorate. Inspection visits and intervention plans are agreed with each Licensed Gas Transporter. Where non compliances are found action appropriate to the severity of non-compliance is taken. This may include enforcement action.

## **Meter Installations & Installation Pipework**

---

<sup>8</sup> HS(L)80 was written before The Institution of Gas Engineers (IGE) changed its name to The Institution of Gas Engineers and Managers (IGEM) and before the status of its documents was changed from Recommendations to Industry Standards.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

105. The Gas Safety (Installation and Use) Regulations 1998 deal with the safe installation, maintenance and use of gas systems, including gas fittings, appliances and flues, mainly in domestic and commercial premises, e.g. offices, shops, public buildings and similar places. Primarily they are concerned with activity downstream of the ECV, although there is some overlap with the Pipeline Safety Regulations in respect of the ECV.
106. As with the Pipeline Safety Regulations, the Gas Safety (Installation and Use) Regulations 1998 defines a service valve as follows:
- “service valve” means a valve (other than an emergency control) for controlling a supply of gas, being a valve*
- (a) incorporated in a service pipe; and*
- (b) intended for use by a transporter of gas; and*
- (c) not situated inside a building.*
107. The term “emergency control” is defined also. It is a valve intended for use by the consumer (i.e. end-user) of gas and to be readily accessible to the consumer. For example, a valve located in a meter-room which is locked (for security), and accessible only to a landlord, gas supplier, gas transporter and/or emergency services, cannot be regarded as an ‘emergency control’. Where a meter is fitted, the meter control valve may be used as the emergency control, subject to certain conditions – see Regulation 9(1).
108. In the context of the Landlord’s Supply to the boilers in Grenfell Tower, the “emergency control” is the valve<sup>9</sup> immediately upstream of the rotary meter installation in the basement. See Figure 7 above.
109. In the context of Residential Gas Supply No. 1 and Residential Gas Supply No. 2 in Grenfell Tower, the “emergency controls” are within the flats and they are the ECVs immediately upstream of the consumers’ meters. See paragraph 50 and Figure 19 and paragraph 61 and Figure 27 respectively.

---

<sup>9</sup> Assuming the service and original meter installation were installed after 1<sup>st</sup> December 1972, this valve would have been designated as the “Meter Control Valve” under the Gas Safety Regulations 1972. With the enactment of the Gas Safety (Management) Regulations 1996 the valve would have been re-designated as the Emergency Control as it was the end of the Gas Network.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

110. The Gas Safety (Installation and Use) Regulations contain other definitions of terms which are within the lexicon of a Gas Engineer's technical language. They include:

- a) *“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;*

In the context of Grenfell Tower there are 3 “service pipes” owned and operated by Cadent Gas Ltd bringing gas into the building from the 15” Ductile Iron gas main located in the road on the eastern side of the Tower, namely the Landlord gas supply to the meter installation in the basement, Residential Gas Supply No.1 to each of the ECVs in flats ending with 1, 3, 4, 5 and 6 and Residential Gas Supply No.2 to each of the ECVs in flats ending with 2.

- b) *“service pipework” means a pipe for supplying gas to premises from a gas storage vessel, being any pipe between the gas storage vessel and the outlet of the emergency control;*

The term “service pipework” is aimed at pipes supplying gas other than Natural Gas, such as Propane, from a storage tank to premises. Although the term “service pipework” may be used by non-gas engineers in general conversation, as a technical term and in the context of this report, it is not relevant to Grenfell Tower.

- c) *“installation pipework” means any pipework for conveying gas for a particular consumer and any associated valve or other gas fitting including any pipework used to connect a gas appliance to other installation pipework and any shut off device at the inlet to the appliance, but it does not mean –*
  - i. *a service pipe;*
  - ii. *a pipe comprised in a gas appliance;*
  - iii. *any valve attached to a storage container or cylinder; or*
  - iv. *service pipework;*
- d) *gas fittings” means gas pipework, valves (other than emergency controls), regulators and meters, and fittings, apparatus and appliances **designed for use by consumers of gas** for heating, lighting, cooking or other purposes for which gas can be used (other than the purpose of an industrial process carried out on industrial premises), but it does not mean –*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- i. *any part of a service pipe;*
- ii. *any part of a distribution main or other pipe upstream of the service pipe;*
- iii. *a gas storage vessel; or*
- iv. *a gas cylinder or cartridge designed to be disposed of when empty;*

The term “gas fitting” is used in all disciplines across the gas industry for items such as valves, bends, tees, caps and sockets. However, from a strictly legal perspective and in the context of the flats in Grenfell Tower, the term only applies to the components downstream of the consumer’s Emergency Control Valve.

- 111. In the context of the Landlord’s Supply to the boilers in Grenfell Tower, the installation pipework is the pipework between the outlet of the meter outlet valve (MOV) running to each of the boilers including the valves and check meter. See paragraphs 35 – 40 and Figures 6, 9 – 15 inclusive.
- 112. In the context of the flats in Grenfell Tower, the pipework between the outlet of the gas meter and the resident’s cooker is installation pipework.
- 113. Regulation 24(1) of the Gas Safety (Installation and Use) Regulations 1998 reads as follows:

*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,*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*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.*

114. The summary of Regulation 24 in HS(L)56 – Safety in the Installation and Use of Gas Systems and Appliances – is as follows:

*This regulation requires that a valve **must be fitted in certain installation pipework** and a system diagram provided (e.g. for use by emergency services) where service pipe/pipework exceeding specified sizes feeds certain buildings or floor areas.*

115. There are a number of Gas Engineers and commentators who argue that this regulation, as drafted, prescribes the fitting of a Service/Pipeline Isolation Valve (PIV) as shown in Figure 24. However, the summary to the regulation specifically refers to fitting the valve in certain installation pipework (in the context of Grenfell Tower this would refer to pipework between the meter and the cooker in a flat). Hence I am of the opinion that the regulation does not prescribe the fitting of a Service/Pipeline Isolation Valve (PIV); I believe that requirement is covered by the Gas Act and the Pipeline Safety Regulations 1996 as discussed in paragraphs 92 – 98 above.

116. Whilst a Gas Transporter does not have a legal requirement to display a system diagram where its pipe system supplies more than one floor and is of 2" (50 mm) diameter or greater, I believe it is certainly good practice to do so. (Paragraph 6.1.17 of IGEM/G/5 specifies that "*Consideration shall be given to the provision of a line diagram at each building entry/IVV, depicting the dwellings served by that particular network pipeline*".)

117. As mentioned in paragraph 23 above, I have consulted and where appropriate made use of the Witness Statement of Kevin Winship, Technical Safety Manager, CORGI Technical Services {MET00016757}, since amended by {MET00039915} and the associated appendices. As will be observed later, I have found the appendices extremely useful.

118. Also as mentioned in paragraph 23 above, I have consulted and where appropriate made use of Dr Barbara Lane's report. The intention of Appendix K of that report



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

{BLAS0000032} was to act as a briefing document to myself whilst noting that fire safety compliance was relevant to her own expert work. I should put on record that I do not believe that her references to Regulations 5, 19, 20, 23 and 24 of the Gas Safety (Installation and Use) Regulations 1998 applying to Cadent Gas Ltd's pipeline are correct. Those regulations apply specifically to installation pipes and where appropriate to fittings as defined in Regulation 2(1) of the regulations. Cadent Gas Ltd's pipeline is a pipeline falling under the Pipeline Safety Regulations 1996, not least because it is upstream of the Emergency Controls<sup>10</sup> which are intended for use by the consumers of the gas.

### **Marking of Pipes and Ventilation**

119. Other current regulations of relevance include the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). DSEAR is of relevance to the life cycle of the gas installation from design through construction, operation and decommissioning in common parts of the building. The marking of pipes is addressed in Regulation 10 and Regulation 6 addresses the adequacy of ventilation in order to disperse any dangerous substance<sup>11</sup> in the "workplace" before it can build up to an explosive atmosphere.
120. A similar requirement relating to the adequacy of ventilation to disperse any dangerous substance is contained in Article 12(3) and Part 4 of Schedule 1 of the Regulatory Reform (Fire Safety) Order 2005. The Responsible Person for the Building under the Regulatory Reform (Fire Safety) Order 2005 should, therefore, ensure that the ventilation of any gas infrastructure located in the common part of the building remains adequate throughout the life of the gas infrastructure.

### **Construction, Design and Management**

---

<sup>10</sup> The demarcation point between a pipeline coming under PSR and installation pipe and fittings coming under GS(I&UR) is the outlet of the ECV. See Regulation 3 of PSR and Regulation 2(1) of GS(I&U)R for the definition of an ECV. In addition it should be noted that at the request of Ofgem the Institution of Gas Engineers and Managers (IGEM) published a document, IGEM/G/1 – Defining the end of the Network, a meter installation and installation pipework, in 2004. The 2<sup>nd</sup> edition of this document was published in 2013 and it is available as a free download from IGEM's web site.

<sup>11</sup> The formal legal interpretation of a dangerous substance under DSEAR is given in Regulation 2. Paragraph 33 of HS(L)138 provides a plain English/common sense definition, namely: "*Any substance used or present at work that could, if not properly controlled, cause harm to people as a result of a fire or explosion*".

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

121. The design and construction of Residential Gas Supply No.2 was construction work and hence the Construction, Design and Management Regulations (CDM) 2015 applied. Detailed guidance for these regulations is to be found in the HSE publication, HS(L)153 – Managing Health and Safety in Construction.
122. From the Cadent Gas Ltd and tRiIO position statements {CAD00002929} and {TRI000001793} respectively), Cadent Gas Ltd is “The Client” as defined in CDM and tRiIO undertakes the roles of “Principal Designer”, “Designer” and “Principal Contractor” as defined in CDM.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

#### **D. British, IGEM and other Standards as at 2016**

123. BS EN 1775:2007 – Gas supply, Gas pipework for buildings MOP  $\leq 5$  bar, functional recommendations, is a European standard which has been adopted within the United Kingdom without any alteration. It describes the common principles and recognized practices concerning the design, construction, operation and maintenance necessary for the safety and integrity of gas supply systems within buildings. Strictly speaking its stated scope covers installation pipework only.
124. BS EN 1775:2007 takes the form of general requirements and recommendations. Among those requirements is protection in case of fire. Annex A provides a procedure for testing resistance to high temperatures which has been incorporated into the Gas Industry Standard GIS/V7-3. Further requirements for use in the United Kingdom can be found in other British and IGEM standards.
125. BS 6400-1 covers the design and installation of domestic gas meter installations. As a minimum, the re-sited meter installations in the flats fed from the replacement gas riser should have been installed to this standard.
126. BS 6891 covers the design and installation of installation pipework up to 35mm (1 $\frac{1}{4}$ " in diameter. The pipework connecting the outlet of the re-sited gas meter to the existing installation pipework at the original meter position within the flats ending in the number 2 should have been installed to this standard.
127. BS EN 12007 Part 5 (2014) specifies the functional requirements for gas services. Paragraph 4.1.7 reads as follows:
- For emergency isolation, maintenance and alteration there shall be a minimum of one manual isolation valve. The manual isolation valve shall be accessible to the distribution system operator and/or the consumer.*
- Paragraph 4.3.2 reads as follows:
- Isolation valve - A minimum of one isolation valve shall be installed (see 4.1.7) to facilitate emergencies, alterations and maintenance.*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

128. When considering the use of current IGEM standards various conventions should be borne in mind. The principal one being that the terms “must”, “shall” and “should” are prescriptive and they have specific meanings, as follows:

- a) *the term “must” identifies a requirement by law in Great Britain (GB) at the time of publication;*
- b) *the term “shall” prescribes a requirement which, it is intended, will be complied with in full and without deviation;*
- c) *the term “should” prescribes a requirement which, it is intended, will be complied with unless, after prior consideration, deviation is considered to be acceptable.*

Notwithstanding the use of these prescriptive terms<sup>12</sup> there is a caveat<sup>13</sup> which reads as follows:

*“The Standard does not attempt to make the use of any method or specification obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for modification to this Standard”.*

129. Another convention is that italicised text, usually in the form of notes to clauses and diagrams, is informative and does not represent formal requirements. Similarly, appendices are informative and do not represent formal requirements unless specifically referenced in the main sections [of the standard] via the prescriptive terms “must”, “shall” or “should”.

130. The second edition of IGEM/G/5 – Gas in multi-occupancy buildings was current when Residential Gas Supply No.2 was designed and constructed. It is referenced frequently in this report and hence it is attached as Appendix 5. IGEM/G/5 Edition 2 addresses the following topics:

- a) Planning including risk assessment, assessment of gas load, pressures, access and security;
- b) Siting of meter installations and means of escape;
- c) Building entries, external risers, internal risers, pipe jointing, ventilation;

---

<sup>12</sup> In IGEM/G/5 see clause 1.4.

<sup>13</sup> In IGEM/G/5 see clause 1.7.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- d) Valves;
- e) Energy centres;
- f) Installation pipework, appliances and chimneys;
- g) Materials;
- h) Electrical safety;
- i) Testing and commissioning;
- j) Records, inspection and maintenance.

In so far as these topics impinge upon the events of 14<sup>th</sup> June 2017, these topics will be discussed later in this report.

## **Valves**

- 131. The current edition of IGEM/TD/4 specifies the installation of a service valve on services supplying premises with more than one primary meter or where the service is of a diameter of 63mmPE/50mm steel or greater.
- 132. IGEM/G/5 contains a whole section dealing with valves. Service Valves, as discussed above, are referred to as Pipeline Isolation Valves (PIV). The relevant clauses are 7.3.4 and 7.3.5, which together with the associated diagram, are reproduced as follows:

*7.3.4 - The location of the PIV shall permit access to it in normal circumstances.*

*In selecting the location of the PIV:*

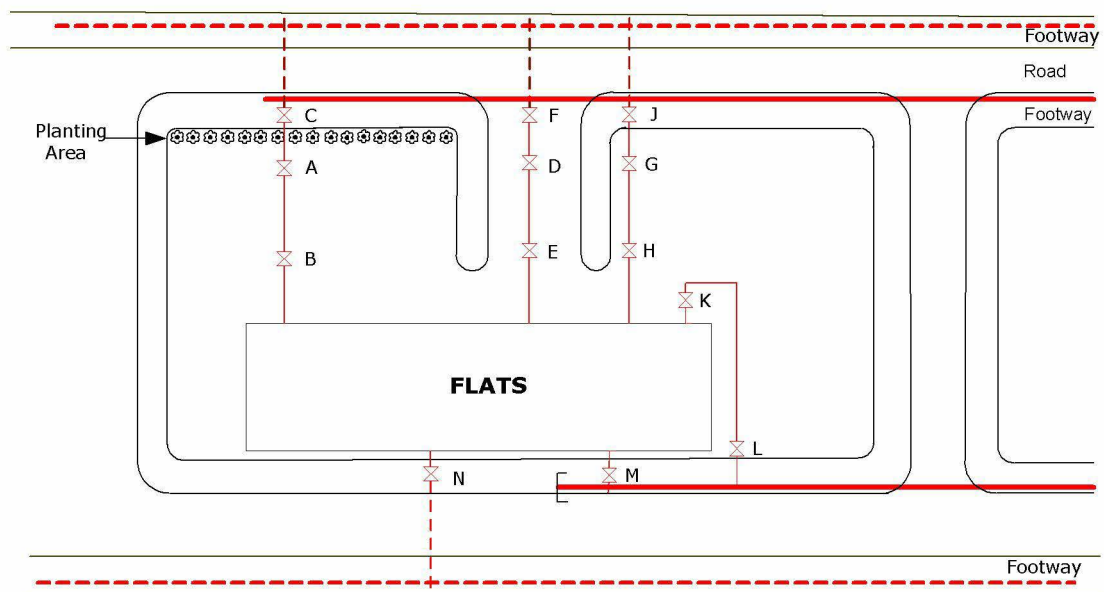
- *it shall be sited as near as is practicable to the boundary of the property*
- *the effect of a building fire on its operability shall be considered*
- *it shall not be positioned where vehicles are likely to stop or park.*

*7.3.5 - Subject to the considerations of clause 7.3.4 and with reference to Figure 27, the PIV should be located in the following order of priority:*

- *in, or in line with, the footway nearest the building (Figure 27, C, F, J, M, N)*
- *inside the property boundary, but not in planted areas such as borders or hedges (Figure 27, A, D, G)*
- *elsewhere within the property boundary, preferably at least 5 m from the building (Figure 27, B, E, H)*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- where the section of pipeline is long and has been laid in a non-standard orientation, in the two most appropriate positions (using the guidelines above) at both ends of the section of pipeline, so as to indicate the line of the pipeline (Figure 27, K, L).



**Fig. 30 - FIGURE 27 of IGEM/G/5 - PREFERRED PIV LOCATIONS**

133. Section 7 of IGEM/G/5 discusses the provision of valves in multi occupancy buildings; the underpinning principle being that a good system shall have multiple safety systems in place. In addition to PIVs and ECVs discussed above, the standard describes the role of and specification for
- Additional Emergency Control Valves (AECV): not relevant to Grenfell Tower as the individual gas meters are located within the flats and not remotely from them;
  - Inlet Isolation Valve (IIV): enables that part of a building complex being fed by an internal pipeline to be isolated for maintenance or safety reasons. An IIV shall:
    - be clearly identified as a gas valve
    - resist the efforts of any person not competent to restore gas supplies from re-opening a closed IIV
    - be accessible for maintenance purposes
    - not be accessible to members of the public. (i.e. it does not perform the function of an “emergency control” as defined in both the

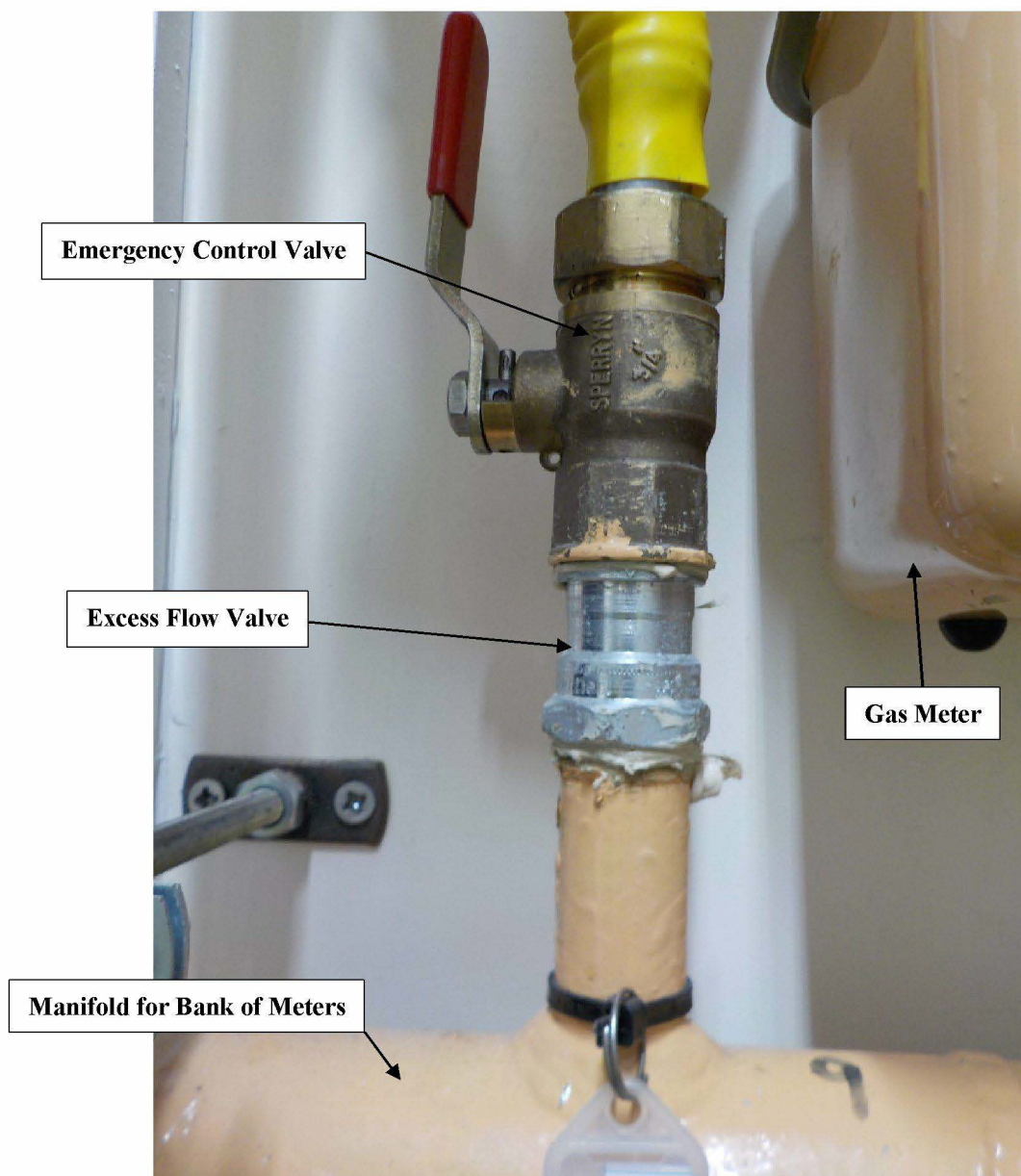
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*Pipeline Safety Regulations and the Gas Safety (Installation and Use) Regulations.)*

- v. *normally, be located inside the building. Where this is impracticable, consideration shall be given to locating the IIV in a locked outside compartment at the point where the pipeline enters the building*
  - vi. *where there is a low risk of vandalism or misuse, give consideration to enclosing the IIV in a standard gas meter box or equivalent structure*
  - vii. *where vandalism or misuse is considered a possibility, have access to the IIV restricted by means of a locked door or an equivalent device*
  - viii. *have permanent identification and gas escape action notices posted on or near the IIV*
  - ix. *have any other required labelling displayed at the IIV.*
- c) Branch or Riser Isolation Valves (BIV); as per IIV items above at (b);
  - d) Lateral Isolation Valves (LIV); as per IIV above at (b);
  - e) Excess Flow Valves (EFV); may be specified where risk assessment shows that there is a significantly higher risk than normal of theft or vandalism relating to meter installations or appliances resulting in an open ended pipe discharging gas into the flat;
  - f) Thermal Cut Off Valves (TCO): may be specified following risk assessment.

For the benefit of the lay reader an EFV is an in line fitting which, depending upon the specified configuration of threads, may be fitted either up-stream or downstream of the ECV. The following photograph shows an EFV fitted on the inlet to an ECV:

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Figure 31: Excess Flow Valve Up-stream of an ECV**



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

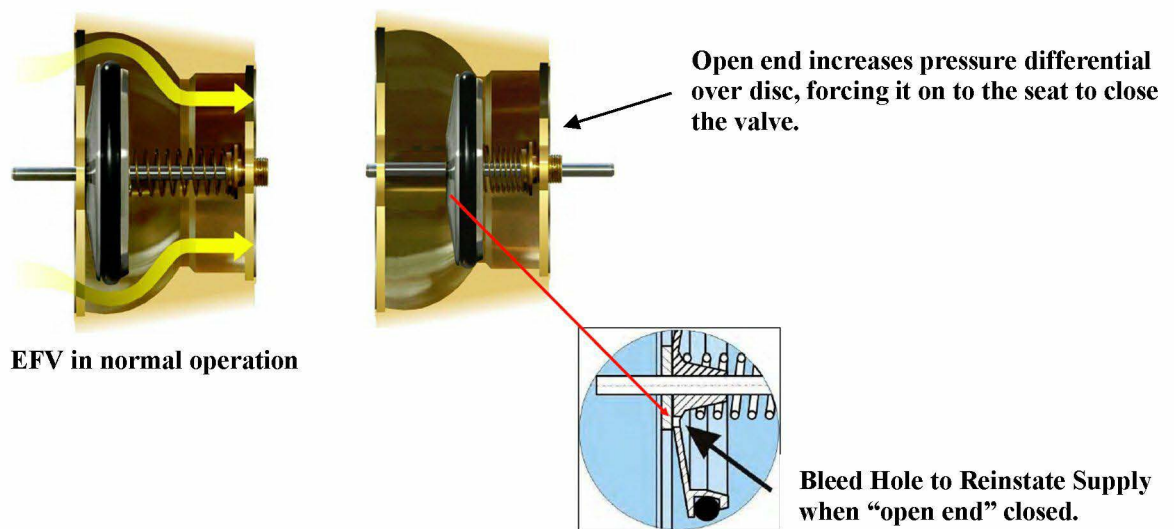


Figure 32: Operation of an Excess Flow Valve

A Thermal Cut Off device is also an in-line fitting. It operates when its temperature reaches 95<sup>0</sup>C. The release mechanism in the diagram below melts at that temperature and a spring forces the closing unit into position to stop the flow of gas.

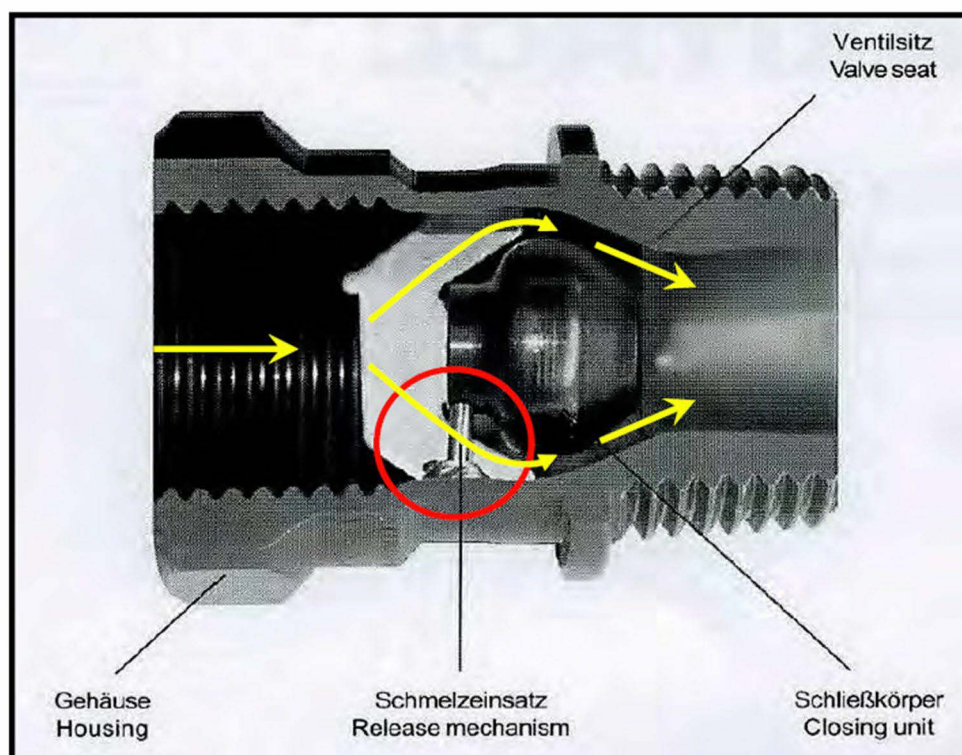


Figure 33: Operation of a Thermal Cut Off Device

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Combined EFV/TCO fittings are available. Again one may be fitted either up-stream or downstream of the ECV, depending upon the specified configuration of threads.

The IGEM/G/5 standard does acknowledge and hence the Designer should take into account, that such fittings do increase the pressure drop across the network and hence increase the risk of not supplying the consumer with gas at the pressure they can reasonably expect to receive.

The IGEM/G/5 standard assumes that the provision of some or all of these valves will be considered during the design risk assessment process and incorporated into the design as appropriate.

134. The reason why IIVs, BIVs and LIVs are intended to resist the efforts of any person not competent to restore gas supplies from reopening a closed valve is that that person would be carrying out an uncontrolled restoration of supply. An uncontrolled restoration of supply poses the risk of the formation of an explosive atmosphere within properties. Appliances, such as older cookers, which have been left turned on and which do not have flame failure devices on the burners, will allow gas to pass into the property if the gas supply is restored in an uncontrolled way. Before gas is restored a competent gas person must access each property to ensure the ECV is turned off. Then and only then should the individual dwelling's gas installation pipework and appliances be recommissioned in a controlled manner.
135. It should be noted that IGEM/G/5 does not discuss the provision of Automatic Isolation Valves (AIV) on gas supply systems. AIVs are often promoted as part of an overall building fire protection philosophy where a gas service is supplying a central boiler under the control of a Building Manager.
136. A hazard associated with an AIV that restores itself automatically and where any appliance installed downstream of it is in use and does not have flame failure devices on the burners, is that gas may pass into the property unless the appliance is turned off by the consumer when gas supply is lost initially.
137. Examples of when AIVs may operate are:
- Transient loss of electrical supply;
  - Activation upon testing a fire alarm;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Transient or intermittent fault of an interlock that actuates the AIV.
138. In other words, if and it is a hypothetical situation, AIVs were installed on network pipelines serving flats, there would be a “loss of supply” incident whenever an AIV was operated. Such loss of supply incidents would involve:
- Gaining access to **every** affected flat;
  - Turning off and capping the ECV in each flat;
  - Re-activating the AIV;
  - Re-visiting every flat to purge and re-light the appliances safely.
139. Such incidents would involve significant resources and because not everyone will be available immediately to provide access, they will take time to resolve. In addition they would be inconvenient to the consumers involved.<sup>14</sup>
140. The operation of an AIV installed in the installation pipe serving a building’s boiler system, all of which is under the control of the Building Owner/Manager, as was the situation with the Landlord’s Supply at the Tower, should not result in a loss of supply incident as described above. For more information on AIVs used in installation pipework on industrial and commercial premises see Section 7.9.8 and Appendix 11 of IGEN/UP/2 Edition 3.

## Ventilation

141. As discussed in paragraph 119 and 120 above, DSEAR and the Fire Safety Order require adequate ventilation to be in place to disperse any credible gas leak<sup>15</sup> before it can build up to an explosive atmosphere. IGEN/SR/25 – Hazardous Area Classification of Natural Gas Installations includes in Appendix A7.2 definitions relating to the adequacy of ventilation and mathematical models for the assessment of

---

<sup>14</sup> Consumers who suffer loss of supply for more than 24 hours are entitled to £30 per day compensation under the Gas (Standards of Performance) Regulations 2005 (as amended). Whilst it is a hypothetical situation, an incident involving the activation of an AIV on a Gas Transporter’s network could generate litigation relating to the cost of dealing with the loss of supply incident and compensation payments.

<sup>15</sup> The term “credible gas leak” is used in Appendix 3 of IGEN/G/5 which discusses risk assessment. It means a minor leak such as would emanate from a screwed joint or valve stem or flanged joint. It is synonymous with secondary grade releases as used in the classification of hazardous areas under DSEAR as determined by IGEN/SR/25 – Hazardous area classification of natural gas installations and BS EN 60079-10-1: Explosive atmospheres (classification of areas – gas) and BS EN 60079-10-1: Explosive atmospheres (classification of areas – gas).

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

the adequacy of ventilation in naturally ventilated enclosed spaces such as ducts and protected shafts.

142. Ventilation is

- a) “more than adequate” if the ventilation achieves a bulk gas concentration in the enclosure equal to or less than 10% of the Lower Flammable Limit<sup>16</sup>;
- b) “adequate” if the ventilation achieves a bulk gas concentration in the enclosure equal to or less than 25% of the Lower Flammable Limit;
- c) “inadequate” if the ventilation achieves a bulk gas concentration in the enclosure more than 25% of the Lower Flammable Limit;
- d) “poor” if the ventilation achieves a bulk gas concentration in the enclosure more than 50% of the Lower Flammable Limit.

143. Paragraphs 8.40 and 8.41 of Approved Document B address gas pipes in protected shafts. The relevant parts of those paragraphs read as follows:

*8.40: 2<sup>nd</sup> paragraph - Any pipe carrying natural gas or LPG in such a shaft should be of screwed steel or all welded steel construction, installed in accordance with the Pipeline Safety Regulations 1996, SI 1996 No 825 and<sup>17</sup> 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.*

*8.41. 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.*

---

<sup>16</sup> Natural Gas as distributed and used in the United Kingdom and which was the gas type at Grenfell Tower would have complied with Regulation 8 and Part 1 of Schedule 3 of the Gas Safety (Management) Regulations. It would have had a LFL of 5% gas in air. For information on the LFL of natural gas see Combustion Engineering and Gas Utilisation 3<sup>rd</sup> Edition, edited by J R Cornforth and published by British Gas in 1992. See also IGEM/SR/22 – Purging operations for fuel gases etc.

<sup>17</sup> I believe an incorrect conjunction has been used here. The pipe should be installed in accordance with either PSR or GS(I&U)R as it is either a pipeline or an installation pipe. It cannot be both at the same time. The overlap between the two sets of regulations concerns the ECV which will not be located in a shaft.



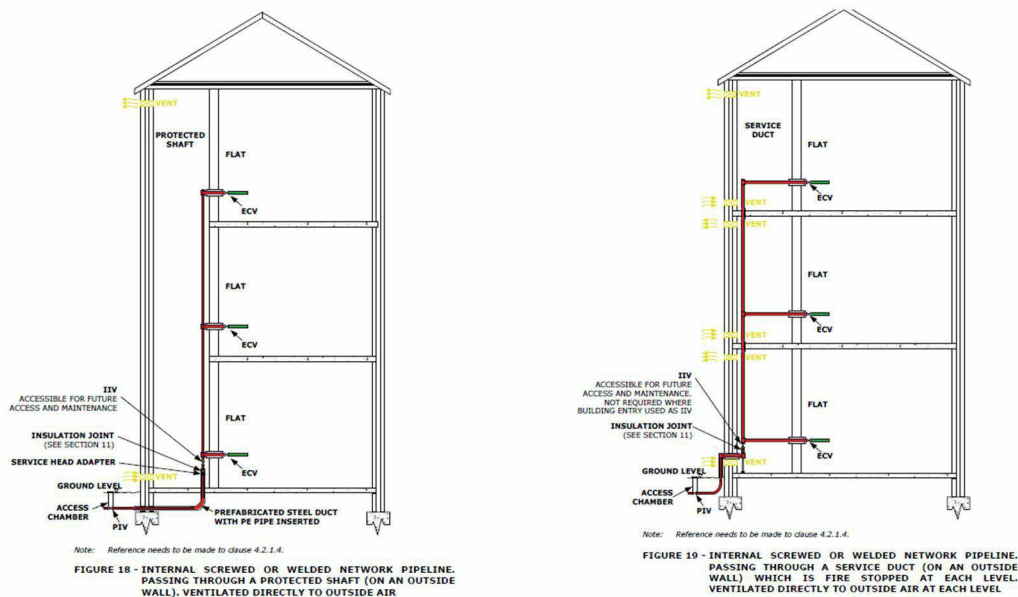
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

144. Section 12.3 of BS 8313 – Code of Practice for the Accommodation of Building Services in Ducts, and which is referred to in Paragraph 8.41 of Approved Document B, addresses safety ventilation. It includes the following table of sizes of ventilation openings:

Free area of ventilation opening for dispersal of small leaks	
Cross-sectional area of duct m <sup>2</sup>	Minimum free area of each opening
Not more than 0.05	Cross-sectional area of duct
More than 0.05 but not more than 7.5	0.05 m <sup>2</sup>
More than 7.5	1/150 of Cross-sectional area of duct

**Fig. 34 – Reproduction of Table 1 from BS 8313  
(Also a Reproduction of Table 6 of BS 6891)**

145. The narrative within Section 12.3 of BS 8313 includes the statement that
- “Ventilation openings should be located such that air movement can occur within the duct e.g. at top and bottom ...”*
146. In respect of network pipelines, IGEM/G/5 follows the engineering principles behind BS 6891 in respect of ventilation except that only ducts containing welded steel network pipelines can be ventilated into a room or space ventilated to normal occupational standards. Ducts containing screwed steel network pipelines shall be ventilated directly to outside air whereas ducts containing screwed steel installation pipework may be ventilated within a room or space, provided the room or space is ventilated to normal occupational standards.
147. The following two diagrams taken from Section 6.4.3 of IGEM/G/5 illustrate the provision of ventilation for network pipelines.



**Fig. 35 – Internal Network Pipeline Diagrams from Section 6.4.3 of IGEM/G/5**

148. BS 6891: 2015 – Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm (R1<sup>1</sup>/<sub>4</sub>) on premises is, strictly speaking, for installation pipework of a size normally found within domestic premises. As such, it does not apply directly to the network pipeline forming Residential Gas Supply No.2. However, it does apply to the installation pipework downstream of the re-located meter installations within the relevant flats ending with the number 2.
149. Included within BS 6891 are paragraphs relating to the ventilation of gas pipes within buildings. In particular, Table 1 of BS 8313 i.e. Figure 34 above, has been reproduced as Table 6 in BS 6891. The engineering principles behind this standard, particularly those relating to ventilation of gas pipes, are accepted by Gas Engineers. In my experience a reasonable Gas Engineer would consider that they applied equally to network pipelines within buildings. To assist the reader, I have included as Appendix 11 relevant extracts from sections 8.16 – 8.19 of BS 6891, which address
- Ventilation
  - pipework in ducts;
  - Multi-occupancy buildings;
  - Fire stopping;
  - Gas pipework inside a protected area.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

As such it should be noted that in respect of the requirements for the ventilation of gas pipes, IGEM/G/5 and BS 6891 are generally consistent<sup>18</sup> with one another.

### **Landlord's Gas Supply Meter & Installation Pipe**

150. The gas meter installation in the basement for the Landlord Supply was observed to be generally compliant with the relevant standard, IGEM/GM/8 – Non-domestic Meter Installations, Flow Rate > 6m<sup>3</sup>/hr and Inlet Pressure ≤ 38 bar.
151. The Landlord Supply pipework from the outlet of the Meter Outlet Valve to the boilers was observed to be generally compliant with the relevant standard, which was published in 2014 i.e. IGEM/UP/2 – Installation Pipework on Industrial and Commercial Premises Edition 3.

### **Marking of Pipes**

152. DSEAR also addresses the marking of pipes. Normal gas industry practice in respect of the marking of pipes is contained in Section 7.10.5 of IGEM/UP/2. The first paragraph of that section reads as follows:

*Pipes and pipework shall be readily identified to indicate it carries a fuel gas. This shall be achieved by fully painting with yellow ochre (to BS 4800 08 C 35) or primrose yellow (to BS 4800 10 E 53) paint or by banding the pipe (which does not have to be so painted) with gas marker tape ..... or in accordance with BS 1710.*

153. Experience has shown that outside of boiler rooms or service ducts, Building Managers, Architects and Planners are hostile to pipes being visible, especially when they are bright yellow. The challenge is to mark them such that the gas professional and building manager will be able to identify them whilst the pipes blend in with their surroundings; hence the use of discrete yellow tapes with the word gas on them in environments such as that at Grenfell Tower.

---

<sup>18</sup> The differences, which in the context of Grenfell Tower are not relevant and are therefore only of academic interest, relate to the minimum Free Area Ventilation (FAV) of each high and low vent in a vertical duct with a cross sectional area up to 0.5m<sup>2</sup>. The minimum FAV of vents specified in IGEM/G/5 was smaller than that specified in BS 8313 as experience had shown that smaller vents appeared to provide adequate ventilation and that they were more acceptable to Architects and Developers.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **E. What ought and what ideally should have been in place to enable the gas supply to be isolated?**

154. Paragraphs 63 – 153 above discuss the relevant legislation, regulations, guidance and industry practice relevant to gas supply to and within Grenfell Tower. It can be seen that for each of the 3 services/network pipelines entering the building, a service/pipeline isolation valve (PIV) was required to have been fitted and to be accessible to Cadent Gas Ltd personnel under normal circumstances<sup>19</sup>.
155. I understand the term accessible to mean that a Cadent Emergency Repair Team should be able to locate the valve box, lift the surface valve box cover and use a valve key to operate the valve.



**Fig. 36 – Posed photograph of an operative operating a valve  
(prepared for and used on IGEN/G/5 seminars and training courses)**

156. In my opinion, and as explained later in the report, circumstances such as burning debris falling off the side of a building in the immediate vicinity of the service valve would not be normal circumstances.
157. A multi-occupancy building survey was carried out on 9<sup>th</sup> September 2008 {CAD00002989}. The survey record shows that service valves were observed.

<sup>19</sup> Paragraph 7.3.4 of IGEN/G/5 states that “The location of the PIV shall permit access to it in normal circumstances.”



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

158. The riser survey exercise carried out at the end of September 2016 {CAD00000031} by Cadent Gas Ltd personnel Matt Lines and Phil Eden (surveyor details extracted from {CAD00002024}) did not locate any PIV/service valve on either of the two “services” which entered the building at that point in time. I note that the survey took place almost 2 months after Rydon Construction Ltd’s contract for the refurbishment of Grenfell Tower was granted a Certificate of Practical Completion {RBK00018810} with the date of practical completion being 4<sup>th</sup> July 2016. The contract {RBK00018809} included extensive landscaping works. I believe it is possible that the valve boxes were removed and the valve chambers were filled in when landscaping work was done. i.e. the valves have been “lost” rather than that they were never installed.
159. A Hazard and Operability (HAZOP) assessment of the riser survey report {CAD00002024} was carried out on 5<sup>th</sup> December 2016 (see also an e-mail dated 6<sup>th</sup> December 2016, {CAD00000068}). It recognised the absence of a PIV/service valve on each of the two services entering the building and it specified the investigation of the reported absence of those valves.
160. A progress report was requested on 20<sup>th</sup> January 2017 from Patrick Kelly, Cadent Gas Ltd’s Multi-occupancy Buildings (MOB) Specialist. His response refers to the installation of a PIV/service valve on the replacement service (i.e. Residential Gas Supply No.2) only. There was no mention in his response of any remedial work having taken place or planned to locate the PIV/service valves on the two original services entering the building. (see {CAD00000109})
161. I have concluded that, as at 14<sup>th</sup> June 2017, the PIV/service valves on the two original services entering the Tower i.e. the Landlord Supply and Residential Gas Supply No.1 had not been kept in working order as required by the Gas Act and Regulation 13 of the Pipeline Safety Regulations 1996 and which are discussed in paragraphs 92 - 100 above.
162. With respect to the replacement “service” installed in 2017 following the decommissioning of the riser supplying flat 2 on each floor of Grenfell Tower, a 90mm PE Certus Ball Valve ({TRI000001419} – Valve Record Card) was installed

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

as the “Service Valve/PIV”. Its location is shown on the following As Installed Drawing.

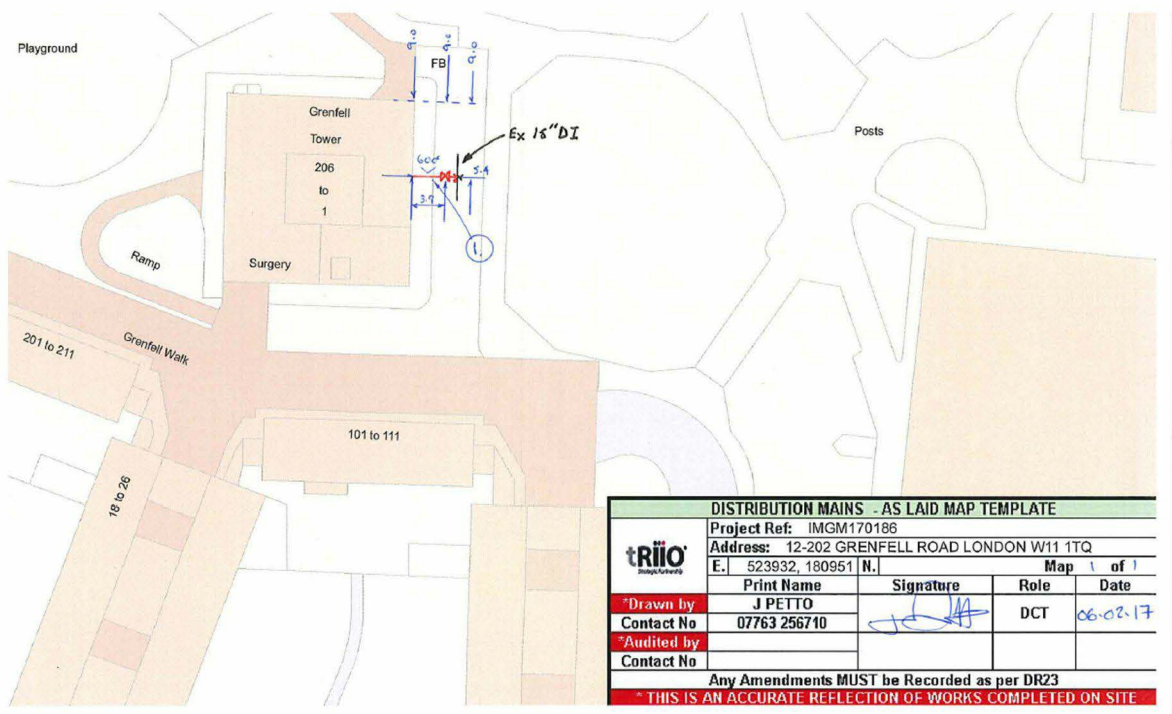


Fig. 37 – {TRI000001417} – As Installed Drawing

163. As can be seen from Figure 37 – {TRI000001417} above, the valve was fitted 3.9 metres out from the eastern wall and 9.0 metres south west of the north east corner of Grenfell Tower. Its location was determined by the location of the 15” Ductile Iron gas main to which the service was connected and its location is compliant with sections 7.3.4 and 7.3.5 of IGEN/G/5 as detailed in paragraph 132 above.
164. It is also noted that the as-installed drawing was signed off on 6<sup>th</sup> February 2017 (see date box in Figure 37 and {TRI000001425}); the commissioning of the pipe having been carried out on 25<sup>th</sup> January 2017 (see timeline {CAD00000731}). It has been industry practice since at least 2001 to record graphically all low pressure gas services of diameter greater than or equal to 2”/50mm steel or 63mm PE and the appropriate network plans should be updated within 30 working days of the “service” being commissioned. Therefore, I believe that Cadent Gas Ltd’s network plan, Figures 2

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

and 29 above, should have contained details of Residential gas supply No.2 including its PIV by 8<sup>th</sup> March 2017<sup>20</sup>.

165. Following the commissioning of Residential Gas Supply No. 2, the excavation in which the connection to the 15" gas main and the pipeline into Grenfell Tower would have had to have been backfilled and reinstated to a permanent standard. This would have included the installation of a valve chamber and valve surface box over the PIV to enable the PIV to be accessed and operated in the future.
166. In order to assist the lay reader, I have copied as Figure 38, an exploded diagram and parts list from Cadent Gas Ltd's work procedure for Servicelaying {CAD00002034} to illustrate the reference to a valve chamber. Photographs of typical valve surface boxes are included as Figure 39.

---

<sup>20</sup> In March 2017 the British Standards Institution published a Publicly Available Specification, PAS 256 – Buried Assets: Capturing, Recording, Maintaining and Sharing of Location Information, Code of Practice. Contained within it is a target of 30 days for the sharing of newly captured asset information.

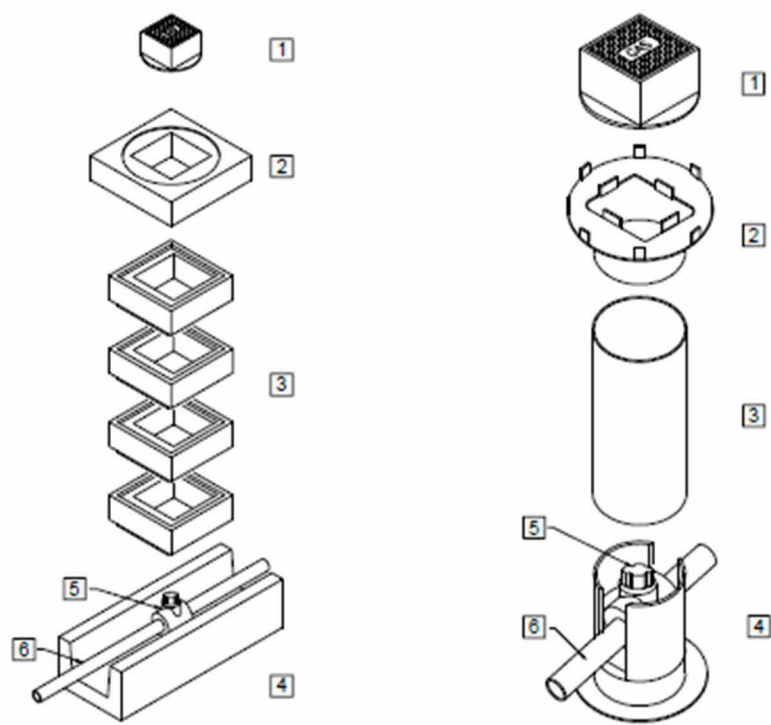


Figure C5 – PE Service Isolation Valve Chambers

No.	Item
1	Surface Box
2	Top Section
3	Intermediate concrete section/ plastic chamber
4	Base section/ plastic chamber base
5	Service Isolation Valve
6	PE pipe spigot

Fig. 38 - Exploded Diagram and Parts List: “Service Valve/PIV” {CAD00002034}



Fig. 39 – Typical Valve Surface Boxes (for illustrative purposes only)

167. It appears that the excavation and the block paved surface in particular, was not reinstated to a permanent standard immediately. An interim or temporary reinstatement of the surface with Bituminous Macadam was carried out as is shown



Report of: Rodney Hancox  
 Specialist Field: Gas Engineering  
 Prepared for: Grenfell Tower Inquiry

by the inspection which was carried out on 1<sup>st</sup> February 2017 {CAD00000945} and which recorded the reinstatement as being defective: see comments above both photographs in Figure 40 below.



**Fig. 40 – Reinstatement defect at PIV location {CAD00000945}**

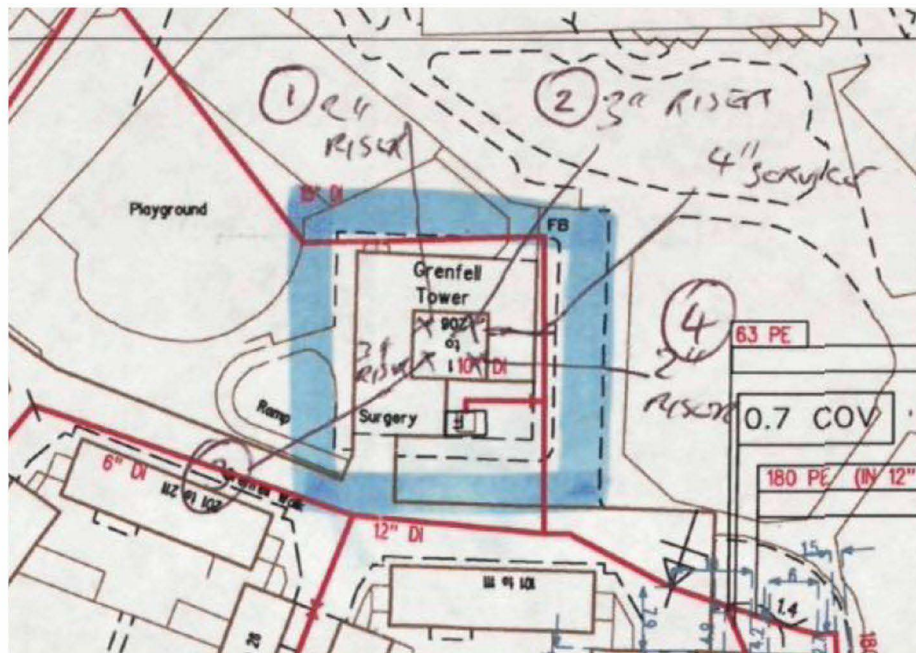
168. No trace has been found of a valve surface box at the expected location of the PIV either by me or the Metropolitan Police Service or CORGI Technical Services. James Harrison in his second witness statement, {CAD00002982} and exhibits {CAD00002983} states that
- The PIV for the new gas 90mm supply that was installed in 2016/2017 is currently buried under a concrete plinth that has been erected since the fire to allow lift access to the Tower from the exterior of the building.*
169. It will be recalled from Figure 37 and paragraph 163 above that the PIV was recorded as being located 9.0 metres from the north east corner of the Tower. My measurement placed the PIV within a metre of the concrete pad for the external lift installed by the Metropolitan Police Service (MPS) on the eastern wall of the Tower after the fire.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Given the possibility of measurement error by both the team and myself, I am not in a position to challenge James Harrison's statement on this point.

170. As discussed in paragraphs 162 - 164 and as shown in Figure 37 above, a Service or Pipeline Isolation Valve was installed externally to the Tower as required. However, no trace has been found of a valve box over the valve either by me or the Metropolitan Police Service or CORGI Technical Services. It is possible, if the measurements given in Figure 37 are inaccurate that the valve box has been covered over by the concrete pad for the external lift installed on the eastern wall of the Tower after the fire.
171. If the valve box was not installed during the reinstatement of the trench such that subsequently under normal circumstances access to the valve would not have been possible, then that omission can be considered a major non-compliance with the regulatory and standards regime outlined in paragraph 98 above.
172. The other measure which ought to have been in place to enable the gas supply to be isolated in the event of a fire is the availability to Cadent Emergency personnel of an accurate plan to enable them to identify and locate each of the service valves. As discussed in paragraph 99 above, Cadent Gas Ltd's network plan of the network Figure 29 {CAD00002174} does not show the service/network pipelines supplying Residential Gas Supply No. 1 and Residential Gas Supply No. 2, which can be deemed to be a non-compliance with the Gas Act and the Pipeline Safety Regulations.
173. The multi-occupancy building survey record of the survey carried out in 2008, {CAD00002989}, included a marked up plan. This shows both gas supplies entering the Tower together with the locations and sizes of the 4 risers exiting the basement.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 41 – Marked-up Plan from {CAD00002989}**

174. It appears to me that National Grid Gas Ltd, as it then was, did not initiate its DR4 Asset Management Error Management Process on receipt of the above survey information from the field.
175. Notwithstanding that I do not believe the Landlord gas supply in the basement and the boilers themselves have any particular relevance to the events of 14<sup>th</sup> June 2017, I observed that the ECV (Figure 7) and the meter outlet valve (Figure 9) would have been readily accessible under normal circumstances to Cadent Emergency personnel and any other competent person, if that had been required.
176. As discussed above the IIVs are not “emergency controls” as they are not intended to be operated by the consumers. However, IGEM/G/5 does specify that IIVs shall have permanent identification and gas escape action notices posted on or near the IIV and have any other required labelling displayed at the IIV. No such identification or gas escape action notices have been observed on site post 14<sup>th</sup> June 2017.
177. Access should have been available under normal circumstances to the BIVs in the basement for Residential Gas Supply No. 1 and to the IIV for Residential Gas Supply No. 2 by Cadent Emergency personnel and any other competent person. As discussed in paragraphs 133 and 134 above, these valves are not designated “emergency

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

controls” as they are not intended to be accessible to the individual consumers or the general public. They are there to enable maintenance i.e. non-emergency work, to be carried out and as a back-up safety system to be operated by either Cadent Emergency personnel or any other competent person.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

**Instruction No. 2 - 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.**

### **Sequence of Events**

178. Cadent Gas Ltd has supplied a log {CAD00000002} of the events covering the period from 03.09hrs on 14<sup>th</sup> June 2018 to 10.30hrs on 15<sup>th</sup> June 2018 when its Bronze Command Team was stood down.
179. Various Cadent personnel have provided witness statements. Key ones are as follows:
- a) Jason Knightly – First Call Operative (FCO) and first Cadent representative to attend site {MET00007821};
  - b) David Edwards – Network Engineer – Emergency {MET00007956};
  - c) Jason Allday <sup>21</sup>– Network Engineer – Repair {MET00012710};
  - d) Peter Hyatt – Repair Team Leader {MET00012825};
  - e) Peter Baynard – Network Engineer {MET00012826};
  - f) Neale Millam – Network Supervisor {MET00012828};
  - g) Tony Day – Network Manager {MET00012830};
  - h) James Harrison – Head of Operations {MET00012831};
  - i) Patrick Kelly – Multi-occupancy Building (MOB) Specialist {MET00012836}.
180. In their witness statements, both James Harrison {MET00012831} and Tony Day {MET00012830} state that as per the Civil Contingencies Act 2004, London Fire Brigade as the Category 1 Responder had control of the site and that Cadent Gas Ltd was a Category 2 Responder acting in support of London Fire Brigade.
181. Cadent's log makes reference to bands of manager, levels of staff, FCOs and Repair Teams. From the witness statements, including that of James Harrison {MET00012831} in particular, I have established the following hierarchy applicable to Cadent's Emergency and Repair Directorate:

---

<sup>21</sup> Jason Allday provided oral evidence to the Inquiry on 14<sup>th</sup> November 2018. A transcript of his evidence is available on the Inquiry's website.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

LEVEL	JOB TITLE	
Band A	Director of Operations	
Band B	Head of Operations	
Band C	Network Manager - Emergency	Network Manager - Repair
Level 7	Network Engineer	Network Engineer
Level 6	Network Supervisor (Emergency)	Network Supervisor (Repair)
Field Force	First Call Operative (FCO)	Repair Team (Team Leader & Assistant)

**Table 2 – Cadent Gas Ltd Emergency & Repair Hierarchy**

182. Logs of the incident were kept on behalf of the London Fire Brigade (LFB) Incident Commanders, AC Andy Roe {MET00005404} and AC Dominic Ellis {MET00005756}. From the Cadent and LFB logs, a timeline produced by the Metropolitan Police Service (Page 15 of {MET00012593}) and the various witness statements, I have been able to make a reasonable reconstruction of the steps taken to isolate the gas supply to and within Grenfell Tower and the factors which influenced the decisions made.

183. The sequence of events and the steps taken to isolate the gas supply to and within Grenfell Tower are understood to be as follows:

Time	Fact	Sources additional to Cadent Log {CAD00000002}
June 14 <sup>th</sup> 00.55	1 <sup>st</sup> call to LFB	See Page 15 of {MET00012593}
01.15	Mr Kebede, occupant of No.16, records falling debris from east elevation on his mobile phone. Recorded in report of Professor Niamh Nic Daeid.	See Fig. 27 of {NNDR00000001}
01.29	Fire now covers 1/3 of East Elevation	See Page 15 of {MET00012593}
01.32	Major Incident declared by MPS	See Page 15 of {MET00012593}
01.42	Fire takes hold of North Elevation.	See Page 15 of {MET00012593}
02.17	Request from LFB Command Unit 8 to LFB Central Control Unit for “dangerous structure engineer, gas and electricity board and local authority liaison officer”	{LFB00000003} See Table 3 in {BLAR00000008}
02.25	Fire takes hold of South Elevation	See Page 15 of {MET00012593}
02.51	Fire takes hold of West Elevation	See Page 15 of

01/10/2019

77

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

		{MET00012593}
03:05	LFB request long shields [from Metropolitan Police] for escort duties	See Page 15 of {MET00012593}
03:22	Call received [by Cadent] via 'Blue Light' Emergency Number – [REDACTED]	
03:25	Call handled by call handler Ben Moore ref 698133. Call starts 'London Fire Brigade here - we have a Major Incident at block of flats in London...' Call lasts 3min 6sec as incorrect post code provided initially causes delay locating property. LFB ref 076029; Cadent Job ref 3002840142	
03:27	03:27:30 Job delivered to FCO Jason Knightley. Jason Knightly received message on "Gobook"	See witness statement {MET00007821}
03:28	03:28:18 Job accepted by FCO Jason Knightley - en route 03:28:37	
03:48	Jason Knightley arrived on site 03:48:20 and requested Repair team at 03:49:16	See witness statement {MET00007821}
03:48	Jason Knightley confirmed his arrival with LFB - instructed to stand-by. Jason Knightly spoke to two firemen at the edge of the cordon and he asked where the incident unit was. He gave them his phone number and they said that they would pass it on. He then walked into the outer cordon with the firemen and he waited at Latimer Road Station under the bridge.	See witness statement {MET00007821}
03:58	Dispatch call to Jason Knightley - advised Peter Baynard is on his way to him, JK reports the whole block is on fire, unable to get anywhere near, has put in team request, may need a few teams to attend.	
04:14	Dispatch called Dave Edwards Dave Edwards had been advised of incident at approximately 04:00 by Peter Baynard. Before leaving home at approximately 04:30 he called Tony Day, Band C Network Manager – Repair to advise him of the incident.	See witness statement {MET00007956}
04:23	Dispatch call Tony Day (Band C Repair Engineer): Call to inform him that Cadent was attending a large tower block fire in W11. Dispatch confirmed that FCO was on site DE and PB were making their way to site. Gas was not thought to be involved. The incident was being reported on media and Sky News.	
	Dave Edwards called Tony Day and informed him that nobody could get anywhere near the building.	
04:27	Call Centre call Dispatch as Met Police have requested contact details for Cadent personnel on site. The call was transferred to Dispatch and then transferred on to Jason Knightley. The Met Police asked him to confirm presence.	
04:30	Jason Knightley call to Peter Baynard. Advised he could not get anywhere near the site and that team had been requested to standby. Between 04:30 and 05:00 and prior to Dave Edwards and Peter Baynard arriving on site, Jason Knightly reported to the incident unit and again gave LFB his contact details. He was told to stand by.	See witness statement {MET00007821}
04:30	Dave Edwards arrived on site - established a Cadent muster point [near Darfield Way]. Cordons in place at Silchester Road and Bramley Road. No one was permitted to approach the site. In his witness statement Dave Edwards gives his time of arrival on site as approximately 04:45.	See witness statement {MET00007956}
04:34	Tactical Command Meeting initially chaired by LFB Commissioner. Noted that <ul style="list-style-type: none"> <li>Access into and egress from the building being enabled by police using riot shields;</li> <li>Incident most dangerous with falling debris;</li> </ul>	See LFB Log {MET00005404}

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

	<ul style="list-style-type: none"> <li>At 04:53 Incident Commander AC Andy Roe did not want to isolate the electricity sub-station in the basement of Grenfell Tower as it was providing lighting to fire-fighting crews;  <i>No Cadent representative attended either this or any subsequent Tactical Command Meeting.</i></li> </ul>	
04:44	Fire has covered each elevation	See Page 15 of {MET00012593}
04:45	Dave Edwards - Instruction from LFB (via Jason Knightly) was to stand-by	
05:00	Peter Baynard arrived on site at approximately 04:50 and he had been stopped at the cordon. He made contact with Dave Edwards and on meeting up walked to Bramley Road to meet up with Jason Knightly.	See witness statement {MET00007956}
05:01	Peter Hyatt (Repair team leader) arrived onsite 05:01:17	
05:10	Peter Baynard meets Dave Edwards and Jason Knightley at the Cadent muster point and start looking at maps [of the gas network] to ascertain where the gas mains are situated. Jason Knightly confirmed that Cadent have been instructed by LFB to standby. Jason Knightly's "Gobook" was used to review the configuration of the gas mains.	See witness statement {MET00007956}
05:30	Jason Allday (Level 7 Repair Engineer) called Tony Day and Neale Milam - both are already aware. Tony Day and Jason Allday agree to attend site	
05:35	Dave Edwards spoke with LFB, who are in command of the site, and told to standby	See witness statement {MET00007956}
05:50	Dave Edwards / Neale Milam call. Conversation consists of discussing where mains are located. DE tells NM he has spoken with LFB Command.	
06:39	Dispatch call Peter Baynard - Tower block still alight unsure if building is structurally sound - Repair Team on site as per LFB instruction to stay on standby.	
07:20	Jason Allday arrived on site	See Witness statement {MET00012710}
07:30	Tony Day and Jason Allday going through maps <sup>22</sup> [of the gas network] between 07:30 and 08:00 so that "when given green light we know where to attack"	
07:45	Jason Allday went to LFB Command Unit to see if LFB wanted the gas supply isolated. LFB confirmed that they did. Jason Allday 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.	See witness statement {MET00007956} See Witness statement {MET00012710}
07:45	Neale Milam arrived on site with copies of drawings retrieved from Cadent's Fulham depot	See Witness statement {MET00012710}
08:00	Tony Day arrived on site	
08:10	LFB log reports that Codon [sic] Gas former National Grid will isolate [the gas network] at 3 separate locations [which will result in the isolation of Grenfell Tower and one other building].	See LFB Log {MET00005404}
08:15	Email from Simon Boyle to Peter Connolly who forwarded it to Neale Milam who forwarded it to Tony Day / Jason Allday with details of gas supplies into building. E-mail reads "Don't know if you are looking to cut any supplies off or can get even close to the block but some information if it helps; -there is a deep boiler room below the block. -boiler room extends approx 3m out past building line so excavations	See {CAD00000432} and {CAD00000433}

<sup>22</sup> See {CAD00001989}, {CAD00002190}, {CAD00002240} and {CAD00002241} which are reproduced below as Figures 42, 43, 44 and 45 respectively.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

	<p>have to be approx 4m away from building.  -I remember there were 2 existing incoming supplies &amp; 1 new welded supply;  -10" exist steel to communal boiler room rotary meter.  -4" screwed steel to existing riser system.  -welded supply to recent replacement section."  <i>Note: no mention of PIVs.</i></p>	
08:50	<p>Jason Allday explains the isolation plan to LFB - estimate gas off 19:00-20:00  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).</p>	See Witness statement {MET00012710}
09:29	Could not locate service valves due to restrictions and debris at the base of the building.	
09:30	Jason Allday and Peter Baynard walk around the site to locate isolation points. Assisted by LFB	
10:00	LFB's Julian Spooner, Sector Safety Commander, states in his witness statement that at 10:00 (?) he received a brief from AC Dominic Ellis. AC Ellis was also keen to get the gas company to the incident in order to isolate the supply. There were a lot of gas fires burning in the Tower. (Timing not consistent with that of AC Ellis)	See witness statement {MET000086071} See witness statement {MET00007693}
10:00	Request for Network Analysis to assess impact of 3 planned isolations	See witness statement {MET00012710}
10:15	LFB log notes that the 8 <sup>th</sup> floor was well alight and was being by-passed.	See LFB Log {MET00005404}
10:24	Response from Network Analysis (assumed to be that there would be no adverse impact on security of gas supplies to the surrounding area)	
10:30	10:30:51 Thomas Hyatt onsite with Duaine Marney (Repair team)	
10:30	Unable to access excavation points - LFB assistance to move fire vehicles in Grenfell Road and ambulances in Bramley Road	
11:00	Jaymini Patel (customer liaison officer) arrives on site and takes responsibility for the register of Cadent personnel	
11:03	11:03:48 Kevin McNicholas on site with Kassey Jaggers (Repair team)	
11:16	11:16:47 Bartłomiej Szostak on site with Artur Rek (Repair team)	
11:19	AC Dominic Ellis arrives on site.	See witness statement {MET00007693}
11:27	11:27:53 - Mark Corcoran on site with Pawel Lis (Keyhole) <sup>23</sup>	
11:30	With LBF assistance, Jason Allday had identified the three excavation points on the ground and arrangements were made with LBF Safety Personnel to facilitate the movement of Cadent personnel and plant to those locations.	See witness statement {MET00012710}
11:30	LFB Log records start of handover of incident control from AC Andy Roe to AC Dominic Ellis.	See LFB Log {MET00005756}
12:20	Access to the isolation sites agreed and granted by LFB.	
12:35	Team briefing	See witness statement {MET00007956} See witness statement {MET00012710}
12:55	Completion of handover of incident control from AC Andy Roe to AC Dominic Ellis followed at 13:00 by a Tactical Command	See LFB Log {MET00005756}

<sup>23</sup> Keyhole – specialist equipment such as air lances and lorry mounted vacuum excavators to enable work to be carried out on gas mains from the surface in very small excavations. Utilities equivalent when working in the road to keyhole surgery on the human body.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

	Meeting. <i>There was no Cadent representation.</i> It was stated that there had been no change since the last meeting but everyone present was reminded of the issues around falling debris, structural stability, areas still alight, slips trips and falls and that there was still a restricted hazard zone in place	
13:25	LFB Log notes that there was a gas fed fire on the 10 <sup>th</sup> floor. This is confirmed by AC Dominic Ellis in his witness statement.	See LFB Log {MET00005756} See witness statement {MET00007693}
13:30	Excavation started on 12" main adjacent to Sterile Area after agreeing movement of facilities.	See witness statement {MET00012710}
13:50	Request LFB to enable access for equipment to excavation points for 4" main and 180mm main	
14:00	LFB request to access basement to operate valves to isolate the supply of gas. LBF have problem obtaining keys (see entry for 15:30hrs)	See witness statement {MET00012710}
14:30	Excavation on to the 4" and 180mm gas mains started.	See witness statement {MET00012710}
15:30	Tactical Command Meeting at which it was reported that the Gas Authority was 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. Remaining fires were gas fed fires.	See LFB Log {MET00005756} See witness statement {MET00007693}
15:30	Jason Allday and Pat Kelly enter the basement under the instruction and supervision of LFB after obtaining keys from Latimer office <i>n.b. The police shielded Jason Allday and Pat Kelly from the debris that was still falling from the building with riot shields.</i>	See witness statement {MET00012710}
15:50	Jason Allday and Pat Kelly instructed by LFB to retreat from the basement due to concerns about the safety of the building - call over LFB radio "all resources out of building". Basement was flooded and as exiting, saw electricity still on	See witness statement {MET00012710}
16:00	Excavation of 4" and 180mm gas mains successfully completed. Repair teams working on the 12" main excavation instructed to retreat from the site.	
16:15	Incident Commander AC Ellis instructs SM Andrew Williams to assess if the gas supply can be shut down in the basement.	See LFB Log {MET00005756}
16:30	James Harrison, Head of Operations (Band B Manager) arrived on site	
16:35	Incident Commander AC Ellis declares a tactical withdrawal due to "booms and bangs".	See LFB Log {MET00005756}
16:50	SM Williams (47596J) reports that they gained access to the basement, however due to the tactical withdrawal they were unable to shut off the gas supply.	See LFB Log {MET00005756}
17:00	Tony Day/Jason Allday/James Harrison discuss safe system of work with LFB including LFB spotters to enable the excavation work on 12" main to continue.	See witness statement {MET00012710}
17:20	Teams return to work on the excavation of the 12" main under safe system of work	See witness statement {MET00012710}
17:50	The LFB Log reports that the Incident Commander "AC Ellis agrees for Gas authority to continue working within the hazard area to isolate supply to Grenfell Tower. The rationale for this is that the remaining fires in the tower are mainly gas fed fires. These will not go out until gas is isolated. 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."	See LFB Log {MET00005756}
18:20	LFB declare building unsafe - Repair teams working on the 12" main	See witness statement

01/10/2019

81

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

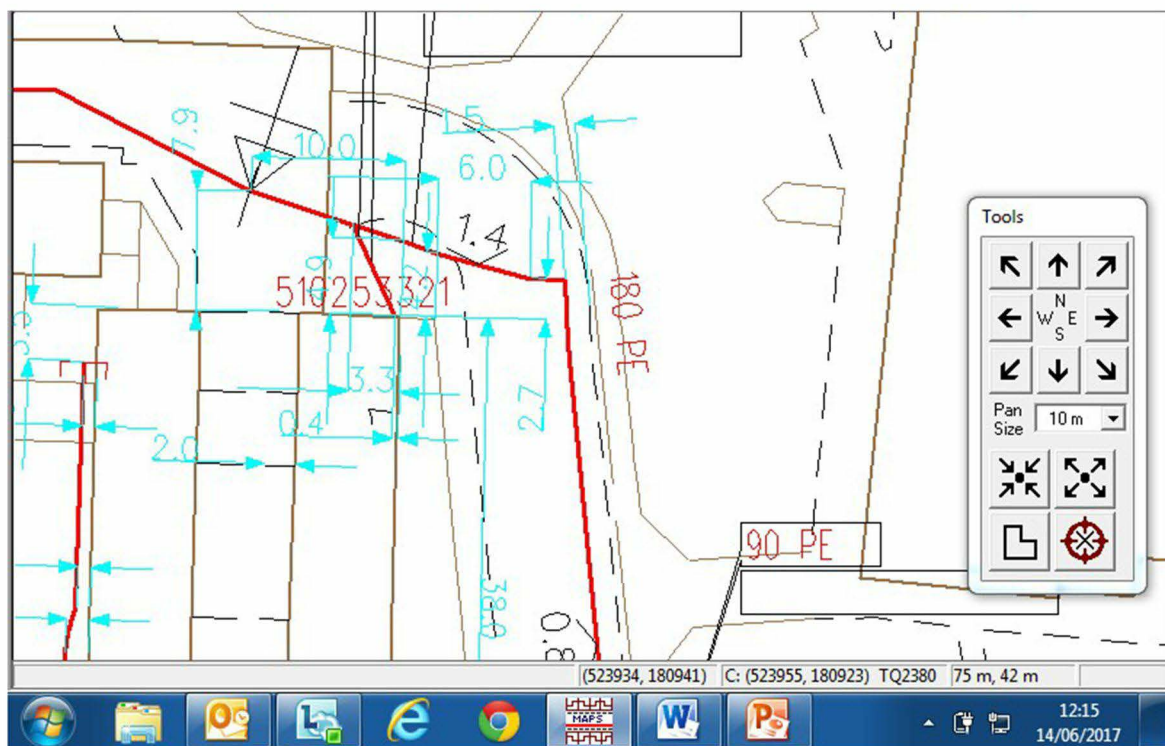
	instructed to retreat again	{MET00012710}
18:20	In view of the restriction of access, timeframe for completion of isolation has been revised to midnight 00:00	
18:27	Repair still awaiting access to the 12" gas main to complete isolation of supply.	
18:45	Tony Day/Jason Allday agree with LFB to continue with the excavations	
19:35	At the end of a Tactical Command Meeting, SM Andrew Williams reported [Cadent Gas were] unable to knock off gas supply in the basement as the gas authority would not enter the basement following their risk assessment. Fire crews [were] not able to knock off [the gas supply] without there [sic] assistance due to a complex piping system.	See LFB Log {MET00005756}
19:50	All teams and engineers in the area to wear face masks due to the asbestos in the building should it collapse.	
20:00	Isolation of 4" and 180mm mains confirmed	See witness statement {MET00012710}
20:10	In his witness statement AC Dominic Ellis states the he recommitted [resources] into the building. We had gas fed fires on floors 10, 11, 12, 13, 15 and various hot spots remaining throughout the building but generally anything else that was combustible had burnt away. The LFB log provides the following information with a time, which is out of sequence, of 21:10: minimal crews have already been committed into the building [in order] to provide an update to AC Ellis and carryout any immediate firefighting if required. 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.	See witness statement {MET00007693} See LFB Log {MET00005756}
20:15	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.	See witness statement {MET00012710}
21:00	AC Dominic Ellis inspected the building himself. He noted that "there were a few floors — four or six in total — where the gas pipes were burning but there was nothing for it to catch fire to. It was quite eerie. It was just a gas flame, like a large Bunsen burner in the middle of a reinforced concrete void".	See witness statement {MET00007693}
21:20	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 on site	See witness statement {MET00012710} See witness statement {MET00012831}
21:30	At the Tactical Command Meeting it was reported that 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. AC Dominic Ellis states in his witness statement that "we all then started planning for the next day. Our priority was to get the gas shut off and knock out and damp down the remaining fires".	See LFB Log {MET00005756} See witness statement {MET00007693}
22:30	Pipelines Maintenance Centre ("PMC") requested to attend to undertake permanent isolation of 15" main. Logged by SC at 23:24	
22:56	LFB Log reports that DAC Wayne Brown has taken over as Incident Controller from AC Dominic Ellis	See LFB Log {MET00005756}
23:40	Temporary Isolation of 15" gas main achieved. James Allday states in his witness statement that "We watched the fire flames inside the tower diminish almost immediately and there was a huge sense of relief". Confirmed by Tony Day. AC Dominic Ellis states in his witness statement that "he recalls	See witness statement {MET00012710} See witness statement {MET00007693} See witness statement

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

	speaking to Wayne Brown later that once the gas was turned off these fires pretty much went out by themselves. There was nothing left round them to burn and they sent crews in to double check and damp down”.	{MET00012830}
<b>June 15<sup>th</sup></b>		
03:30	PMC arrive to undertake flowstop and cut & cap of 15" gas main between temporary isolation bag and governor	
05:15	Nicola Wilkinson Band C Manager arrived on site	
06:15	Permanent cut and cap of 15" gas main confirmed	
06:15	Tony Day handover to Nicola Wilkinson	
06:45	Jason Allday handover to Nicola Wilkinson	See witness statement {MET00012710}
07:00	Dave Edwards arrived on site - day 2	
08:30	Nicola Wilkinson attended command meeting with LFB	
10:30	Final Bronze teleconference - incident closed	

**Table 3 – Timeline of Events Relating to the Isolation of the Gas Supplies**

184. The plans from the “Gobook” system used by Tony Day and James Allday on site to plan the shut off of supplies to the Tower are understood to be the following:



**Fig 42 - 180mm PE main in Grenfell Road {CAD00001989}**



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

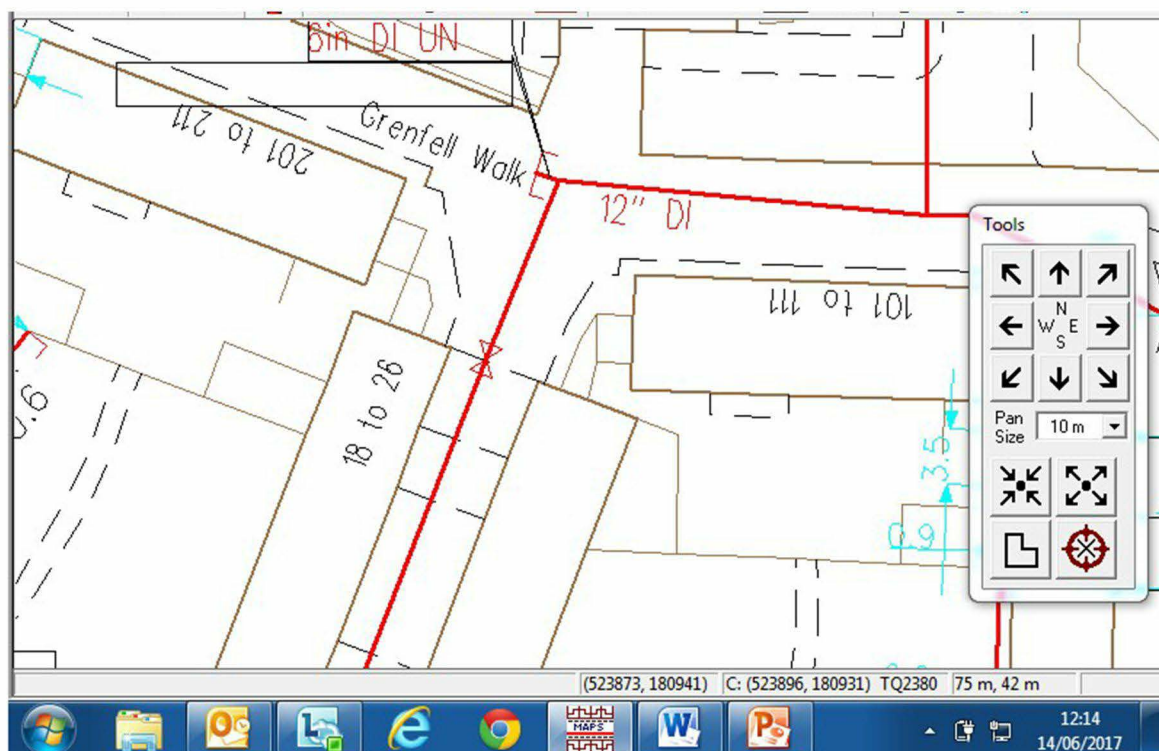


Fig 43 - 4" main in Testerton Walk {CAD00002190}

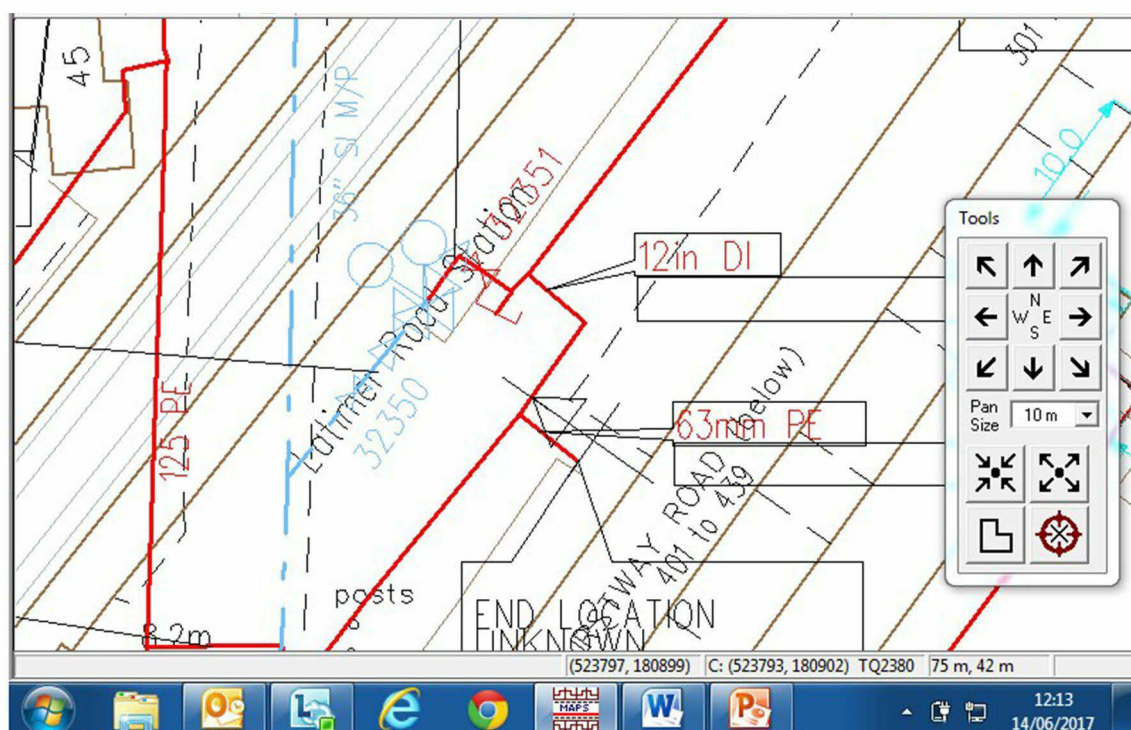
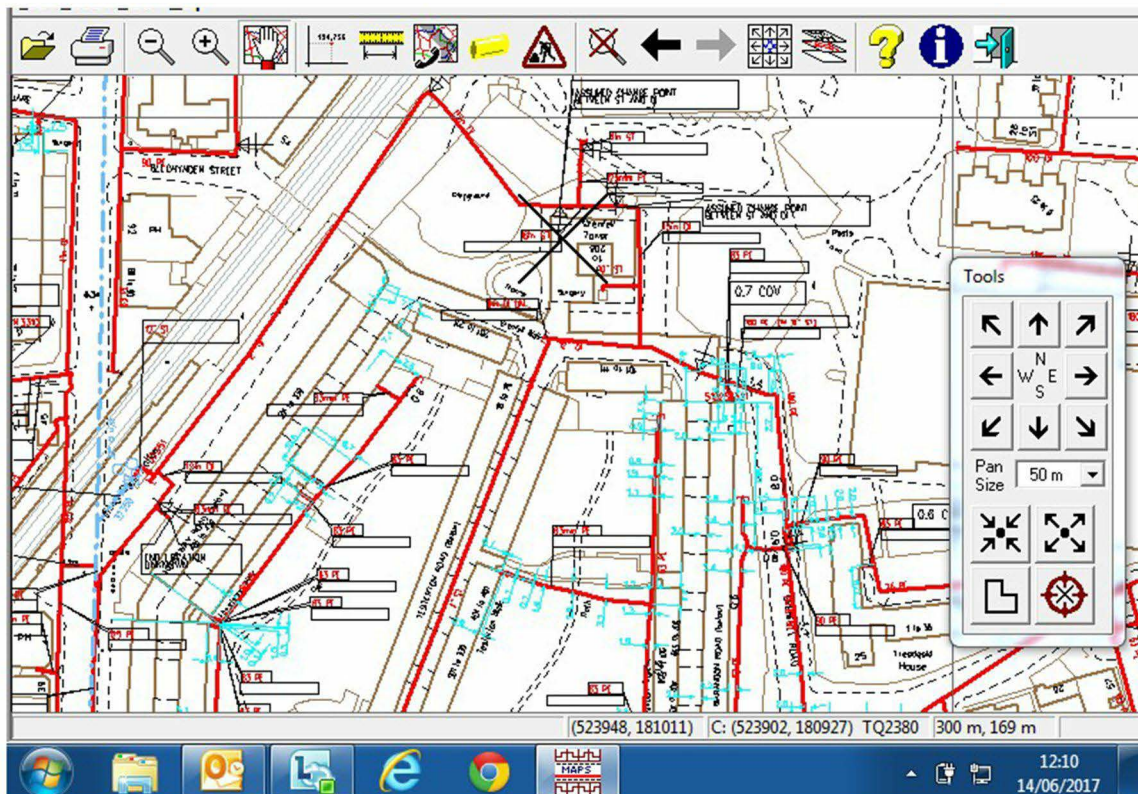


Fig 44 - 12" main at SW End of Station Walk {CAD00002240}

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Fig 45- Overview of the Site {CAD00002241}**

185. I understand that questions have been raised as to whether the Cadent Gas Ltd personnel on site should have known that the main in Station Walk was of 15 inch diameter. I have examined copies of Cadent Gas Ltd's network plans, including those on their Gobooks system reproduced as Figures 42 - 45 above. I have noted references to 12 inch diameter and the change of diameter symbol at the bend in the main to the north west of Grenfell Tower.
186. In his oral evidence to the Inquiry on 14<sup>th</sup> November 2018 Jason Allday described how he used the cursor on "gobooks" to "hover" over the main in Station Walk to bring up its digital record. He advised the Inquiry emphatically that this action revealed the main in Station Walk to be of 12 inches diameter.
187. I am of the opinion that it was very reasonable for the Cadent Gas Ltd personnel on site to assume that the main, at the location where it was eventually found, would be of 12 inch diameter. I do not believe it to be reasonable to expect them to have known the main was 15 inch diameter prior to it being exposed.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

188. Peter Hyatt, Repair Team Leader, has recorded in his witness statement {MET00012825} that he worked on the isolation of the 15" ductile iron main, which initially had been understood to be 12" diameter. A mini-excavator was able to be deployed but the vacuum excavators were not able to get to the site. Difficulties were experienced obtaining a trace of the main with his Cable Avoidance Tool and Transmitter (colloquially known as CAT and Gennie). The presence of a brick wall hindered progress. Five excavations were made before the main was located and Peter Hyatt estimated that the delay in locating the main accounted for approximately 4 hours of the time it took to complete the temporary isolation of this main.
189. Tony Day {MET00012830} recorded that the 15" main at a depth of cover of 1.5 metres was deeper than expected. He also recorded that the ground conditions were very stable such that there was no risk of the trench collapsing as the team excavated the ground to a depth sufficient to get all around the main.
190. With respect to the other isolation points both Tony Day {MET00012830} and James Harrison {MET00012831} report that they were within the exclusion zone and that hand excavation had to be carried out as excavators could not be deployed due to emergency vehicles blocking access.
191. Post incident Cadent Gas Ltd produced the following annotated plan.



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

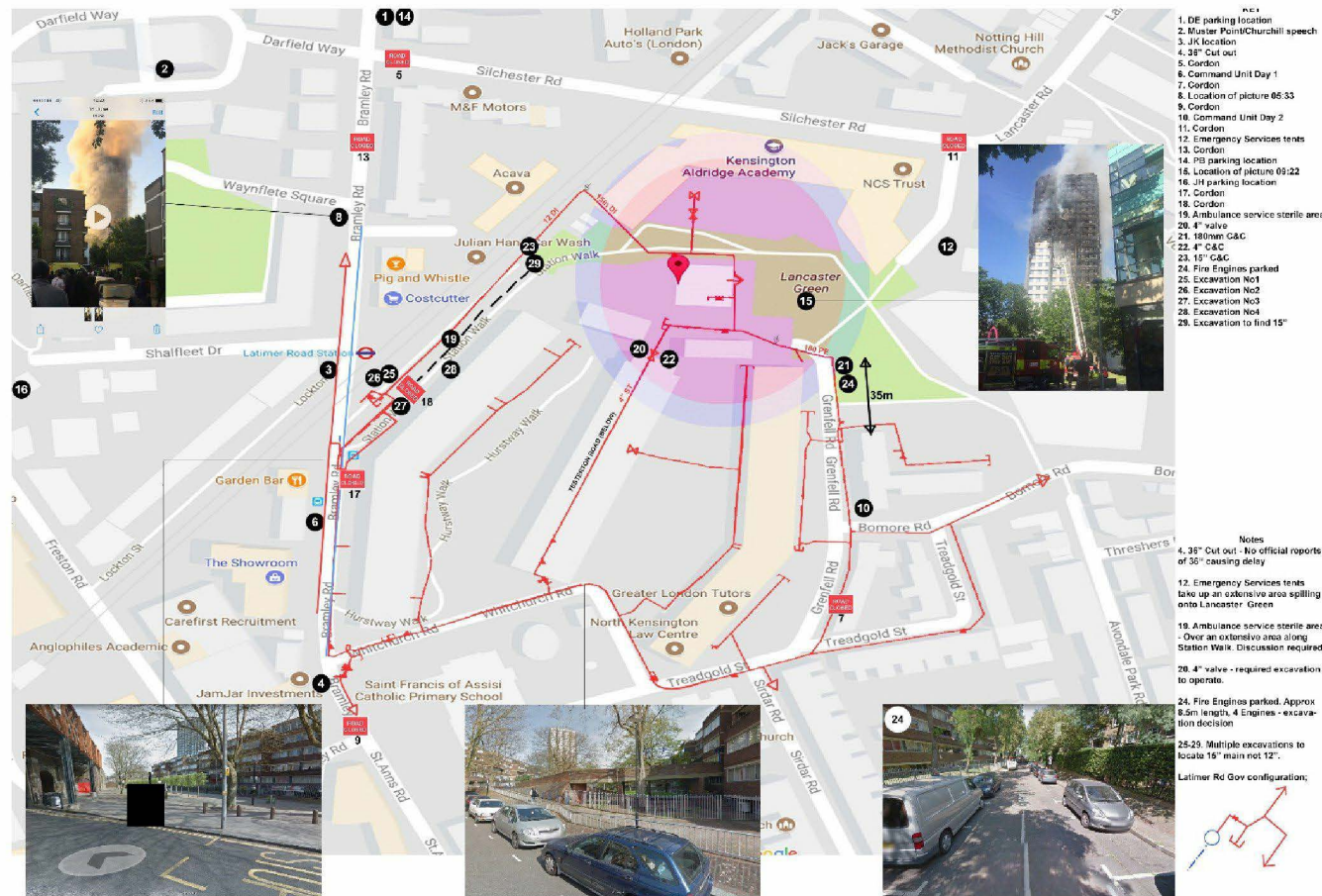


Fig. 46 - Post Incident Annotated Plan {CAD00002274}



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

192. From Figure 46, the following should be noted:

- Point 21 is the location of the cut and cap on the 180mm PE main;
- Point 22 is the location of the cut and cap on the 4" main
- Point 23 is the location of the cut and cap on the 15" main;
- Points 25 – 29 inclusive are excavations to find the main in Station Walk mentioned by Peter Hyatt in his witness statement {MET00012825} and by Jason Allday in his oral evidence to the Inquiry.

193. From Table 2 it is noted that:

- a) Cadent were not called to attend site until 03.22hrs i.e. 2 hours 27 minutes into the incident and 1 hour and 5 minutes after the request from LFB Command Unit 8 to LFB Central Control;
- b) Cadent personnel were “standing by” waiting for a request to turn the gas off for just under 4 hours;
- c) It took an hour and a half to obtain a key for access to the basement;
- d) Debris<sup>24</sup> was falling off the Tower into the area where PIVs were expected to be found from before Cadent were called to attend the incident;
- e) The building’s collapse was feared.

194. The following photograph, which was taken after the fire had been put out, shows debris at ground floor level on the eastern side of the Tower;

---

<sup>24</sup> There is spectacular video footage of falling debris in {IWS00000023} and {IWS00000453} in particular.



**Fig. 47 – Debris at Ground Floor Level {MET00015909}**

195. It is very apparent to me from the contents of Table 2 above and paragraphs 52 – 58 of James Allday’s Witness Statement {MET00012710} that there were significant risks to life associated with accessing the various valves located at high level in the basement during the afternoon of 14<sup>th</sup> June. From reading his and other witness statements, I believe those risks included building collapse, live electricity in a

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

flooded environment, fumes in a confined space and working at height assuming suitable ladders could have been brought into the basement.

196. In paragraphs 68 – 73 of his Witness Statement {MET00012710} Jason Allday describes the steps taken when it was discovered that the main shown as being 12” diameter was 15” diameter. Because of the urgency to isolate the gas supply it was decided to see if it was possible to over-inflate the 12” bags in order to effect a temporary seal of the main until equipment appropriate for stopping the flow in a 15” main could be brought to site by a specialist team from the National Grid Pipeline Maintenance Centre (PMC). It was found that the 12” bag could be inflated to a diameter of 14.5” which was sufficient to seal the main temporarily.
197. The specialist team from PMC arrived on site at 03.30 hrs on 15<sup>th</sup> June and completed the permanent isolation of the main at 06.15 hrs.
198. IGEM/TD/3 Edition 5 is the Institution of Gas Engineers and Managers current standard for the design, construction, operation and maintenance of Gas Distribution mains. Section 8.4 deals with methods of isolation and the first paragraph of clause 8.4.4.1 states
- For a metallic pipeline of OP [operating pressure] not exceeding 75 mbar, the equipment used for stopping-off shall utilize semi-supported bags for a nominal bore ≤ 300mm or fully supported inflated bags for larger bores. Unsupported bags shall not be used.*
199. The specification for semi-supported bags is for use on mains operating at less than 75 mbar and of a diameter up to and including 300mm (12”) is Gas Industry Specification GIS:E4.
200. Bags fitted with a backbone and extended neck complying with the gas industry specification GIS:E20A supported by bag tubes nominally ¼ of the diameter of the main being isolated are used for the isolation of larger diameter Ductile Iron low pressure gas mains. See figures 48 - 53 below for diagrams and photographs which are intended to help to explain the process of isolating Ductile Iron gas mains to the lay reader.

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

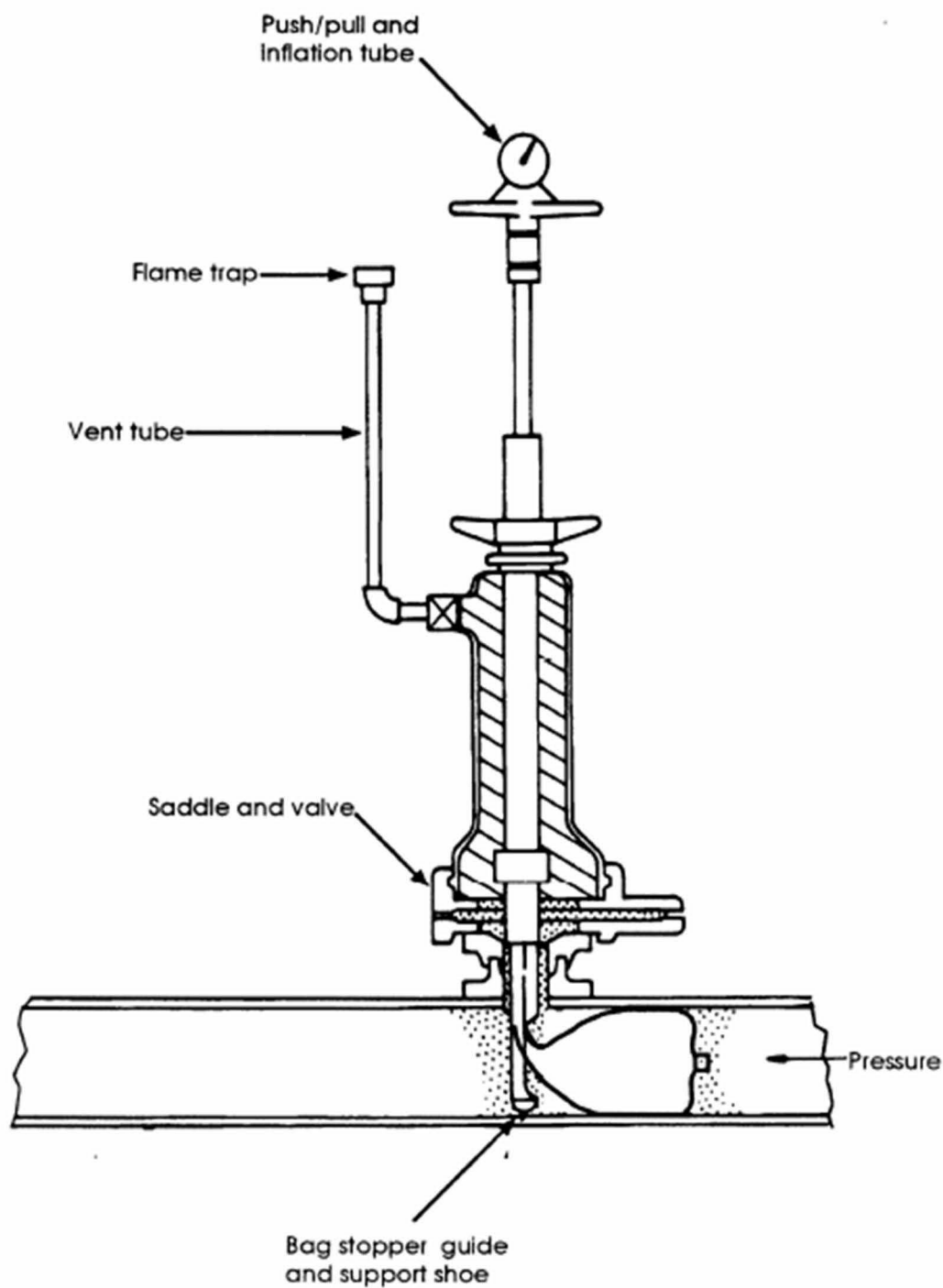
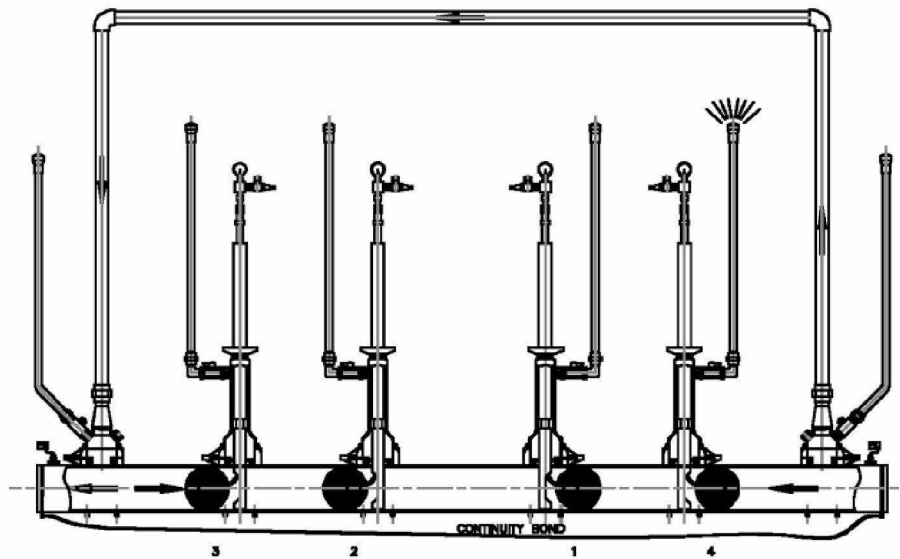


Fig. 48 – Diagram of Semi-supported bag to GIS:E4 in gas main



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Fig. 49 – Diagram of semi-supported Bagging Off Equipment Prior to Cutting and Capping Main Between Points 1 & 2;  $d \leq 12$ "**



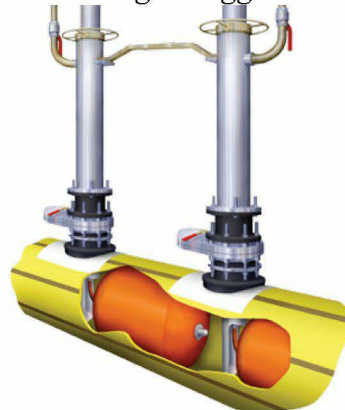
**Fig. 50 – Inflated Bag at End of Bag Tube**



**Fig. 51 – Cutting a Bagged Off Gas Main**



**Fig. 52 – Capped Gas Main**



**Fig. 53 – Diagram of Supported LP Bagging Off Equipment;  $d > 12$ "**

201. The following photograph {CAD00002832} shows the cut and capped 15" main.  
01/10/2019

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 54 – Permanently Cut and Capped 15” Ductile Iron Main**

#### **Regulations, Legislation, Guidance and Industry Practice**

202. Regulation 12 of the Pipeline Safety Regulations 1996 reads as follows:

*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.*

203. The HSE publication, HS(L)82 – Guide to the Pipeline Safety Regulations specifies that this regulation requires that adequate arrangements are in place in the event of an incident or emergency relating to the pipeline. In particular, arrangements should be



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

in place for loss of containment and for discovery of damage to, or a defect in, the pipeline which requires immediate attention or action. The detail and scope of the arrangements will vary according to the type of pipeline, its location and the fluid being conveyed. Where a defect in, or damage to, a pipeline is found which could affect the safety of the pipeline, but not requiring immediate attention, then consideration will be needed of appropriate action in such circumstances.

204. The publication goes on to state that in the case of gas pipelines subject to the Gas Safety (Management) Regulations 1996, these arrangements for incidents and emergencies may be referred to in the gas transporter's safety case.
205. Whilst the Gas Safety (Management) Regulations 1996, have already been discussed briefly in paragraphs 101 - 104 above, it should be noted that Regulation 7 deals with gas escapes and incident investigations. In particular, Regulations 7(4) and 7(5) place a legal obligation on the Gas Transporter to attend the site of a reported escape as soon as is reasonably practical. Also within 12 hours of being so informed of the escape, the Gas Transporter's Emergency Service Provider shall prevent the gas escaping.
206. Schedule 1 of the Gas Safety (Management) Regulations specifies the topics which have to be addressed in the safety case, one of which is "escapes and emergencies". I understand that in order to comply with these regulations Cadent Gas Ltd has a number of relevant procedures which are referenced in its safety case including:
- E/2 – Management procedure for Local Gas Supply Emergency;
  - EM/71 – Management procedure for dealing with gas escapes and other emergencies<sup>25</sup>;
  - EM/72 – Operational procedure for dealing with gas escapes and other emergencies.
207. The focus of Cadent Gas Ltd's procedures is understood to be the response to an incident caused by the escape of gas or the loss of gas supply. Nevertheless, the

---

<sup>25</sup> EM/71 is understood to make reference to co-operating with the Emergency Services and co-ordinating gas work with their actions.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

principles embodied in the procedures may be considered applicable to the events at Grenfell Tower on 14<sup>th</sup> June 2017. The key principle was that, from a gas perspective, stopping the flow of gas into the building as soon as practicable would make the situation safe. There is an underpinning assumption within the gas industry that under normal circumstances stopping the flow of gas into a multi-occupancy building would be achieved by closing the PIV/service valve.

208. The Institution of Gas Engineers and Managers published a standard IGEM/SR/29 – Dealing with Gas Escapes in 2012. It sets out the requirements for dealing safely with gas escapes. It does not address ignited gas escapes. Nevertheless, its underpinning principles are also relevant to dealing with all types of gas incident.
209. The hierarchy of priorities specified in IGEM/SR/29 and I believe also in EM/71 and EM/72, that should be applied in all cases is:-
- Safeguard life;
  - Safeguard property;
  - Find and secure all gas escapes;
  - Complete a final investigation before leaving site.
210. IGEM/SR/29 includes as an appendix a copy of a leaflet produced by the Gas Transporters' Incident Review Panel entitled "Safety Advice for Emergency Services Attending Gas Escapes". It has been disclosed as {CAD00002972} and it is reproduced as Appendix 6 of this report. Its content is consistent with the following extract from Page 16 of AC Dominic Ellis's Witness Statement {MET00007693}:-
- "we were allowing the gas to burn off in a controlled manner, as if we had extinguished them then there would be the danger of a build-up of gas with the risk of a gas explosion which could lead to a further collapse risk in the building."*
211. When called to assist the Emergency Services at a building fire, which is not considered to have been caused by gas, a Gas Transporter, such as Cadent Gas Ltd would be expected to:-
- a) Dispatch a First Call Operative (FCO) to site immediately with the standard of service that the operative would arrive on site within one hour;



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- b) Liaise with the Emergency Services as required. The Emergency Services are deemed to have control of the site;
- c) Turn off the gas supply at the ECV or any other accessible internal valve if requested by the Emergency Services and if it is safe to do so;
- d) Dispatch a Repair Team equipped with valve keys to site to turn off the gas supply to the building at the service valve/PIV if requested by the FCO and if safe to do so;
- e) Mobilise extra resources, including incident management teams, to disconnect the gas supply to the building by operating upstream strategic valves or cutting and capping gas mains as required if access to the service valve or other internal valve had not been obtained.

**Compliance and/or appropriateness in the circumstances**

- 212. As noted on the Riser Survey carried out on 30<sup>th</sup> September 2016 {CAD00000031} the valve boxes over the PIVs on the Landlord's Supply and Residential Supply No.1 were not visible. No evidence has been provided to indicate that steps were taken after 30<sup>th</sup> September 2016 to locate these PIVs, reinstate the valve box covers and so put those PIVs back into proper working order.
- 213. Given the quality of the as installed drawing, Fig. 37 above, I believe it is reasonable to assume that the PIV for Residential Supply No.2, would have been able to have been located and operated under normal circumstances.
- 214. However, the falling debris from the Tower prevented access to the area where the PIVs were expected to be found and I do not believe such circumstances constitute "normal circumstances".
- 215. As discussed in my response to Instruction No.1 and in paragraph 177 in particular, ideally access should have been available under normal circumstances to the valves in the basement. With the benefit of hindsight, it may be speculated that if the decision to access the basement had been made during the morning, say at 07.45hrs when LFB Command Unit requested the isolation of the gas supply, and if a key to the basement had been obtained quickly, the risks to life identified in paragraph 195 above may not

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

have been so great. (At that time there were no “booms and bangs”<sup>26</sup> suggesting the building was in imminent danger of collapse, neither would there have been so much water in the basement. There would, however, have still been the considerable risks associated with falling debris.)

216. Consequently, it may also be speculated that Cadent personnel, carrying ladders capable of reaching over 5 metres in height and with the employment of police using long riot shields to protect them from falling debris whilst they gained access to the basement, would have been able to operate the various valves therein.
217. The arguments in paragraphs 215 and 216 above are pure speculation. I am of the opinion that given the circumstances it is very unreasonable to have expected Cadent Gas Ltd personnel to have entered the basement with such long ladders to access and operate the valves located therein. (They were, after all, level 2 responders under the Civil Contingencies Act working under the control of LFB, the Level 1 responder.)
218. I understand that it has been suggested that the Latimer Road Pressure Reduction Installation<sup>27</sup> should have been turned off in order to isolate the gas supply to Grenfell Tower. The suggestion takes no account of the interconnectivity of the Low Pressure gas distribution system and the existence of other Pressure Reduction Installations farther afield as illustrated by Figure 1 above. Whilst this Pressure Reduction Installation is the principal source of gas supply to the area, I would expect any competent Gas Distribution Engineer to assume, unless he had specific information to the contrary, that switching off the installation would not result in the turning off of the gas supply to the area. This is because low pressure gas distribution systems in the UK’s towns and cities are very interconnected and other Pressure Reduction Installations farther afield would take over the supply especially in the middle of summer when there is no heating load.
219. I also understand that it has been suggested that all of the Pressure Reduction Installations feeding gas into the West London Low Pressure Distribution System

---

<sup>26</sup> As described in {MET00005756}.

<sup>27</sup> Traditionally pressure reduction installations have been referred to as “governors”. Strictly speaking the term governor applies to the pressure regulator which is one of the components which make up a pressure reduction installation. In his oral evidence to the Inquiry, Jason Allday used the term “governor” when referring to pressure reduction installations.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

should have been turned down on the grounds that whilst gas would have continued to fuel the fire in the Tower the fire would not have been so intense. The risks inherent in such a suggestion are that of a widespread loss of supply incident and at the Tower itself the gas flames may self extinguish initially followed by a build up of gas within the Tower that could then cause an explosion.

220. In addition to providing {CAD00003006} in response to the request for further information on 25<sup>th</sup> October 2018, Cadent Gas Ltd provided two colour coded plans to illustrate:
- a) The expected zones of influence of each of the Pressure Reduction Installations in the area {CAD00003007};
  - b) The effect on those expected zones of influence of shutting down the Latimer Rd. Pressure Reduction Installation {CAD00003008}.





Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

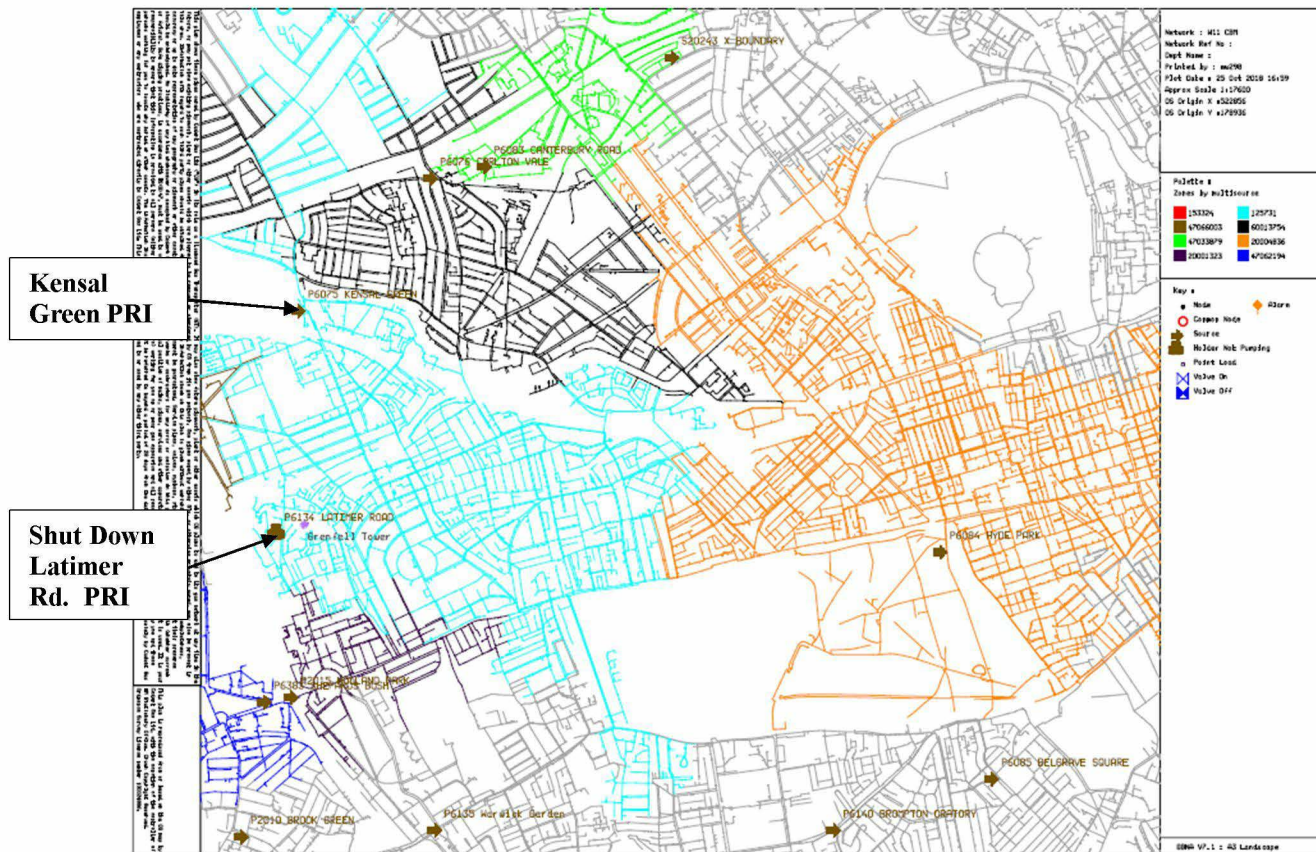


Fig 56 - Expected Zones of Influence of Other PRIs with Latimer Road PRI Shut Down {CAD00003008}

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

221. I am of the opinion that Figures 55 and 56 confirm the view that switching off the Latimer Road Pressure Reduction Installation would not have resulted in the turning off of the gas supply to the Tower and therefore the discarding of this option was correct.
222. I am of the opinion that the decision to isolate the mains system at the 3 locations was correct i.e. it was appropriate in the circumstances. I would like to think that if I had been the Engineer in control of the site in those circumstances, I would have made the same decision.
223. In paragraph 196 I have described the use of an over inflated [semi-supported] 12” bag to make a temporary seal of the 15” gas main. In paragraph 198 I have referenced the IGEM standard which states that a supported bag system shall be used to isolate a 15” low pressure gas main. Strictly speaking the action on site was a non-compliance with standards but I am of the opinion that the contravention was entirely appropriate in the circumstances.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

**Instruction No.3 - The extent to which the presence of gas in the Tower contributed to the spread of fire and/or the conditions inside Grenfell Tower on the night of 14 June 2017.**

224. In considering this instruction I will be referring in particular to Table 3 - Timeline of Events Relating to the Isolation of the Gas Supplies, the Witness Statement of AC Dominic Ellis {MET00005756}, data contained within CORGI's Revised Summary Report {MET00016759} and their associated Examination Log {MET00016762}, my own observations on site and the results of Cadent Gas Ltd's riser survey of 30<sup>th</sup> September 2016 {CAD00000031}. I will also refer to the witness statements of various fire fighters and Cadent personnel that contain relevant references to burning gas, some of which are timed and some of which are not timed.
225. The first reference in Table 3 to indicate that the presence of gas might be causing problems within the Tower is timed at 10.00hrs on 14 June 2017. Fire Officer Julian Spooner states in his Witness Statement {MET000086071} that "there were a lot of gas fires burning in the Tower" at the time he went outside the building and received a briefing from AC Dominic ELLIS. However, AC Dominic ELLIS states in his witness statement that he did not arrive on site until 11.19hrs which makes Julian Spooner's timing suspect.
226. Other references in Table 3 are as follows:-
- a) At 13.25hrs there is a reference to a gas fed fire on the 10<sup>th</sup> floor;
  - b) At 17.50hrs the LFB Log reports that "the remaining fires in the tower are mainly gas fed fires. These will not go out until gas is isolated....";
  - c) At 20.10hrs it was reported that there were "gas fed fires on floors 10, 11, 12, 13, 15 and various hot spots remaining throughout the building but generally anything else that was combustible had burnt away";
  - d) AC Dominic Ellis inspected the building himself at 21.00hrs. He noted that "there were a few floors — four or six in total — where the gas pipes were burning but there was nothing for it to catch fire to. It was quite eerie. It was just a gas flame, like a large Bunsen burner in the middle of a reinforced concrete void";

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- e) At the Tactical Command Meeting held at 21.30hrs, it was reported that there were still pockets of fire on multiple floors caused by the gas still supplied to the building. LFB stated that they were confident that these will go out once the gas supply had been isolated. At the same time AC Dominic Ellis states in his witness statement that “we all then started planning for the next day. Our priority was to get the gas shut off and knock out and damp down the remaining fires”;
- f) At 23.40hrs the gas supply to the Tower was isolated when the 12” bags were inserted into the 15” main and over inflated to effect a temporary seal (see Figures 48 and 50 and paragraph 194 above). James Allday of Cadent Gas Ltd in his witness statement {MET00012710} states that “We watched the fire flames inside the tower diminish almost immediately and there was a huge sense of relief”. Tony Day of Cadent Gas Ltd in his witness statement {MET00012830} confirms seeing the flames die down.

227. A number of fire fighters remarked on the presence of gas in their witness statements. They include:-

- a) John Graham {MET00005257} who stated that “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 [I] received confirmation that the gas had been dug up in the street and it was off, I moved the bridgehead up to [floor] seven only to have to return it to [floor] 4, 20 minutes later as the gas was not off. It then re-ignited fires below the bridge head.”;
- b) Stuart Beale {MET00007512} who stated “much of the fire on the East side was either burnt out or put out, there was a part that just continued to light up and the flames looked blue which made me think that perhaps there was a burst gas main. This seemed to be between the 11<sup>th</sup> – 13<sup>th</sup> floors on the East side”;
- c) Devani Dilleish {MET00007951} who stated “What you could see on some floors were blue flames, from my experience I would say that that was quite gas rich. Whether the gas mains had been isolated or turned off I don’t know. If the mains hadn’t been switched off there is a chance there was some gas still



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

in the pipework basically fueling the fire. There was a blue flame in a couple of flats and orange flames”;

- d) Jason King {MET00010813} who stated “I had heard that the gas had been turned off, however, I was absolutely convinced that through the middle of the building some 8 hours into this fire there was what looked like a self-propagating flame clear yellow in colour. I think it was burning in the centre of 8<sup>th</sup> floor everything else around it had burnt out but not this. After such a long time burning there couldn’t have been anything left to burn” and “As I left the tower it was a sunny day the fire was all but burnt out except for what I think was a train of a gas fire still alight which they were trying to put out it was a similar fire to the one I had seen earlier but this was now higher than 8<sup>th</sup> floor. We had been at this fire for about 12 hours....”;
- e) Ernest Okoh {MET000080593} who states that “I heard a number of loud cracks that sounded like mini explosions which, I believe, were coming from the gas piping.”;
- f) John Wright {MET000083339} who states “I could see what I believed to be Gas alight in some flats. Burning Gas is green colour flame. I did not see any members of the Gas Company at the scene.” From times he quotes elsewhere in his witness statement the inference can be drawn that his observation was made before 03.30hrs on the 14<sup>th</sup> June.

228. A number of residents have submitted witness statements in which they reference seeing “blue flames” and attributing those flames to gas. A typical example is that of Nina Masroh {IWS00000792} who stated in paragraph 10 of her witness statement

*██████████ pointed out blue flames at the top of the Tower. I saw them too but at first I did not understand the significance. Then ██████████ explained it, 'There's blue flames. That means there's gas.' The blue flames were moving and rippling like a waterfall but they were contained near the top of the building and were not moving further down”.*

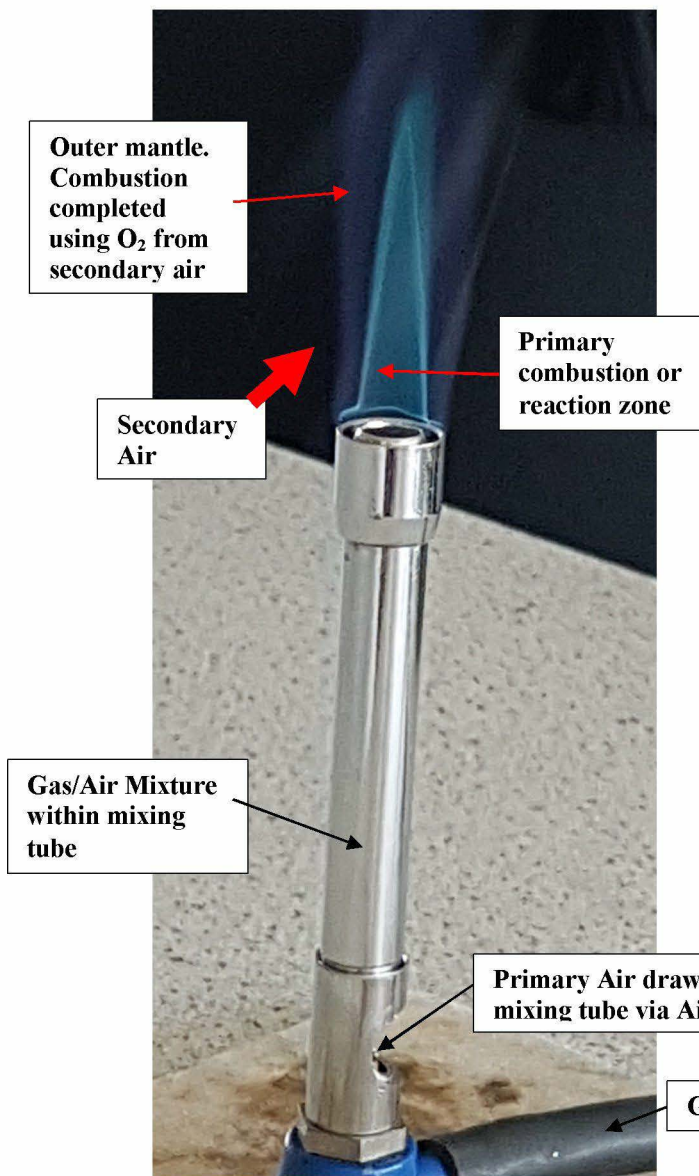
229. None of the witness statements provide a time as to when the “blue flames” were observed although the inference can be drawn from other observations in those witness statements that the “blue flames” were seen very early in the course of events.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

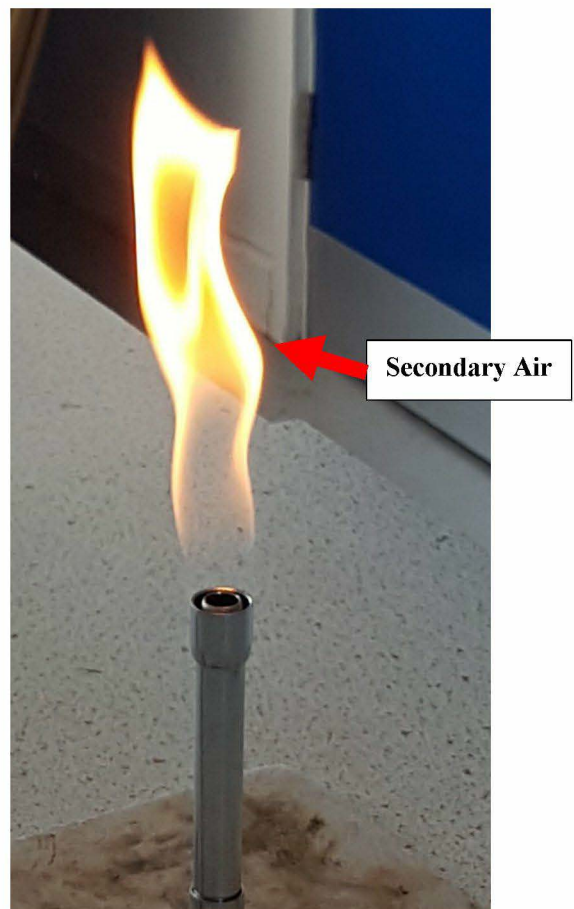
A number of the references to the “blue flames” suggest that they were on the outside of the building which is not where the gas infrastructure in the building was located.

230. Before proceeding with a re/sume/ of my observations during my visits to the Tower and other evidence I will discuss the combustion of natural gas in simple terms. Good combustion of natural gas can be identified by the presence of stable blue flames with a distinctive bright green-blue colour inner cone, sometimes known as a Primary combustion or reaction zone, and a distinctive bluish-purple outer cone. For such good combustion, air, known as “primary air”, is mixed with the gas before combustion takes place at the burner tip. To complete the combustion process, air, known as “secondary air”, is required around the flame. Please see Figure 57A below.
231. Poor or incomplete combustion of natural gas is characterised by long yellow unstable flames, which occur if there is too little or no primary air. Please see Figure 57B below which shows the effect of closing the Air Control on the Bunsen burner to shut off the supply of primary air.

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Fig. 57A – Bunsen Burner Flame With Primary & Secondary Air**



**Fig. 57B – Bunsen Burner Flame With Secondary Air Only**

(Photographs courtesy of staff at Aylesbury High School for Girls)

232. I would not have expected gas flames at Grenfell Tower to be coloured blue. A gas flame at the end of an open end of a pipe would not have been able to have had primary air injected into the gas stream prior to the point of combustion i.e. there would not have been the equivalent of the air control at the base of the Bunsen Burner.
233. Given the above I am very sceptical as whether the “blue flames” reported by residents were due to the burning of natural gas.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

234. During my visits to the Tower I inspected the riser in the stairwell and the branches/laterals in the lobbies. I saw no evidence to suggest that that pipework which constituted Residential Gas Supply No.2 had failed to contain the gas within it during the fire.
235. I observed numerous “burnt out” meter installations<sup>28</sup>, many of them where the Emergency Control Valve was either fully or partially in the “on” position thereby presenting an “open end” through which gas could have fed the fire.



**Fig. 58 – Two examples of burnt out meter installations**

236. CORGI Technical Services in their Revised Summary Report {MET00016759} and the associated Examination Log {MET00016762} recorded 26 installations where the ECV was either fully or partially in the “on” position thereby potentially presenting an “open end” through which gas could have fed the fire. There may have been other burnt out meter installations which were not observed as access could not be given to

---

<sup>28</sup> Due to the circumstances surrounding my first visit to site, I did not record the exact locations where I observed the burnt out meter installations. Please see Table 4 for a summary of relevant information gathered by CORGI Technical Services.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

CORGI Technical Services to all of the flats due to either access panels/boxing still being in place or debris or the removal of the meter installations to enable the installation of building supports.

237. The following table is a record of those 26 installations. It can be seen that the meter regulator had either melted or had been badly damaged in 18 of those cases. The remaining 8 “open ends” were due to either the meter or regulator being missing and the ECV being in the open position or even the ECV itself being missing and as such it cannot be claimed with certainty that the missing components were not removed after the fire during the clean up process. In addition, marked in **red** are those flats recorded in Table 14.10 of Dr Barbara Lane’s report {BLAR00000009} as having missing entrance doors.

Floor	Flat	Melted or Badly Damaged (i.e. Failed) Regulator	Meter or Regulator Removed	Floor	Flat	Melted or Badly Damaged (i.e. Failed) Regulator	Meter or Regulator Removed
5	<b>6</b>	√		17	<b>6</b>	√	
7	6	√		18	<b>3</b>	√	
8	<b>5</b>		√	18	<b>4</b>	√	
8	<b>6</b>	√		19	<b>1</b>	√	
10	<b>4</b>		√	19	<b>4</b>		√
12	<b>2</b>		√	19	<b>5</b>		√
13	<b>2</b>		√	20	<b>4</b>		√
14	3	√		20	<b>5</b>	√	
14	<b>6</b>	√		20	<b>6</b>	√	
16	<b>1</b>	√		22	<b>5</b>		√
16	3	√		22	<b>6</b>	√	
16	<b>5</b>	√		23	<b>4</b>	√	
16	<b>6</b>	√		23	<b>6</b>	√	

**Table 4 – Open Ends & Missing Entrance Doors (marked in red)**

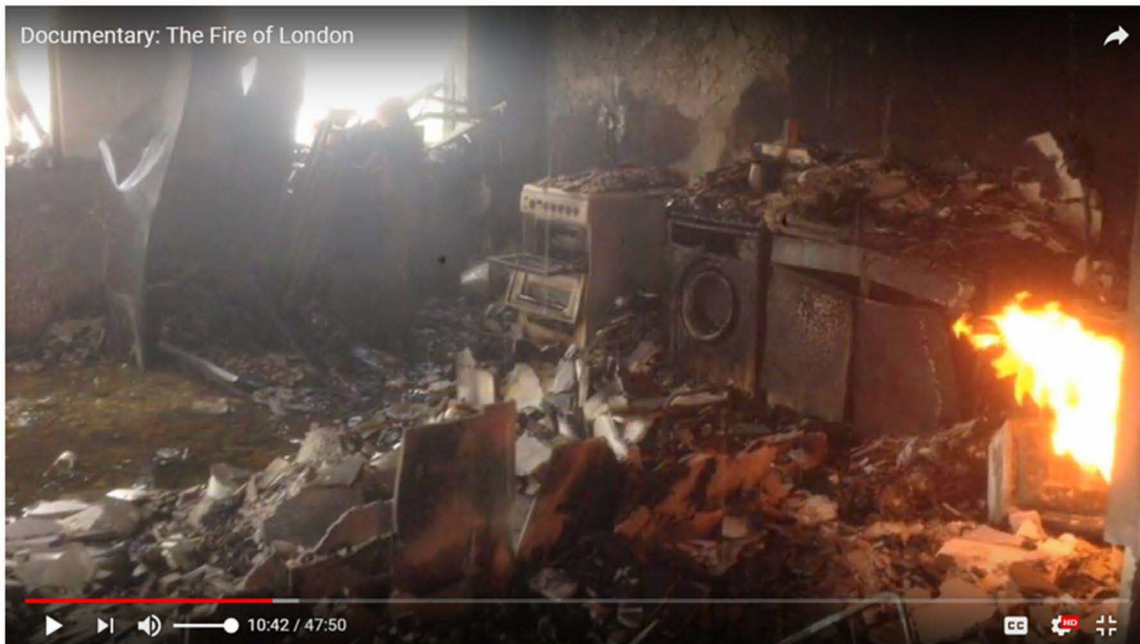
238. Whilst steel pipe is non-combustible the components of a meter installation are not, and I believe, never have been required to be non-combustible. Gas meters to BS EN 1359 and pliable connectors to IGEM/GM/PRS/6 are specified therein to be fire resistant for 30 minutes. Meter Regulators, which are of an aluminium alloy construction, are manufactured in accordance with IGEM/GM/PRS/3, which does not include any reference to fire resistance testing.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

239. Cadent Gas Ltd has submitted a Power Point presentation to the Inquiry {CAD00002970}. It contains the following slide:

**Grenfell Tower Internal Photograph**

**This is believed to be a flat ending with either the number '3' or '6' with the gas service pipe/meter installation on fire**



**Fig. 59 - Extract from {CAD00002970}.**

240. It is noted that the flames are yellow in colour, which is consistent with the absence of primary air. Air for combustion in this case is coming from the surrounding atmosphere i.e. it is secondary air. (See paragraphs 228 - 231 and Figures 57A and 57B above.)
241. In addition to observing “burnt out” meter installations I observed that the riser supplying flats with numbers ending in 5 was ruptured in Flat 5 on the 14<sup>th</sup> floor i.e. Flat no. 115. Just above the point where the riser reduces in diameter from 2 inches to 1½ inches there is a tee, the branch of which is for the lateral supplying the flat, and the rupture at the in-line socket can be seen in Figures 60 and 61 below.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 60 – Ruptured 1½” Riser in Flat 5 on 14<sup>th</sup> Floor i.e. Flat No. 115**





Fig. 61 – Magnification of Rupture {MET00016615}

242. It can be seen from the above photographs that the rupture occurred on exposed threads immediately outside of a screwed socket connection. There is a further split near the end of the exposed threads. In my experience, poorly protected exposed threads in the vicinity of threaded sockets are a weak point in screwed steel pipe systems due to their susceptibility to corrosion in the medium to long term.
243. I note from Dr Barbara Lane’s report that Flat No 115 (i.e. Flat ending with the number 5 on the 14<sup>th</sup> Floor) had a missing entrance door.
244. {CAD00002970} includes slides in which flat numbers containing live meter point reference numbers<sup>29</sup> have been superimposed on to photographs of the Tower i.e. flats known to be being supplied with gas. The following two slides illustrate the extent of the fire in flat 115:



<sup>29</sup> Each gas service is allocated its own unique meter point reference number (MPRN). The consumer can find it on their gas bill. The system is administered by Xoserve, the central data service provider for the UK’s gas market.



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

Fig. 62 - Extract from {CAD00002970}.

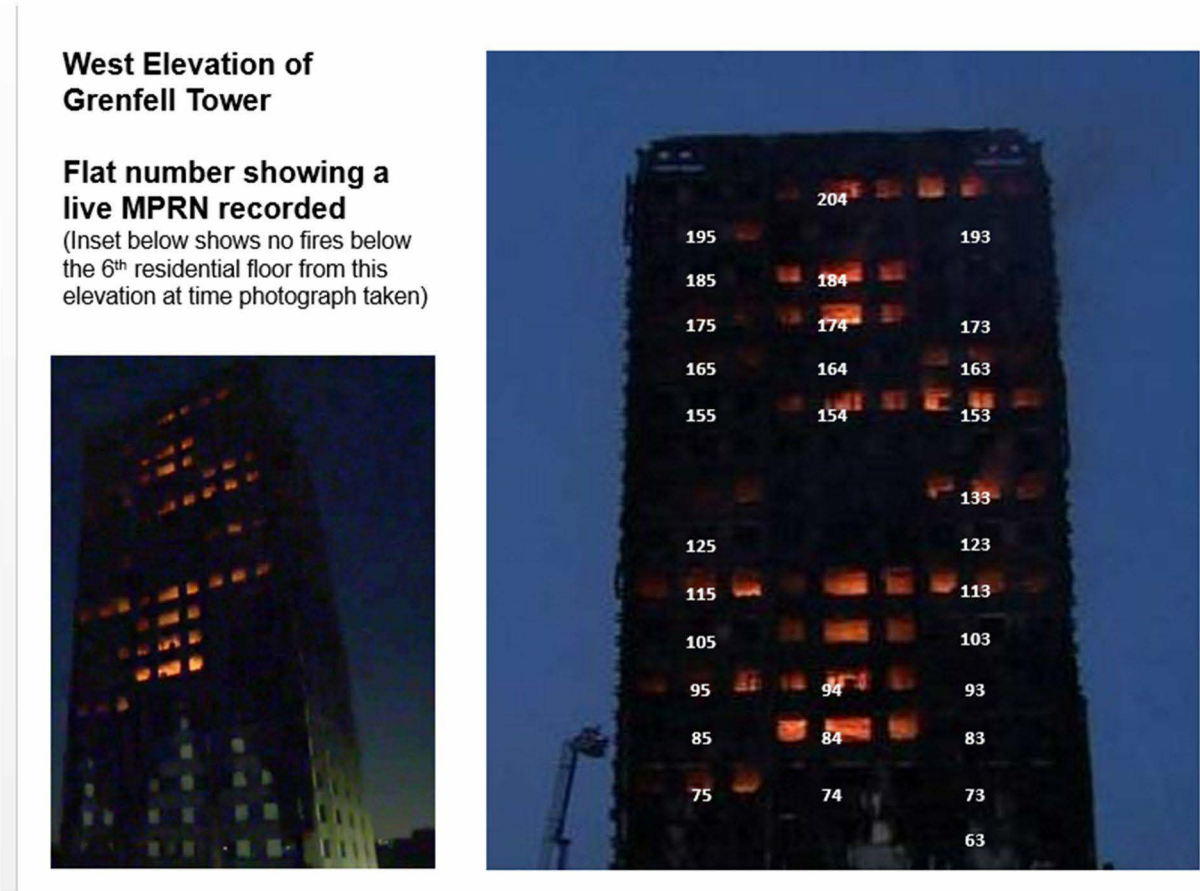


Fig. 63 - Extract from {CAD00002970}.

245. I noted from the CORGI Technical Services Examination Log {MET00016762}, taken between 18 December 2017 to 3 April 2018, that their surveyors observed numerous cases of distortion or warping of the risers making up Residential Gas Supply No.1 as follows:

The riser serving flats with the number ending in	Observed to be distorted/warped at Floors
1	11, 13, 15, 16, 18, 20, 21, 22 and 23
3	15, 16, 17, 18, 19, 20, 21 and 22
4	10, 11, 16, 17, 18, 20, 21, and 22
5	20 <sup>30</sup>
6	10, 11, 15 and 21

Table 5 – Risers Observed to be distorted/warped

<sup>30</sup>This was in addition to the rupture at Floor 14.  
01/10/2019



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

246. The following photograph shows the distorted/warped riser serving flat No 193 on the 22<sup>nd</sup> floor.



**Fig. 64: Distorted/Warped Riser serving flat No 193 on the 22<sup>nd</sup> floor {MET00016575}**



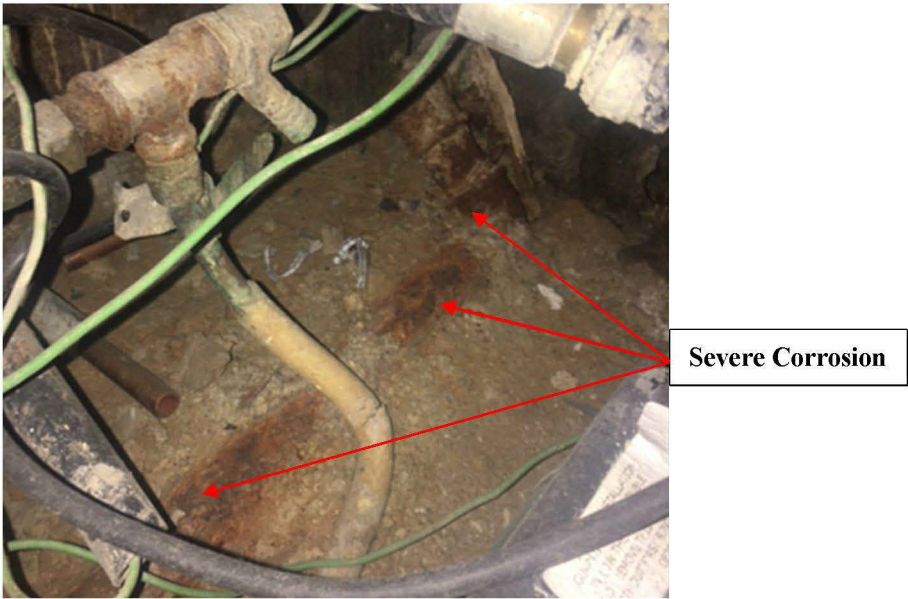
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

247. I also noted from the CORGI Technical Services Examination Log {MET00016762} that their surveyors observed at least 14 cases of fire damaged cookers.

Floor No	Flat with No Ending in
7	3 & 6
8	1 & 4
9	3
11	3
12	3 & 5
16	2 & 3
18	3
19	1 & 5
20	5

**Table 6 – Fire Damaged Cookers**

248. Cadent Gas Ltd’s Riser Survey Report of 30<sup>th</sup> September 2016, {CAD000000031}, recorded the identification of severe corrosion on the lateral within Flat No. 165, which I understand to be the Flat with the number ending in 5 and which is located on the north west corner of the 19<sup>th</sup> Floor of the Tower. The Cadent Gas Ltd surveyors attributed the corrosion to a water leak emanating from an old hot water tank located above the pipe. The Cadent Gas Ltd surveyors also identified moderate/severe corrosion on the lateral within Flat No. 105, which I understand to be Flat 5 on the 13<sup>th</sup> Floor.



**Fig. 65 – Severe Corrosion on Lateral within Flat No. 165 {CAD000000031}**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

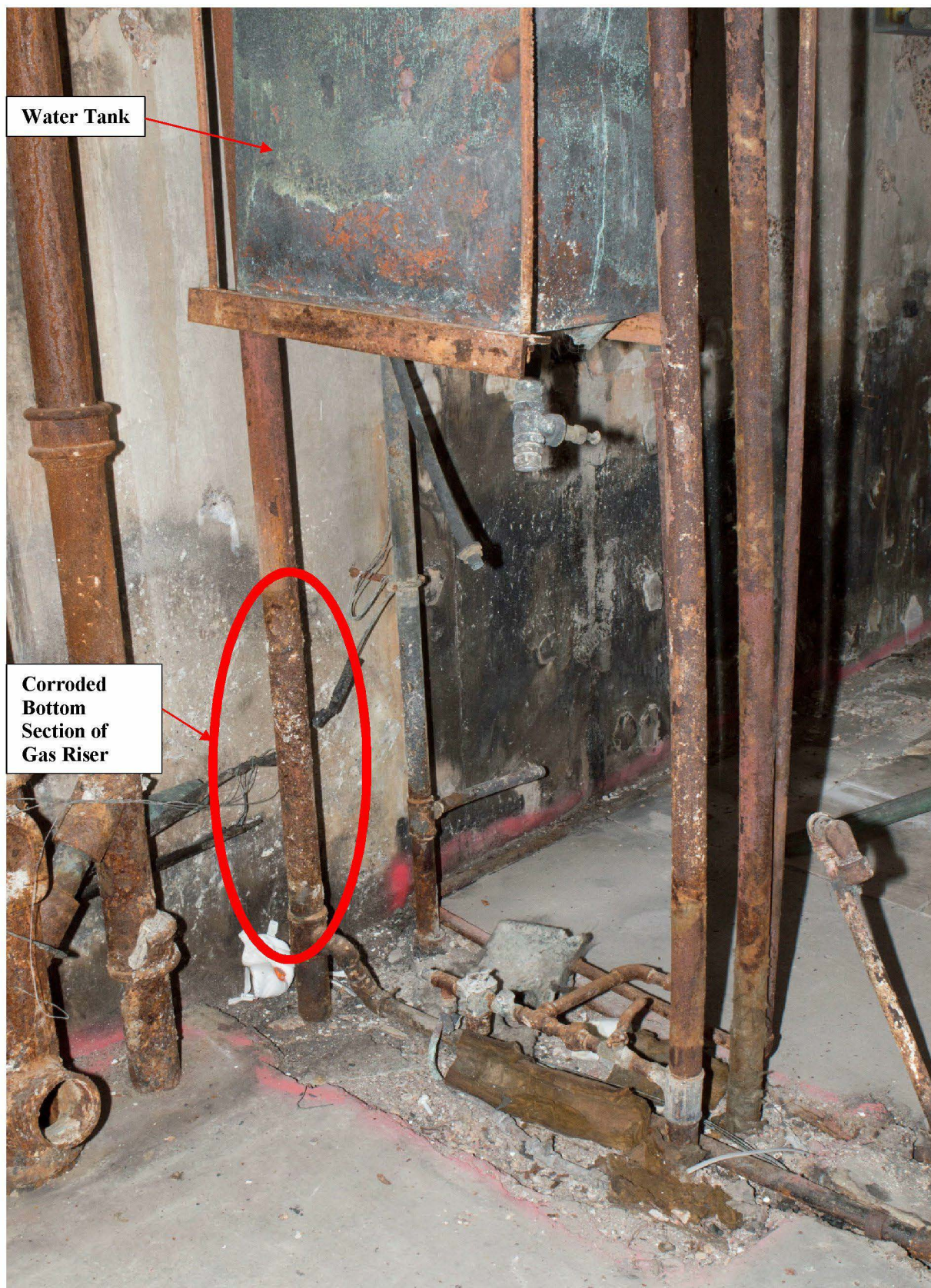


**Fig. 66 – Moderate/Severe Corrosion in Flat 105 {CAD00000031}**

249. The following photograph was taken in flat 105 i.e. flat 5 on the 13<sup>th</sup> floor, when I visited site on 30<sup>th</sup> May 2018. Corrosion on the bottom third of the riser and the water tank referenced by the Cadent Gas Ltd surveyors in {CAD00000031} can be seen.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 67 - Water Tank & Corrosion on Bottom  $\frac{1}{3}$  of Riser in Flat 105 {MET00016564}**



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

250. The Cadent Gas Ltd surveyors also recorded that the risers were not sleeved through the floors. The pipe was embedded in the concrete. From my visit I concur with that observation as do CORGI Technical Services in their Revised Summary Report {MET00016759} and the associated Examination Log {MET00016762}. As discussed in paragraphs 257 and 297 below, the rupture of the riser at Flat 5 on the 14<sup>th</sup> floor (see Figures 60 and 61 above) may have been due to stress caused by the application of prolonged extreme heat on the pipe that was rigidly fixed at the floor and ceiling, coupled with the presence of a corrosion induced weak point. It is not known when the riser serving flats with numbers ending in 5 was ruptured.

### **Discussion/Conclusions**

251. From my observations and in the absence of any evidence to the contrary, I am of the opinion that the gas supply to the boilers in the basement and the boilers themselves did not have any particular relevance to the events of 14<sup>th</sup> June 2017.

252. Similarly, excluding the associated meter installations, there is no evidence that the riser and associated lateral pipework forming Residential gas supply system No.2 leaked during the fire.

253. It is clear from Table 2 and AC Dominic Ellis's Witness Statement {MET00007693} that from mid-afternoon on the 14<sup>th</sup> June most of the remaining fires were gas fed. The presence of gas fed fires is confirmed by the observations of other fire fighters.

254. It is possible to make a very rough estimate of the flow of gas from the ruptured 1½ inch pipe and 18 definite meter related "open ends" feeding the fire. In section A1.1 of The Investigation and Control of Gas Explosions in Buildings and Heating Plant by Dr R J Harris (ISBN 0-419-13220-1) an equation to determine the gas flow rate through an open ended pipe is presented. That equation is:

$$Q = 0.00403 \times (((P1 - P2) \times D^{4.8}) / (S^{0.8} \times L))^{0.555}$$

Where Q = gas flow rate in m<sup>3</sup>/hr at 15<sup>0</sup>C and atmospheric pressure;

(P1 – P2) = pressure drop along the length of pipe in mbar;

D = internal diameter of the pipe in mm;

S = specific gravity of the gas;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

L = length of pipe over which the pressure drop occurs in metres.

255. I have assumed that:

- a.  $(P1 - P2)$  is 24 mbar;
- b. D for the 1½ inch pipe is 40.3 mm;
- c. D for the 1 inch open ends is 25.7 mm;
- d. S is 0.6;
- e. L is 60 m being the approximate distance from the 15 inch gas main outside of the building to the 14<sup>th</sup> Floor.

256. The resulting estimated flow of gas being discharged is 370m<sup>3</sup>/hr, which is approximately equal to the design flow rate for an estate of 370 dwellings.

257. One of the remaining original risers and its associated laterals within the flats, i.e. the one supplying flats with numbers ending in 5, was observed by the Cadent Gas Ltd surveyors to be suffering from severe corrosion. The rupturing of the riser in flat no. 115 on the 14<sup>th</sup> floor, is in my opinion likely to be due to a combination of the poor condition of the pipe at the time of the fire and the stress on the pipe from building movement <sup>31</sup>and/or thermal expansion given that it was held rigid in the concrete floors.

258. I have noted in Table 4 above that 23 of the 26 dwellings in which there were potential “open ends” had missing entrance doors. The entrance door to flat 115, which contained the ruptured riser, was one of those that were missing. I have also noted that Dr Barbara Lane in paragraph 14.6.69 of her supplementary report {BLAS0000014} concluded that there was no evidence of significant fuel load generally present in the lobbies. She also concluded in paragraph 14.4.70 that most of the heat in the lobbies probably originated from within the flats. Consequently, I believe it is possible that flames from the burning gas in some of the dwellings may have travelled as far as the front doors and into the lobbies when gas was fuelling the fire from late-morning on 14<sup>th</sup> June 2017.

---

<sup>31</sup> See Table 5 and Figure 64 above for evidence of distorted pipes which may have been caused by a combination of building movement and thermal expansion given that the pipes were held rigid in the concrete floors.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

259. I have also noted that Dr Barbara Lane, in paragraph 14.4.166 of her supplementary report {BLAS0000014}, has concluded that the “hot zone” she had identified at levels 13 – 16 may have been a temporary condition that occurred around 02.00 – 0230. If that is the case, I believe it is unlikely to have been caused by burning natural gas because evidence from fire fighters does not mention gas fires until approximately 08.00hrs<sup>32</sup>.

---

<sup>32</sup> Jason King {MET00010813} stated “I had heard that the gas had been turned off, however, I was absolutely convinced that through the middle of the building some 8 hours into this fire there was what looked like a self-propagating flame ...”



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

**Instruction No.4 – Address in so far 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 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.**

## **A. Landlord Supply**

260. The Landlord Gas Supply system is described in paragraphs 30 - 40 above. It is shown on Cadent's plans {CAD00002174} complete with a Service/Pipeline Isolation Valve, as can be seen in Figure 29 above. Within the building it was only located in the basement, which was not affected by the fire.
261. As discussed in paragraph 158 above, the riser survey exercise carried out at the end of September 2016 {CAD00000031} did not locate a PIV/service valve on this 40+ year old "service" into the building. I did not find one on either of my visits and, I understand, neither did the Metropolitan Police Service in conjunction with CORGI Technical Services when they lifted available surface box and manhole covers. The covers were found to be over electrical, water, BT apparatus and drains.
262. I believe it is possible that the gas valve box was removed and not reinstated when landscaping and/or re-surfacing work has been carried out in the interim, i.e. the valve has been "lost" rather than that it was never installed. As I stated previously in paragraph 163 above, I have concluded that, as at 14<sup>th</sup> June 2017, the PIV/service valves on the Landlord Supply had not been kept in working order as required by the Gas Act and Regulation 13 of the Pipeline Safety Regulations 1996 and which are discussed in more detail in paragraphs 85 - 100 above.
263. Notwithstanding the non-compliance relating to the maintenance of access to the service valve, from my observations on site and the absence of any evidence to the contrary I am of the opinion that the gas supply to the boilers in the basement and the boilers themselves did not have any particular relevance to the events of 14<sup>th</sup> June 2017.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **B. Residential Supply No.1**

264. The original gas supply system to the flats was installed when the Tower was built, sometime in the three year period 1972 – 1974. I have been given to understand that it was designed in or around 1967. It is described in paragraphs 41 - 50 above.
265. The regulatory and standards regime applicable to the design and construction of Residential Supply No. 1 and covering the period 1972 – 1974 was:
- a) London Gas Undertaking Regulations 1954;
  - b) Gas Safety Regulations 1972 (superceded the London Gas Undertaking Regulations 1954 on 1<sup>st</sup> December 1972);
  - c) BS Code of Practice 331 – 101: Gas Service Pipes (published in 1957);
  - d) Institution of Gas Engineers Communication 563 – Recommendations for the Laying of Steel gas service pipes (published in 1962);
  - e) Institution of Gas Engineers document IGE/TD/4 – Edition 1: Laying of Steel and Ductile Iron Gas Service Pipes (published in November 1973<sup>33</sup>)
266. From my observations on site, the Cadent Gas Ltd survey of 30<sup>th</sup> September 2016 {CAD00000031} and the CORGI Technical Services summary report {MET00012524} a number of compliance issues relating to the original design and construction have been identified. These issues are discussed below.

### **Provision of a Service or Pipeline Isolation Valve**

267. As with the Landlord Supply, the riser survey exercise carried out at the end of September 2016 {CAD00000031} did not locate a PIV/service valve on this 40+ year old “service” into the building. I did not find one on either of my visits and, I understand, neither did the Metropolitan Police Service in conjunction with CORGI Technical Services when they lifted available surface box and manhole covers.
268. In an e-mail dated 12<sup>th</sup> October 2016, Simon Boygle<sup>34</sup> identified a route for the replacement of the riser which had been cut off on 1<sup>st</sup> October 2016

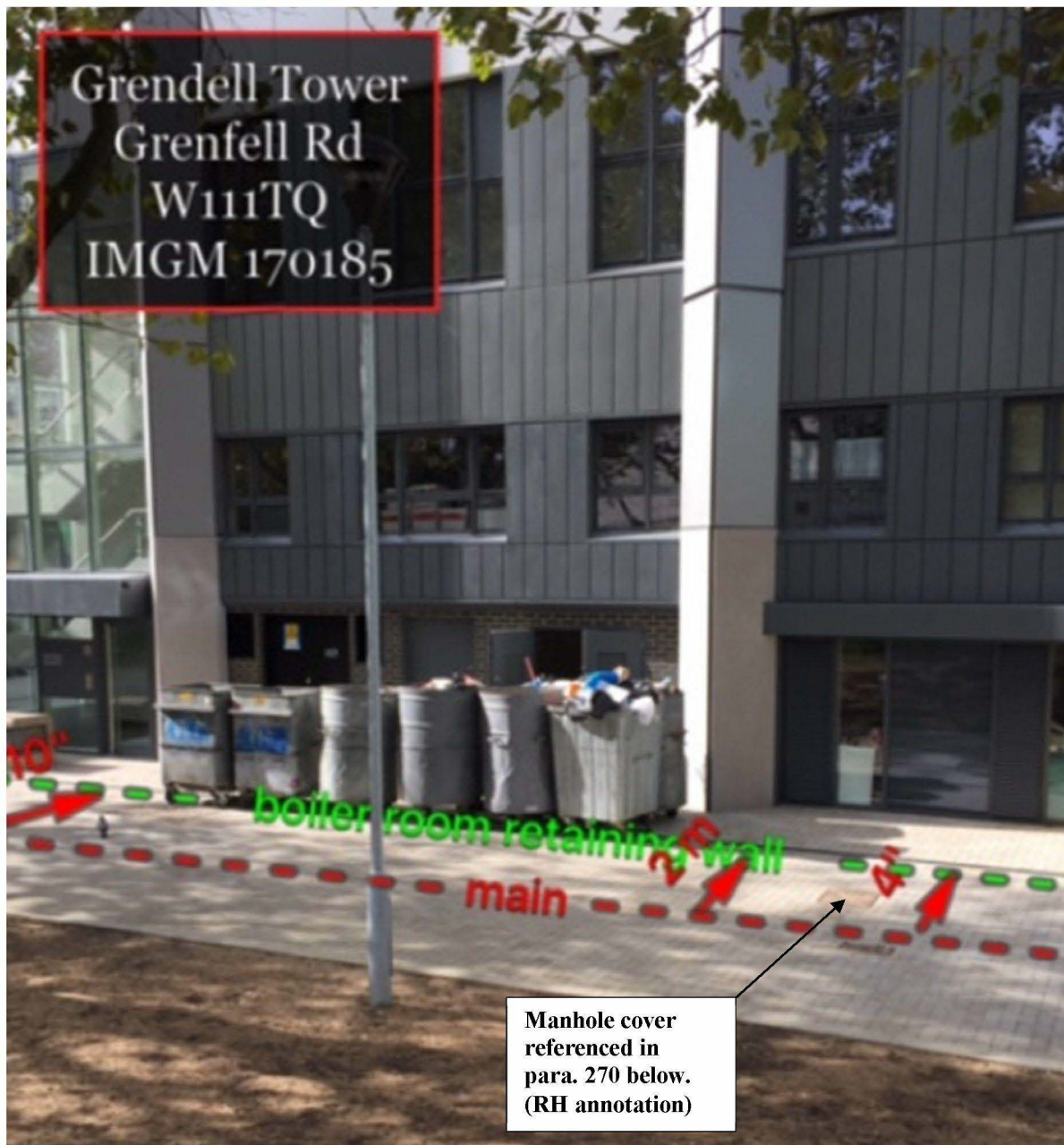
---

<sup>33</sup> This superceded Communication 563 when it was published.

<sup>34</sup> Simon Boygle trades as London Operations – Gas and he was sub-contracted through the pipeline replacement contractor, K & S Pipe Contractors LLP, to survey the Tower in order to determine a suitable route for the replacement riser and laterals i.e. Residential Gas Supply No.2. (See {TRI000001793} – tRIIO Position Statement).

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

{TRI0000000044}. It included a number of annotated photographs, which have been catalogued separately; one of which {TRI0000000050} is reproduced below.



**Figure 68 – Annotated Photograph {TRI0000000050}**

269. Figure 68 shows the 15" main, to which the gas supplies into Grenfell Tower were connected, was located under a block paved road that was in pristine condition. A manhole cover can be seen to the left of the marked route of the 4" Residential gas supply No. 1. There is no sign of a valve box on the route of Residential gas supply No. 1.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

270. Given that the gas valve box was observed during the survey carried out in September 2008 by National Grid Gas {CAD00002989}, I believe it is likely that the gas valve box installed at the time the “service” was constructed over 40 years ago was removed and not reinstated when landscaping work was carried out during the Tower’s refurbishment.
271. As discussed in the response to Instruction No. 2, the falling debris from the Tower prevented access to the area where the PIVs were expected to be found. Nevertheless, it would appear that, as at 14<sup>th</sup> June 2017, the PIV/service valve on Residential Gas Supply No. 1 had not been kept in working order as required by the Gas Act and Regulation 13 of the Pipeline Safety Regulations 1996 and which are discussed in more detail in paragraphs 85 - 100 above.

### **Protection from Corrosion**

272. The reason for addressing this topic is that corrosion over time reduces the thickness of the pipe wall and creates a point of weakness, at which the pipe is most likely to rupture when the pipe comes under stress from the differential movement of the pipe and the building caused by the fire.
273. Regulation 8 of the London Gas Undertaking Regulations 1954 addresses protection from corrosion. It reads as follows:

*Where a service pipe passes through or is in contact with or is likely to be exposed to any material to cause the corrosion of such pipe, such pipe shall be constructed of material which is inherently resistant to such corrosion or shall be of such construction as to have an integral casing of bituminous, bituminous/rubber, plastic or other corrosion resistant material reinforced where appropriate with a textile or other suitable insertion, the whole permanent casing being resistant to such corrosion.*

274. Regulation 8 of the Gas Safety Regulations 1972 also addresses protection from corrosion and it reads as follows:

*All service pipes installed shall be constructed of material which is inherently resistant to corrosion or shall be protected against corrosion externally and, unless there is no risk of internal corrosion, internally.*



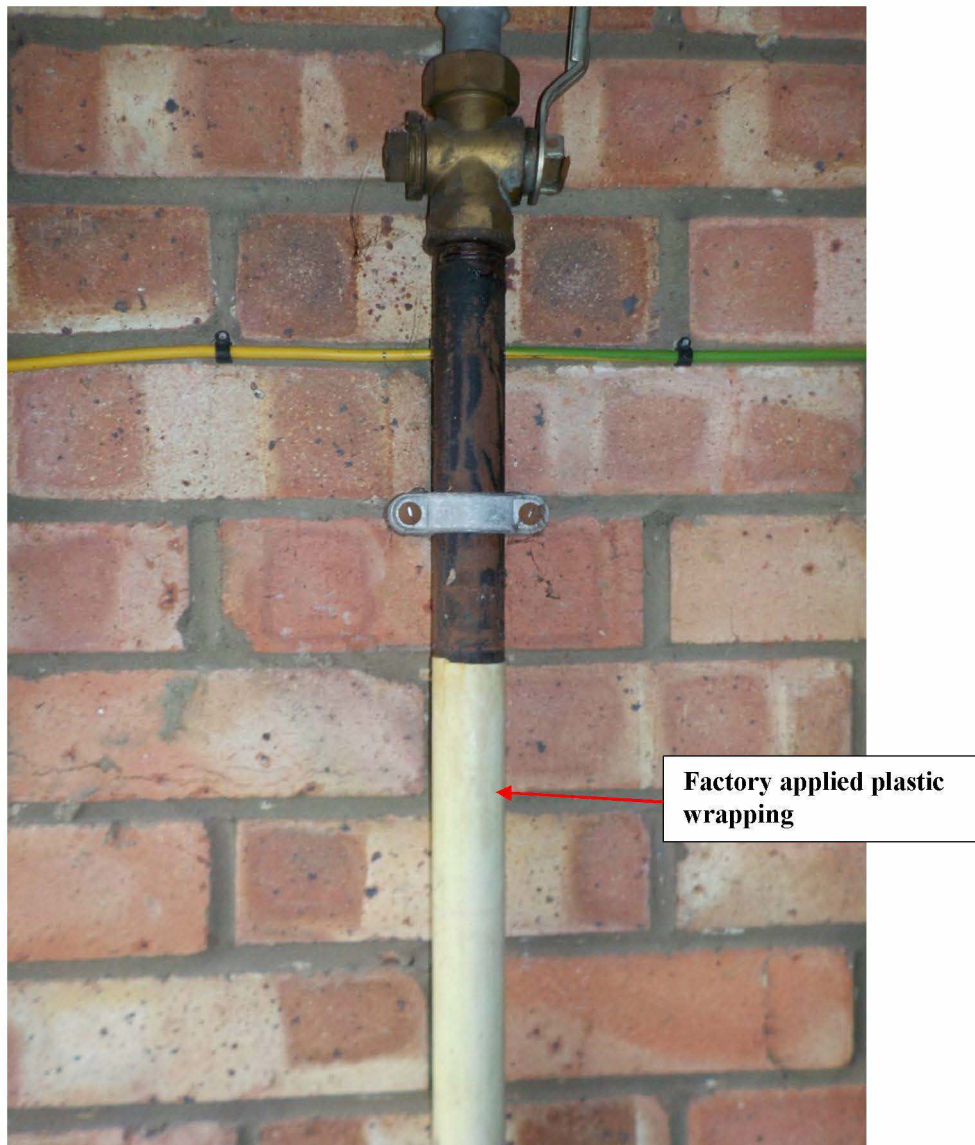
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

275. Sub-section 504 of BS Code of Practice 331 – 101: Gas Service Pipes includes a paragraph on the protection from corrosion of exposed pipe. That paragraph reads as follows:

*Service pipes in exposed positions e.g. above ground on the outside of the building or in damp cellars should be protected with red lead or bituminous paint or by other means approved by the Gas Undertaking and should be so positioned and supported as to enable the protection to be renewed as required. Any part of the service pipe which is particularly liable to corrosion or in a position where it cannot readily be inspected should be protected in the same way as pipes laid underground.*

276. In the early 1970s steel pipe used for gas services was encased in a factory applied yellow plastic wrapping. For the benefit of the lay reader the following photograph is of such a pipe located in the garage of a house built in 1971.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 69 – Plastic Clad Steel Service Pipe of 1971 Vintage**

277. It was industry practice to wrap any exposed steel or damaged wrapping with a protective bandage if the pipe was to be laid underground or in a potentially corrosive atmosphere. The common brand of protective bandage used at the time was “Denso Tape”.
278. Institution of Gas Engineers Communication 563 – Recommendations for the Laying of Steel gas service pipes purports to supplement BS Code of Practice 331 – 101: Gas Service Pipes and to provide more detailed information on the practical aspects.
279. Section X of Communication 563 is entitled “Wrapping of Steel Services. It includes the following:

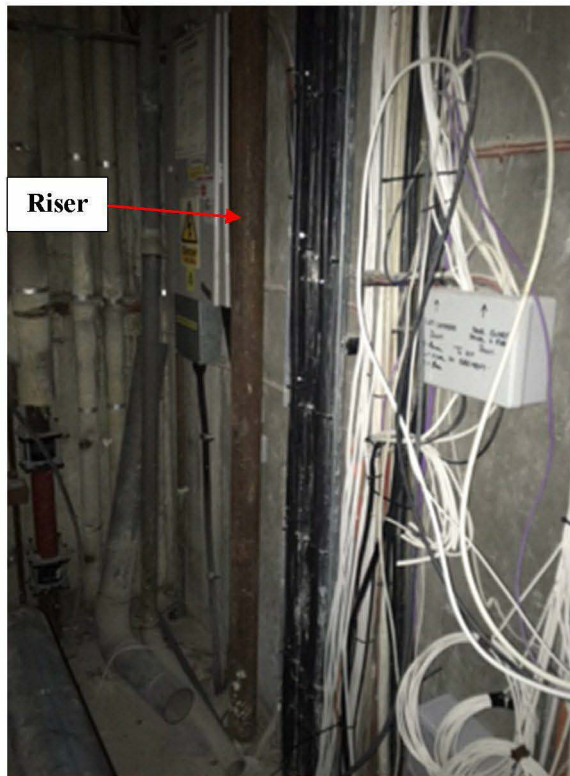
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*Exposed threads and unwrapped parts of the pipe and fittings should be protected with paste and wrapping or other approved material.*

*The wrapping should overlap the existing wrapping for at least 2 in.*

280. Section XV of Communication 563 addresses services to flats. Where service pipes rise to the floor above, an unwrapped tube may be used. It shall be secured clear of the wall with pipe clips to enable it to be properly painted.
281. The Institution of Gas Engineers document IGE/TD/4 – Edition 1: Laying of Steel and Ductile Iron Gas Service Pipes was published in November 1973. It was an update of Communication 563, which it superseded. It contained a section on services to multi-storey buildings, Section 7, and which has been reproduced as Appendix 7 to this Report.
282. However it will be noted that Section 7 does not address corrosion protection of steel pipes within multi-storey buildings. External protection of steel services is addressed in Section 9 and the relevant paragraphs are as follows:
- Exposed threads and uncoated parts of the pipe and fittings should be protected by a method approved by the gas undertaking.*
- The protection applied on site should overlap the existing coating for at least 50mm (2in).*
283. The Cadent Gas Ltd survey team took a number of photographs {CAD00000031} which indicate that the risers had not been constructed with wrapped steel pipe. They also recorded that the pipework, except for that part located in the basement, was bare steel in an environment categorised with localised dampness. I believe that at best the pipes may have been painted at the time of installation, over 40 years before.

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



a) Riser in service cupboard showing superficial corrosion



b) Riser in service cupboard believed to be showing original painting

**Fig. 70 – Photographs of Risers Taken by Cadent Survey Team on 30/09/16**

284. I took the following photograph in one of the flats which had not been badly damaged by the fire when I visited site on 28<sup>th</sup> February 2018.



**Fig. 71 – Riser in Duct in Flat which had not been badly damaged (28/02/18)**



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

285. The Cadent Gas Ltd survey team also recorded {CAD00000031} the presence of “old hot water tanks and water leaks that will corrode laterals in kitchen voids”. In addition they recorded a lack of natural ventilation and the absence of sleeves which are topics discussed in paragraphs 301 – 305 and 290 – 295 respectively.
286. Given the above and because most of the riser pipework was hidden in non or poorly ventilated and relatively non-accessible ducts containing other services such as water and drainage within the flats, I believe that corrosion protection in the form of PE clad pipe with any bare pipe, fittings and screwed joints being wrapped with protective bandage, should have been applied. On the other hand, the Gas Undertaking i.e. North Thames Gas Board (or North Thames Region of British Gas Corporation if the system was constructed after 1<sup>st</sup> January 1973), may have deemed painting in such circumstances to be sufficient to ensure compliance with the corrosion protection requirements of the Regulations and Standards quoted above. In the absence of an inspection regime I do not believe that such a view is justifiable.
287. I am not aware of there being an inspection regime either contemplated or in place at the time of construction. It should be noted in this regard that, notwithstanding Regulation 7 of the Pipeline Safety Regulations 1996, it was not until the early years of this century that Gas Transporters put multi-occupancy building inspection regimes in place.
288. Given the absence of an inspection regime until one was designed in the early 2000s, I believe that Residential System No.1 did not comply fully with the corrosion protection provisions within the legislation and standards applicable at the time of construction.
289. Inspection and maintenance post construction is considered in paragraphs 449 - 466 below.

### **Sleeving**

290. Regulation 6 of the London Gas Undertaking Regulations 1954 allowed service pipes to pass through a wall or solid floor without them being sleeved. The space between the service pipe and the surrounding structure shall have been filled in solid with cement mortar, concrete or other incombustible material throughout the full thickness

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

of the wall or floor. The Regulation specified the action to be taken where a sleeve was specially provided for the purpose of passing through a wall or floor.

291. Regulation 7 of the Gas Safety Regulations 1972 brought the requirement for pipes passing through walls and floors to be sleeved into the legislative arena across the whole of the United Kingdom. The regulation, which also addressed laying services in unventilated voids, building foundations and footings, reads in full as follows:

*(1) No service pipe shall be installed in a cavity wall nor so as to pass through a cavity wall otherwise than by the shortest practical route.*

*(2) Where a service pipe is installed so as to pass through any wall or is installed so as to pass through any floor of solid construction –*

*(a) the service pipe shall be enclosed in a sleeve, and*

*(b) the service pipe and sleeve shall be so constructed and installed as to prevent gas passing along the spaces between the pipe and the sleeve and between the sleeve and the wall or floors and so as to allow normal movement of the pipe.*

*(3) No service pipe shall be installed in an unventilated void space.*

*(4) No service pipe shall be installed under the foundations of a building or under the base of walls or footings.*

292. Sub-section 304 of BS Code of Practice 331 – 101: Gas Service Pipes addresses the provision of sleeves. It states that where the service passes through a cavity wall a sleeve of non-combustible material should be built into the wall. However, for solid walls, it states that it would be “advantageous” if such a sleeve is provided also. Sub-section 304 goes on to state that a similar sleeve should be provided when a service pipe or riser is to pass through any partition wall or floor.

293. The relevant wording in Institution of Gas Engineers Communication 563 is the same as that used in Sub-section 304 of BS Code of Practice 331 – 101.

294. From the wording in Institution of Gas Engineers Communication 563 and BS Code of Practice 331 – 101, I note that those standards did not prescribe the fitting of sleeves in floors. They stated that it was only advantageous for such sleeves to be provided. Consequently, if Residential Gas supply No. 1 was installed before 1<sup>st</sup>

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

December 1972, the date on which the Gas Safety Regulations 1972 came into force, there was no requirement for sleeves to have been fitted where the pipes went through floors.

295. There are a number of references to sleeves in IGE/TD/4 – Edition 1: Laying of Steel and Ductile Iron Gas Service Pipes which superseded Communication 563 when it was published in November 1973. These include:

*Paragraph 6.2.7 – “Where the service enters the building through a solid floor or load bearing or cavity wall, a sleeve of non-corrodible material should be built into the wall....”*

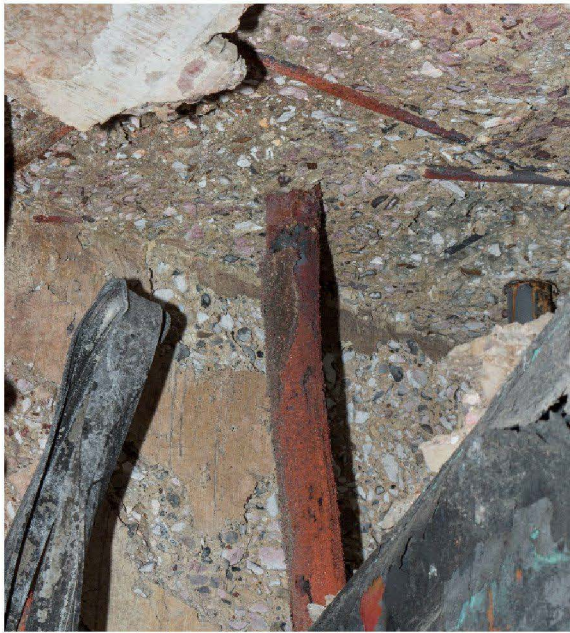
*Paragraph 6.2.8 – “A similar sleeve .... may be provided when a service pipe or riser passes through any partition wall or floor.”*

*Paragraph 6.2.10 – “Where the service pipe passes through an inner wall or floor of the building, the space should be filled with non-combustible material. The space between the sleeve and the structure should be filled with cement mortar throughout the thickness of the wall.”*

*Paragraph 7.1.3.3 – “Where the riser passes through each floor, a sleeve should be provided.”*

296. Neither I nor the Cadent Gas Ltd Survey Team {CAD00000031} nor CORGI Technical Services {MET00012524} observed any evidence that the risers had been sleeved as required by the Gas Safety Regulations 1972 and IGE/TD/4 – Edition 1.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**{MET00016520} Example of Unsleeved Riser**



**{MET00016548} Example of Unsleeved Riser**

**Fig. 72 - Examples of Unsleeved Risers Going Through Floors as seen on 30<sup>th</sup> May 2018**

297. As can be seen from Figure 72 above, the existing risers were not sleeved and they were fixed rigid in position at each floor. One hypothesis to explain the rupture of the riser at Flat 5 on the 14<sup>th</sup> floor (see Figures 60 and 61 above) is that the stress caused by the application of prolonged extreme heat on a pipe rigidly fixed at the floor and ceiling that were also subject to extreme heat, coupled with the presence of a corrosion induced weak point, was sufficient to rupture the pipe at the point of weakness<sup>35</sup>.

### **Thermal Expansion and Contraction**

298. Thermal expansion and contraction of the pipes was not addressed in either the London Gas Undertaking Regulations 1954 or the Gas Safety Regulations 1972.

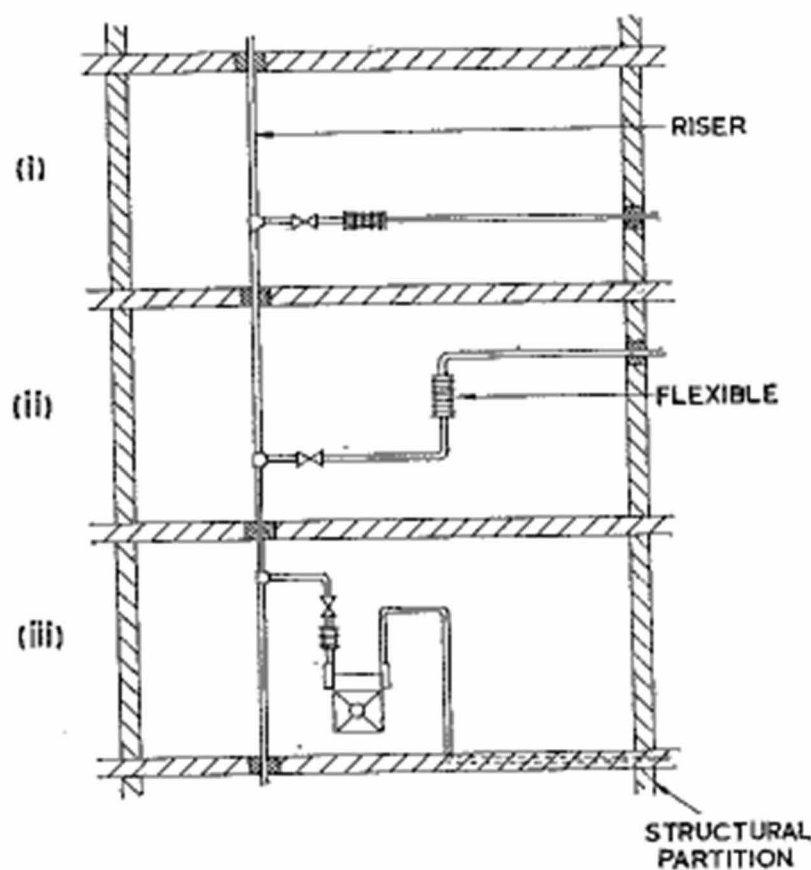
299. The only document which does address the topic and then only at a fairly superficial level, is IGE/TD/4 Edition 1 which was published in November 1973. Section 7.2 – Laterals and the following diagram provide guidance on the incorporation of flexibles in laterals in order to accommodate thermal expansion and contraction.

---

<sup>35</sup> If the pipes had been sleeved through the floor then there would have been some accommodation of differential movement of the pipes and the building during the fire and hence less stress on the pipe at the point of weakness.



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



**Fig. 73 – Extract from IGE/TD/4 Ed.1 – Methods of Incorporating Flexibles in Laterals**

300. No provision appears to have been made in the construction of Residential Gas System No.1 for thermal expansion and contraction. If it had been, it is my opinion that the rupturing of the pipe in Flat 5 on the 14<sup>th</sup> floor would have been less likely to have occurred.

### Ventilation

301. The purpose of ventilation is to disperse any minor, credible leaks before the gas in air mixture builds up to a flammable mixture<sup>36</sup>. The lay reader may care to note that for Natural Gas:

- a) The Upper Explosive Limit (UEL) or Upper Flammable Limit (UFL) is 15% gas in air (gia) or 150,000 parts per million (ppm);

<sup>36</sup> See Combustion Engineering and Gas Utilisation 3<sup>rd</sup> Edition, edited by J R Cornforth and published by British Gas in 1992. See also IGEM/SR/22 – Purging operations for fuel gases etc.

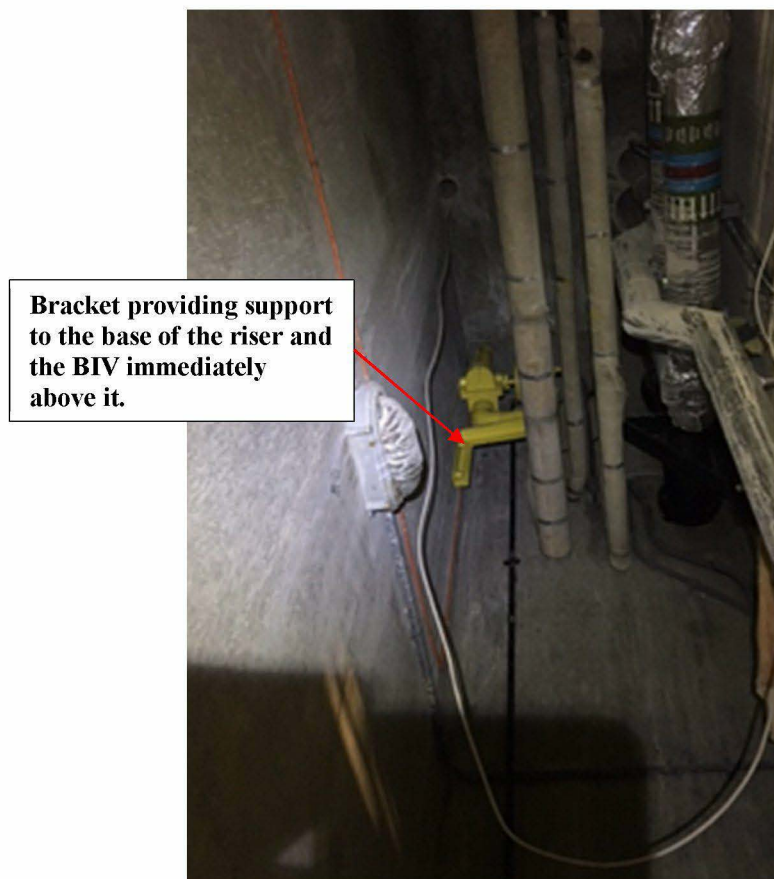
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- b) The Lower Explosive Limit (LEL) or Lower Flammable Limit (LFL) is 5% gas in air (gia) or 50,000 ppm;
  - c) Odorant is added to natural gas such that the average person will smell a concentration of 0.1% gia or 1,000 ppm.
302. The topic of ventilation of ducts and voids was not addressed in the London Gas Undertaking Regulations 1954. However, it was addressed in the Gas Safety Regulations 1972. As stated in paragraphs 71 and 291 above, Regulation 7(3) of the Gas Safety Regulations 1972 prohibits the installation of a gas service in an unventilated void.
303. I understand that at Grenfell Tower each riser was located in what was as best a poorly ventilated cupboard within each flat. They may even have been in unventilated voids: see the reference to kitchen voids in {CAD00000031}.
304. IGE/TD/4 Edition 1 dated November 1973 addresses the provision of ventilation. Paragraph 7.1.3.4 states:
- Wherever possible, the use of a ventilated duct to accommodate the riser is recommended. (See the British Standard Code of Practice CP413 – Design and construction of ducts for services.)*
- I understand BS CP 413 is a precursor of the current standard BS 8313 – Accommodation of Building Services in Ducts
305. Whilst this was a non-compliance, I do not believe that it had any bearing on the events of 14<sup>th</sup> June 2017.

#### **Support at the Base of the Risers**

306. The only document which addresses the topic of support at the base of the risers at or around the time of construction is IGE/TD/4 Edition 1 in paragraph 7.1.3.1. The 4 risers emanating from the basement were each supported. See Figure 16 above and Figure 74 below.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 74 – Riser Support**

307. Residential gas supply No.1 was compliant in this respect.

### **Conclusions**

308. I am of the opinion that the following non-compliant elements of the design and construction of Residential Gas Supply No. 1 at the time of construction are relevant to the events of 14<sup>th</sup> June 2017:

- a) Lack of corrosion protection particularly where there were exposed threads;
- b) Pipes not sleeved and fixed rigid in each floor, assuming installation was carried out after 1<sup>st</sup> December 1972;
- c) No provision for thermal expansion.

I consider the lack of a normally accessible PIV to be a major non-conformance.

However, I do not consider it to be relevant to the events of 14<sup>th</sup> June 2017 because falling debris prevented access to the area in which the PIV would have been located.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

309. Inspection and maintenance post construction is considered in paragraphs 449 - 466 below.

## **Residential Gas Supply No. 2**

310. Cadent Gas Ltd undertook an inspection of the risers and laterals at Grenfell Tower in accordance with its procedure T/PM/LC/21 – Management Procedure for the Asset Management of Gas Supplies to Multi-occupancy High and Medium Rise Buildings, on 30<sup>th</sup> September 2016. During the course of that inspection gas leaks were discovered on the riser at flats numbering 22 and 32. The riser was eventually isolated in order to make the situation safe at approximately 02.00 hrs on 1<sup>st</sup> October. Details of that survey were recorded on a spreadsheet {CAD00000031}.
311. In addition to the leaks, other issues were identified including
- severe and moderate corrosion on laterals emanating from the leaking and one other riser;
  - inadequate ventilation;
  - pipes not sleeved through floors, and
  - lack of accessible PIVs on both pipelines entering the building.
312. Cadent Gas Ltd commissioned tRIIO to design and build replacement infrastructure to supply those flats ending with the number 2 that had had their existing gas supply isolated. This replacement work is termed “reactive replacement”. They were instructed to design the works such that it could accommodate supplying the other flats in the Tower at a future date, given that corrosion had been found elsewhere in the building (see {CAD00000032}). The possible future replacement work is termed “proactive replacement”.
313. Matthew Dolan, Contract Director of Skanska Construction UK Ltd is one of two tRIIO Contract Directors and part of his area of responsibility relates to the design and construction of the multi-occupancy building projects for both the London and East of England Cadent Gas Ltd Networks. He has provided a witness statement {MET00012711} in which he details roles of different parties in the design and construction of Residential Gas Supply No.2 and the chronology and reasoning of key events in its design and construction. He has also provided a second witness statement



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

pursuant to Rule 9 of the Inquiry Rules 2006 to the Inquiry {TRI00001797}. I have quoted extensively from these witness statements in order to provide a background to the review of the design and construction of Residential Gas Supply No.2 in paragraphs 326 – 448 below.

314. In his original witness statement {MET00012711}, Matthew Dolan makes a number of statements regarding the roles of different personnel and sub-contracted organisations. Key points, quoted verbatim, are as follows:

- *As the reactive work was design and construction work, it was to be undertaken in accordance with the Construction Design and Management Regulations 2015 (CDM). Cadent was the Client under CDM and appointed tRIIO as Principal Designer, Designer and Principal Contractor for the duration of the project.*
- *As Principal Designer, tRIIO had responsibility to plan, manage, monitor and coordinate health and safety during the pre-construction phase and to liaise with the Principal Contractor during the delivery of the construction work.*
- *As Designer, tRIIO's role<sup>37</sup> was to prepare and modify the design in relation to the in ground works and riser pipework at the Tower. In performing that role, tRIIO's designers took account of pre-construction information provided by Cadent to try to eliminate foreseeable risks to the health and safety of those working on the project, the residents and others affected by the works. In circumstances where the risks could not be eliminated, tRIIO's designers took steps to reduce and control those risks. The design was then shared with the construction team and others working for tRIIO.*
- *As Principal Contractor, tRIIO had responsibility to plan, manage, monitor and coordinate the entire construction phase of the reactive and proactive works.*
- *I set out below a table of those tRIIO individuals involved in this project.*

<i>tRIIO</i>		
<i>tRIIO</i>	<i>Contract Director</i>	<i>Matt DOLAN</i>
<i>Design &amp; pre construction</i>	<i>Design Manager</i>	<i>Stephen JOHNSON</i>
	<i>Design Engineer</i>	<i>Martyn WISKEN</i>
	<i>Design Analyst</i>	<i>Ashley JOHNSON</i>
	<i>Design Analyst</i>	<i>Mark BEHM</i>

<sup>37</sup> I note that no mention is made of the designer's responsibilities under Regulation 9 of CDM in respect of risks relating to the operation and maintenance of the works post construction.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

	<i>Pre-Construction Programme Manager</i>	<i>Cerianne TALBOT</i>
<i>Construction</i>	<i>Operations Managers</i>	<i>Stuart STEPHENS (left December 2016) Stephen JOHNSON (to Apr 2017) Terry PENNY (to current day)</i>
	<i>Project Manager</i>	<i>Harvey SMITH (until end of February 2017)  Martin LOVEDAY (end of February 2017 onwards)</i>
	<i>Site Manager</i>	<i>Andrew RADLEY</i>
<i>Others</i>	<i>H&amp;S Advisor</i>	<i>Michelle UMAGHO-UKUEKU</i>
	<i>Project Manager Customer Liaison Officer</i>	<i>Dave CASSIN Ian HOSKINS (junior to David CASSIN)</i>

- *tRIIO subcontracted parts of the specialist construction work to a number of contractors from its approved contractor register.*

<i>Sub-contractors</i>		
<i>Company</i>	<i>Role</i>	<i>Key Contact</i>
<i>K&amp;S (sub-contractor to tRIIO)</i>	<i>Senior Partner</i>	<i>Kenny SNELL</i>
<i>London Operations Gas (sub-contractor to K&amp;S)</i>	<i>Surveyor (sole trader)</i>	<i>Simon BOYGLE</i>
<i>Holland Gas Engineers Ltd (Sub-contractor to K&amp;S)</i>	<i>Director</i>	<i>Nathan LITTLEBURY</i>
<i>Express Building Contractors Ltd (sub-contractor to tRIIO)</i>	<i>Director</i>	<i>Alan MONAHAN</i>
<i>Cape Electrical (sub-contractor to tRIIO)</i>	<i>Managing Director</i>	<i>Phil CASSATERI</i>
<i>LAB UK (Asbestos) (sub-contractor to tRIIO)</i>	<i>Contracts Manager</i>	<i>James DENNIS</i>
<i>Globe Scaffolding Ltd (sub-contractor to tRIIO)</i>	<i>Contracts Manager</i>	<i>Richard DAINES</i>

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

<i>T&amp;S Environmental Limited (sub-contractor to tRIIO)</i>	<i>Managing Director</i>	<i>Bradley REES</i>
<i>Price Brothers (sub-contractor to K&amp;S)</i>	<i>Director</i>	<i>Dan PRICE</i>
<i>Angles Inspection (sub-contractor to K&amp;S)</i>	<i>Owner (sole trader)</i>	<i>Malcolm RUSSELL</i>

- *K&S was contracted to install and weld the new replacement riser and laterals running from the incoming below ground gas pipe, up through the height of the building and into the 13 individual flats.*

- *With tRIIO's approval, K&S subcontracted parts of its work to specialist contractors so that:*

*London Operations Gas, a survey company run by Simon BOYGLE, was contracted to survey the Tower to determine a suitable route for the replacement riser and laterals.*

*Holland Gas Engineers Ltd (Holland Gas) was contracted to move the meters within the 13 residential properties, reconnect and certify the internal "gas safe" supply to the cooking facilities.*

*Price Brothers Surfacing was engaged to complete the in-ground reinstatement works (i.e. works outside the Tower building).*

*Angles Inspection was engaged to inspect the quality of the welds undertaken on the riser and laterals.*

- *tRIIO also engaged a number of other contractors directly, namely:*

*Express Building Contractors Limited (Express) assisted Holland Gas fitters with carpentry work in January 2017 by opening the existing boxing around the heating system into the individual flats. Express was then engaged in April 2017 to box-in the replacement riser in the stairwell and the lateral pipework in the communal landings to the identified flats.*

*Globe Scaffolding Limited (Globe), was contracted to install scaffolding on Floor 20 and it did so on 12 and 13 of June 2017. This was to allow safe access for the installation of the boxing-in around the new vertical riser from the 20th Floor up to the roof vent,*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*Cape Electrical & Mechanical Limited (Cape) was contracted to move the lighting in the stairwells and communal areas where additional room was needed for the new riser and lateral pipework and/or boxing-in to the 13 flats. Lab UK Limited was contracted by tRIIO to conduct an asbestos survey on the 13 flats and adjoining communal areas at the Tower in December 2016 following the completion of the design.*

*T&S Environmental Limited was contracted to carry out asbestos sampling, removal and disposal work*

315. The route for the reactive gas supply was surveyed by Simon Boygle of London Operations – Gas. His survey report is dated 12<sup>th</sup> October 2016 {TRI000000044}. A colour version is contained within {CAD00000054} and it has been attached as Appendix 8 of this report. It should be read alongside Figure 20 – Initial Design Drawing of Replacement Riser, drawing no. IMG170186 {TRI000000263} reproduced above.
316. Simon Boygle revisited the Tower to review the route of the pipe within the lobby for possible proactive work and to consider options for avoiding the placement of any pipework within the heating pipe boxing that formed the false ceiling. His report ({TRI000000182} & {CAD00000038}) is dated 1<sup>st</sup> November 2016 and it has been attached as Appendix 9 of this report.
317. In his witness statement {MET00012711}, Matthew Dolan makes a number of other statements including the following:
- *In accordance with edition 2 IGEN/G/5 (the industry standard for gas installations within MOBs), tRIIO's designer must consider the most appropriate design option based on consideration of factors, namely safety, security, future access and maintenance. IGEN/G/5 sets out a hierarchy of options to consider, the first of which is to run the riser external to the building. This is tRIIO's standard approach as it is less disruptive to the tenants, easier to install and would be naturally ventilated. Verbal discussions with KCTMO concluded that running the riser external to the building was not an option here given the cladding on the exterior of the Tower. Drilling and fixing gas pipes to the exterior would have rendered any cladding guarantee null and void as we would have*



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*penetrated any seals or system integrity. Accordingly, it was necessary for the riser to be run internally within the Tower.*

- ... Simon BOYGLE of London Ops Gas, with support from Harvey SMITH and Martyn WISKEN of tRIIO to determine the route for the new riser. Achieving a buildable route is often a joint effort and was on this occasion with a number of options being considered by Simon BOYGLE, tRIIO and Cadent and shared with KCTMO, for example running the replacement riser in the same place as the old riser and running the lateral pipework through the false ceilings in the landings, but these were discounted in discussions between tRIIO and KCTMO. There were also **problems with ventilation in the location of the original riser in the utility shaft (My emphasis)**... .... Given these constraints, tRIIO and the surveyor had no further option but to propose a route to KCTMO for the riser to run inside the building through the stairwell in the Tower to achieve compliance with IGEM/G/5 and Building Regulations.*
- The design required the laterals to be 'boxed-in' to provide a route for any gas leaks to escape to the stairwell, which was directly ventilated to outside, direct ventilation being a requirement of IGEM/G/5. The design did not require the riser pipe in the stairwell to be boxed-in as the stairwell had natural ventilation. However, given the fire compartment having being penetrated between the stairwell and hallways to facilitate the route of the lateral pipework, the boxing-in also served as fire protection within the hallways **thus maintaining the integrity of the stairwell fire compartment. (My emphasis: I look upon this phrase as providing confirmation that the design involved reconfiguration of the fire compartmentation.)** tRIIO considered the use of fire rated materials from the outset and discussions took place with KCTMO about the fire rating of the materials for the boxing-in.*

318. In his witness statement pursuant to Rule 9 of the Inquiry Rules {TRI00001797} Matthew Dolan reaffirms that

*Fire safety was considered by tRIIO at an early stage and discussions took place in October and November 2016 between tRIIO, KCTMO and Cadent regarding whether*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*the proposed route of the gas riser pipe was acceptable and compliant with the fire management precautions in place at the Tower.*

and

*Mr Stokes was in contact with tRIIO on 25<sup>th</sup> November 2016 (see {TRI000000397}) seeking clarification regarding compartmentation. tRIIO responded to confirm that its pipework would be fire stopped to maintain fire compartmentation and that its pipework would be installed by reference to IGEN/G/5. (see {TRI000000392} & {TRI000000403}).*

319. The design was agreed by KCTMO on 30<sup>th</sup> November 2016. {TRI000000791}.

320. In his witness statement {MET00012711}, Matthew Dolan makes further statements including the following:

- *KCTMO instructed .....Carl STOKES, of C S Stokes and Associates Limited to visit the Tower and inspect the newly installed gas riser and laterals. He visited the site on 26 January 2017 and published a report, which was provided to tRIIO for comment (see {TRI000000693}). tRIIO provided assurance to KCTMO that the newly installed lateral pipework would be boxed-in for ventilation purposes and holes sealed where they were not needed for such ventilation. (My emphasis) (see {TRI000000757})*
- *Between 7 March and 24 March, KCTMO communicated to tRIIO that concerns had been raised by some residents about the newly installed exposed gas pipes. One email raised concerns regarding the riser being in the fire escape and mentioned that vandalism and antisocial behaviour were daily occurrences on the staircase and the exposed gas pipes might be an easy target for vandalism. These emails were escalated to me as a Contract Director. (see {TRI000001145}; {TRI000000905} and {TRI000000943} are also of relevance)*
- *I understood the concerns raised by some of the residents and considered them as legitimate. However, the pipework was constructed of seamless carbon steel and would be difficult to vandalise and in any event, for the reasons I have identified, the riser had to be installed internally in the Tower. The riser itself was not boxed-in as this was not required by IGEN/G/5. Nonetheless, a meeting was arranged with Cadent and KCTMO to address the residents' concerns.*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

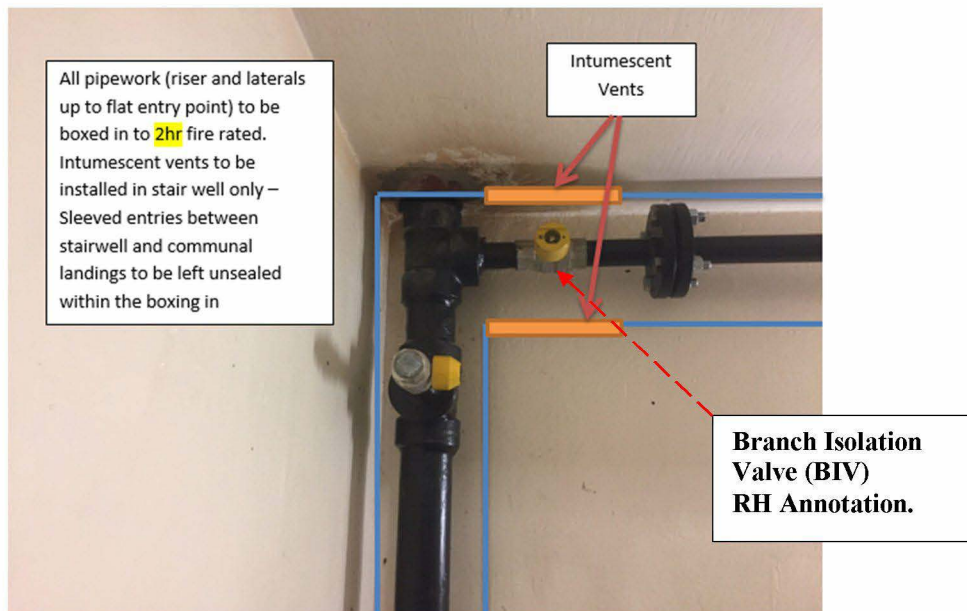
- *On 21 March 2017, Steve JOHNSON, a Design Manager for tRIIO, was made aware that flanged compression joints had been installed onto the pipework rather than welded joints, as per the design. These were installed by K&S in discussion with tRIIO's Project Manager and Site Manager. tRIIO's instructions from Cadent were that gas reinstatement was a priority<sup>38</sup>. The flanged joints would allow the residents to have their gas supply reinstated more quickly. As a result, on 24 March 2017, the tRIIO design team completed a design review and modified the ventilation and boxing-in requirements to include boxing-in of the riser in the stairwell. Building Regulations and IGEM/G/5 require that any pipework in a stairwell not screwed or welded to be boxed-in with fire rated materials. The modified design, therefore, provided that all pipework (riser and laterals up to the flat entry point) be boxed-in with 2 hour fire rated materials, including the use of fire rated sealant. **It also stated that the entry between the protected shaft (stairwell) and the common landing needed to be unsealed within the boxing for ventilation purposes. (My emphasis)** Express Builders used Everflex fire mate sealant on the screw heads on the boxing, on all boxing butt joints, and to seal the boxing where it met the wall, floor and ceiling. **The entry between each floor needed to be unsealed within the boxing for ventilation purposes. (My emphasis)***

321. The updated design drawing {TRI000001223} includes the following annotated photograph.

---

<sup>38</sup> Section 10 of The Gas Act places an obligation to provide a gas supply on to a GT if a premise is within 23 metres of a gas main. In addition, The Gas (Standards of Performance (Amendment) Regulations provide an incentive to licenced Gas Transporters to restore gas supplies as soon as practicable by requiring compensation payments to be made.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 75 – Updated Boxing/Ventilation Requirements {TRI000001206}**

322. The updated drawing {TRI000001223} is as follows, and an A3 sized version is reproduced as Appendix 10 to this report:



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

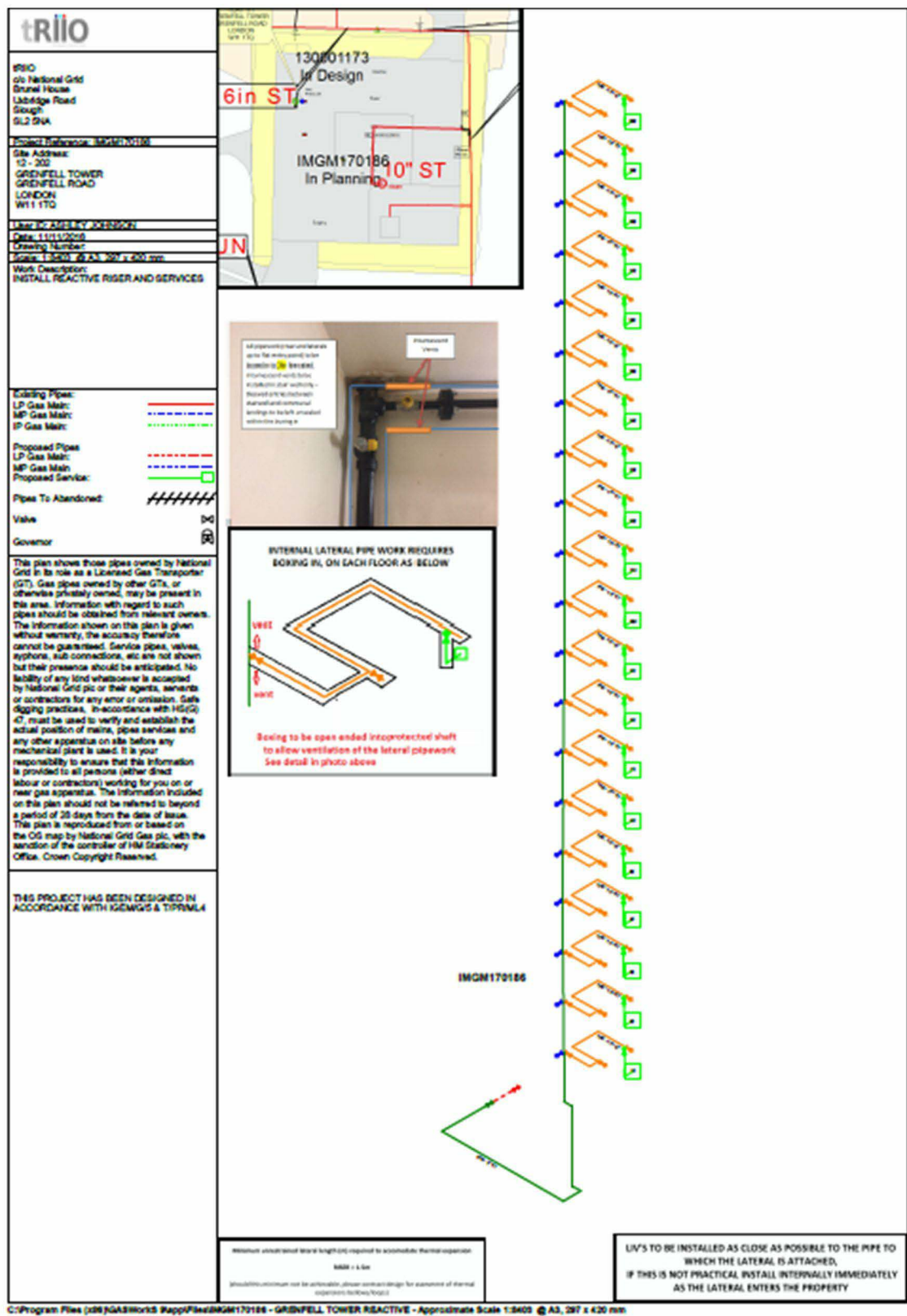
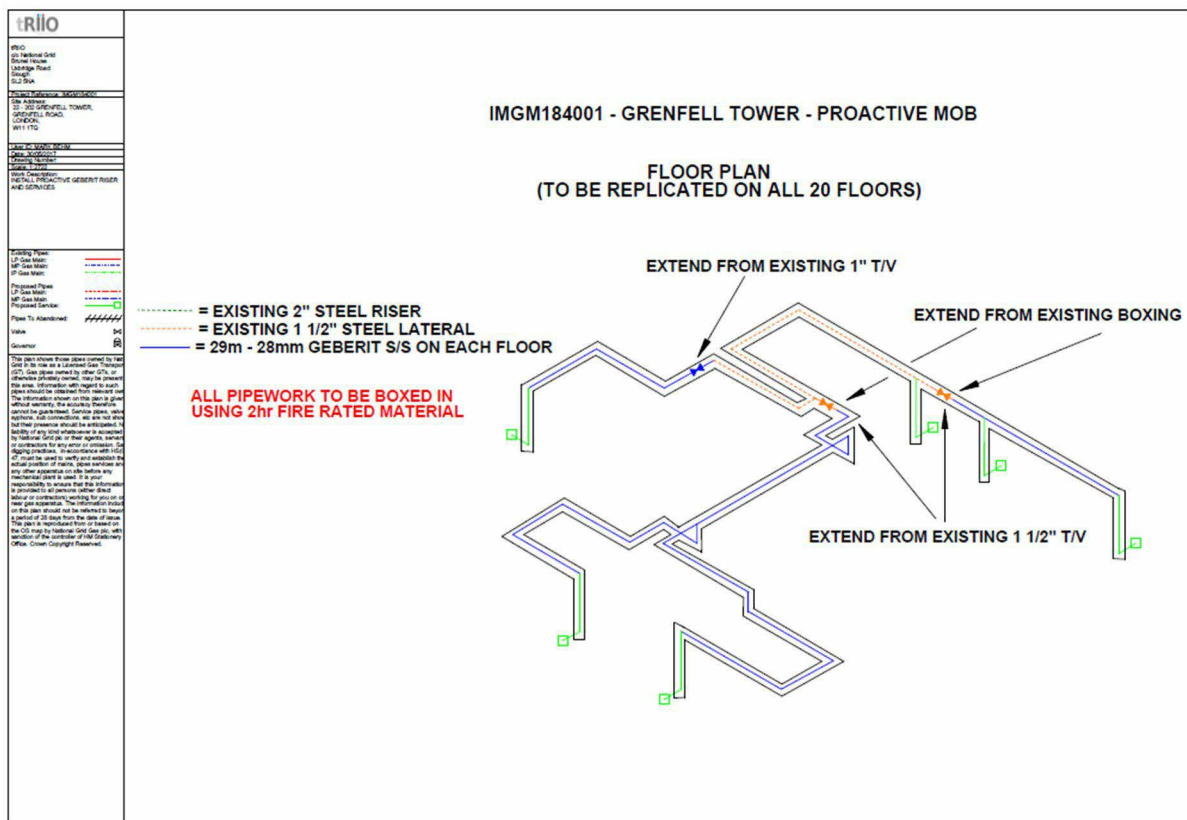


Fig. 76 – Updated Drawing: March 2017 {TRI000001223}

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

323. In parallel with this update, a design was prepared for the pro-active works to supply the other 5 flats on each floor from Residential Gas Supply No.2. The design documents appear to be Simon Boygle's report ({TRI000000182} & {CAD00000038}) dated 1<sup>st</sup> November 2016 which has been attached as Appendix 9 of this report and the following drawing, IMG184001 (see {TRI000001358}):



**Fig. 77 – Proactive Work to Supply the Other 5 Flats on Each Floor {TRI000001358}**

324. I note that that the use of Geberit Stainless Steel was proposed. I understand this is a press fit jointed system which at the time the design was prepared was still at the field trial stage of development and acceptance.

325. Apart from issuing letters to residents advising them of the intention to replace the gas supply into their flats (see {CAD000000288}) no proactive work had been carried out prior to 14<sup>th</sup> June 2017.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **Review of Design & Construction of Reactive Works**

326. The principal elements of the regulatory and standards regime applicable to the design and construction of Residential Supply No. 2 in 2016 – 2017 are as follows:
- a) Construction (Design and Management) Regulations 2015;
  - b) Gas Safety (Management) Regulations 1996;
  - c) Pipeline Safety Regulations 1996;
  - d) Gas Safety (Installation and Use) Regulations 1998;
  - e) Approved Document B of the Building Regulations;
  - f) IGEN/G/5 Edition 2 – Gas in Multi-occupancy Buildings;
  - g) IGEN/TD/4 Edition 4 – PE and Steel Gas Services and Service pipework;
  - h) BS 6400 Part 1 – Specification for Installation, Exchange, Relocation and Removal of Gas Meters  $Q_{\max} \leq 6\text{m}^3/\text{hr}$ ;
  - i) BS 6891:2015 – Specification for the Installation and Maintenance of Installation Pipework  $d \leq 35\text{mm}$  in Premises;
  - j) BS 8313 – Code of Practice for Accommodation of Building Services in Ducts.
327. I understand that where the building remains occupied during replacement works, as was the case at Grenfell Tower, under the “Fire Safety Order”, the Responsible Person for the Building is responsible for general fire precautions for the “construction site” as well as for the rest of the building. Given that a fire on the “construction site” can affect persons within the occupied premises, and vice versa, this ensures that the general fire precautions are co-ordinated. (See HSG168 and duty to co-operate under Article 22 of the “Fire Safety Order”.)
328. In addition, Regulation 6 of the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) and Article 12(3) and Part 4 of Schedule 1 of the Regulatory Reform (Fire Safety) Order 2005 refer to the adequacy of ventilation to disperse any dangerous substance before it can build up to an explosive atmosphere throughout the life cycle of the building.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

329. The design objectives met by compliance with the above regulatory and standards regime are:
- a) ensure gas will be delivered to consumers at a suitable pressure to ensure the safe operation of any gas appliance which they could reasonably be expected to operate;
  - b) ensure the gas infrastructure will be able to be inspected and maintained in the future;
  - c) minimise the risk of fire and/or explosion resulting from the ignition of gas escaping from the proposed gas infrastructure;
  - d) minimise the risk of serious aggravation of any building fire.
330. Design objective a) which stems from Regulation 8 and Part 1 of Schedule 3 of the Gas Safety (Management) Regulations, is met by ensuring the size of the network pipeline is of a sufficiently large diameter to supply the peak load under 1 in 20 winter conditions at a pressure at the outlet of the Emergency Control Valves of at least 19 mbar. The maximum pressure absorption over the meter installation shall be no more than 4 mbar in accordance with BS 6400: Part 1. In addition the consumer's installation pipework with all appliances in operation shall be sized such that the pressure drop is no more than 1 mbar, as per BS 6891:2015.
331. Design objective b) which stems from Regulation 7 of the Pipeline Safety Regulations, is usually met by locating as much of the gas infrastructure as possible outside of the building or in common areas so that access can be obtained for inspection and maintenance without having to enter individual flats to undertake what many people consider to be an unwelcome intrusive exercise.
332. Design objective c) is specifically mentioned in paragraph 4.4 of BS EN 1775. It is met by using sound, properly jointed and where appropriate, protected materials located in a ventilated location, sufficiently remote from sources of ignition but where passers-by will smell any escaping gas. The provision of valves and relevant signage contribute to the meeting of this objective.
333. Design objective d) is specifically mentioned in paragraph 4.4 of BS EN 1775. It is generally met by using properly jointed non-combustible or fire resistant materials. In



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

addition, pipes must be sleeved when passing through walls and floors to prevent stress being placed on the pipe caused by building movement. Any breaches of fire compartment walls or floors shall be fire stopped. The provision of valves also contributes to the meeting of this objective.

334. As pipe sizing for the purposes of providing a suitable pressure to each consumer has no bearing on the events of 14<sup>th</sup> June 2016, I do not propose to examine the pressure and load assumptions or the network analysis model used to determine the diameter of the riser and laterals.
335. The reactive design issued to K & S Pipelines LLP appears to comprise drawing no. IMG170186 {TRI000000263} i.e. Figure 20 and Simon Boygle's survey reports of 12<sup>th</sup> October 2016 ({TRI000000044} & {CAD000000054}) and 1<sup>st</sup> November 2016 ({TRI000000182} & {CAD000000038}) i.e. Appendices 8 and 9 of this report.
336. As part of the pre-design hazard assessment process, crime statistics were obtained (see {TRI000001295}). These showed that the area around the Lancaster West Estate had a crime rate much lower than the regional average. Figures presented were:
- 171 total crimes in the previous 12 months was 24% below the regional average;
  - 38 burglary and theft crimes was 48% below the regional average;
  - 60 antisocial behaviour crimes was 13% below the regional average;
  - 62 violent and drug crimes was 1% above the regional average.
337. I believe that these crime statistics, particularly the one relating to antisocial behaviour, suggest that vandalism was not considered to be a problem on the estate. However, I note that Matthew Dolan in his witness statement {MET00012711} and quoted in the second bullet point of paragraph 319, refers to correspondence relating to vandalism.
338. Backing up the design is a generic CDM Design Risk Assessment Document {TRI0000000369} which is dated 15<sup>th</sup> November 2016. The first page of which is the Design Risk Register. Normally it is a four page spreadsheet, the last one of which addresses a list of hazards. Under the sub-heading MOBs specific hazards, three hazards are listed. They are:
- Breach of fire compartments;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Failure mode – Expansion, south facing pipework and thermal expansion;
- Inadequate ventilation.

However, only the first page, the Design Risk Register had been disclosed.

339. Solicitors for tRIIO advised the Inquiry in a letter dated 16<sup>th</sup> July 2018 {TRI000001796} sent in response to a letter dated 12<sup>th</sup> June 2018 from the Inquiry requesting further information on the design risk assessment, that

*The Design Risk Register (DRR) was completed by a tRIIO designer in November 2016. A residual risk score of 17 was then generated based on the risks and activities identified for this project. A full Design Risk Assessment (DRA) is required for projects scoring 18 or more. Accordingly, this project did not score highly enough for a full DRA to be required and so one was not completed.*

A copy of that Design Risk Register is as follows:

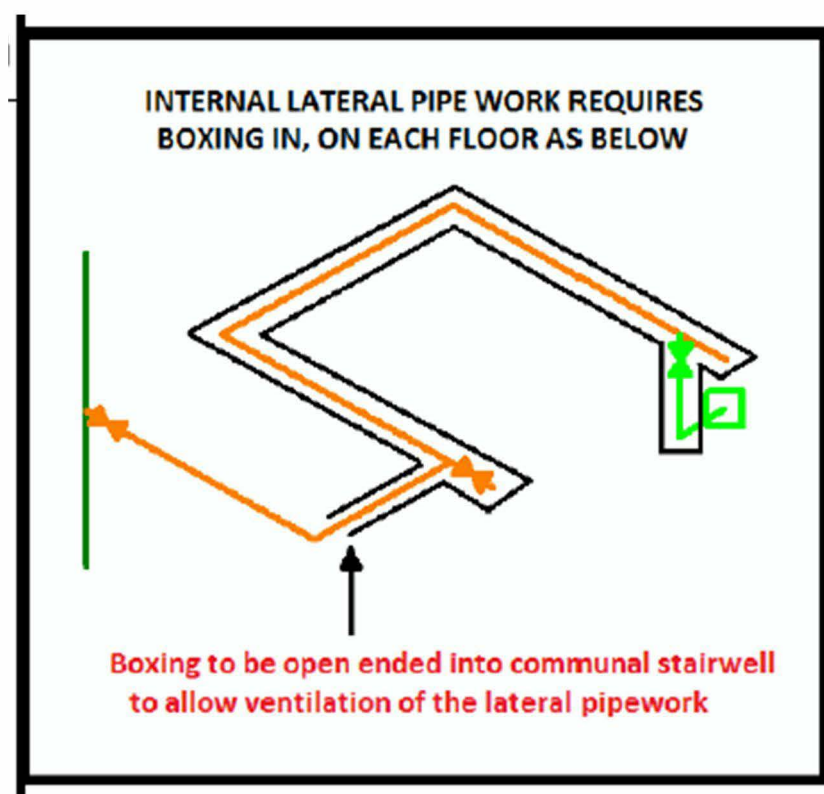
Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

CDM Design Risk Register				TRIO
Project: Project Ref: Doc Ref: Date:		22 - 202 GRENELL TOWER, GRENELL ROAD, LONDON, W11 1TQ IMGM170186 IMGM170186 15/11/2016		
Designer:		Ashley Johnson		
<p>This DRR and DRA details the actions taken to apply ERICPD and create a design with the principles of ALARP as the foremost concern, the repeatable nature of the TRIO design deliverable enables a Generic, and Site Specific approach to be taken.</p> <p>The limited nature of the design options enables a Risk Register to be developed specific to the TRIO contract scope.</p>		<p>Project RAG Status based on Residual Risk Score</p> <p>The 'Yield/Op Overall Risk RAG Status' automatically calculates the residual risk score (and colour).</p> <p>17</p> <p>Low to Open, No Hard/Op Handover Meeting Required Full DRA Required</p>		
Activity / Risk	Identified Present by Designer	Design Options / Reasons for Rejection	Highest Risk Tier	
Method of Construction	<input type="checkbox"/>	Open Trench by others		Medium
	<input type="checkbox"/>	Insertion		
	<input checked="" type="checkbox"/>	Open Cut		
	<input type="checkbox"/>	Above Ground		
	<input type="checkbox"/>	Special Engineer Difficulty		
Gas Specific Hazards	<input checked="" type="checkbox"/>	LP		Low
	<input type="checkbox"/>	MP		
	<input type="checkbox"/>	JP		
Network Hazards	<input type="checkbox"/>	SEED, ALARP, DIMP, ENM & RAT		
	<input type="checkbox"/>	Syphons, CSEP, Low point monitor or Pressure logger		
	<input type="checkbox"/>	Governor proximity		
	<input type="checkbox"/>	Pressure below 24mb		
	<input type="checkbox"/>	Rural		
Locale Hazards	<input checked="" type="checkbox"/>	Residential estate		Low
	<input type="checkbox"/>	Commercial / Industrial / High Street		
	<input type="checkbox"/>	Civic Amenities affected		
	<input type="checkbox"/>	Contamination		
	<input type="checkbox"/>	Environmental		
	<input type="checkbox"/>	Crossings		
Underground & Aboveground Plant	<input type="checkbox"/>	Significant = HV, oil, NTS EHV open cut		
	<input type="checkbox"/>	Significant = HV, oil, NTS EHV insertion		
	<input type="checkbox"/>	Unmade Ground		
Highway / Logistics Hazards	<input type="checkbox"/>	Verge		Low
	<input checked="" type="checkbox"/>	Footpath		
	<input type="checkbox"/>	Private		
	<input type="checkbox"/>	Carriageway ~30mph		
	<input type="checkbox"/>	Carriageway above 30mph		
Structural Hazards	<input checked="" type="checkbox"/>	Standard Depth		Low
	<input type="checkbox"/>	Shallow Depth		
	<input type="checkbox"/>	Extra Depth / Temporary Works Required		
Utility Lay / abandon	<input checked="" type="checkbox"/>	32 - 150 dia, >= 8" / 200mm		Low
	<input type="checkbox"/>	>150 - 315 dia, 8" / 200mm <= 12" / 300mm		
	<input type="checkbox"/>	above 315 dia, >12" - above		
Special Activities	<input type="checkbox"/>	Maintenance		
	<input type="checkbox"/>	Operational		
	<input type="checkbox"/>	Decommissioning Risk		
MOBS	<input type="checkbox"/>	0 - 20m		High
	<input type="checkbox"/>	20-40m		
	<input checked="" type="checkbox"/>	>40m		
Manual DRA override needed?		<input type="checkbox"/>	Comment/Reason	

Fig 78 Design Risk Register for Original Design {TRI000000369}

340. In other words, a risk assessment as specified in paragraph 4.2.1.1 of IGEM/G/5 Edition 2 was not deemed to be necessary to be carried out for the original design.
341. It will be recalled that Figure 20 – Initial Design Drawing of the Replacement Riser {TRI000000263} includes the following sketch:

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 79 – Extract from Initial Design Drawing of Replacement Riser {TRI000000263}**

342. It can be seen that, the intent of the design involved changing the configuration of the fire compartmentation. From the e-mail from Patrick Kelly of Cadent Gas Ltd to Martin Loveday of TRIO dated 21/03/17 – {CAD000000175} and Matthew Dolan's witness statement {MET00012711}, I understand the intent was to make the boxed in pipework in the lobbies part of the stairwell fire compartment. Oversized holes were to be drilled in the compartment wall to enable the boxed in pipework in the lobby to be vented into the stairwell. This is illustrated by the following photographs:



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry



Lateral exiting stairwell {CAD00001879}



Lateral entering lobby {CAD00001880}

**Fig. 80 – Oversized holes in stairwell/lobby compartment wall**



**Fig. 81 – Boxed in pipework in floor 5 lobby {TRI000001439}**

343. A separate drawing {TRI000001422} was issued for the external works i.e. under pressure tee connection to the 15" main and the installation of a 90mm PE pipeline into the building including the Pipeline Isolation Valve.

Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

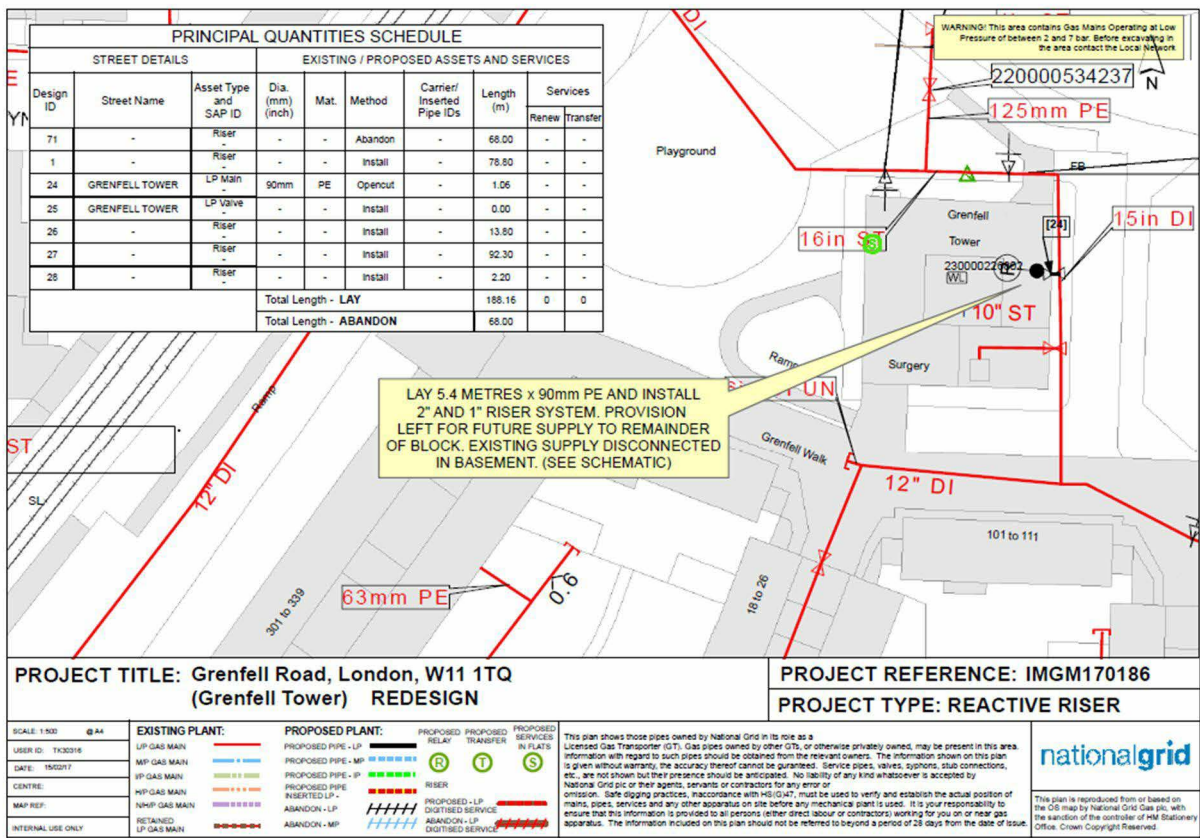


Fig. 82 – Drawing for external works {TRI000001422}

344. As mentioned in paragraphs 319 - 321, the design was updated to include the boxing in of all the pipework in the stairwell and the fitting of intumescent vents into that boxing. The CDM Design Risk Assessment document was updated on 24<sup>th</sup> March 2017 {TRI000001218}. This document contained all 4 pages of the spreadsheet. It is noted that on page 4 of the document, that:

- Line 19 – Breach of Fire Compartments is acknowledged and the actions to be taken column states “Follow Building Regulations & Fire Safety Order, seal compartments accordingly”;
- Line 20 – Failure Mode: expansion etc. box not ticked and no comment in the actions to be taken column;
- Line 21 – Inadequate ventilation is acknowledged and the actions to be taken column states “Generic statement to Design for Operations to enable ventilation review on site, Gas Safe Engineer Review”;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- In the review section there is a further comment against Breach of Fire Compartments and that is “Welded internal riser system. Stairwell considered a shaft in G5. Common area to be vented back to shaft. Additional fire protection boxing required for protection of valves and flanges in shaft area”;
- Also in the review section there is a further comment against inadequate ventilation and that is “See gasworks design for specific ventilation requirements. Sealed Boxing and intumescent vents to be fitted”.

345. Solicitors for tRIIO advised the Inquiry in a letter dated 16<sup>th</sup> July 2018 {TRI000001796} sent in response to a letter dated 12<sup>th</sup> June 2018 from the Inquiry requesting further information that:

*On 21 March 2017, tRIIO was made aware that flanged compression joints had been installed onto the pipework rather than welded joints, as per the design. The flanged joints would allow the residents to have their gas supply reinstated more quickly. As a result, on 24 March 2017, the tRIIO design team completed a further DRR. Whilst the DRR score was still 17, the designer opted to override this manually and to complete a DRA so as to include comments regarding the design change. Hence, a DRA was completed in March 2017, but not in November 2016.*

346. The boxing around the pipework in the stairwell between the 2<sup>nd</sup> and 22<sup>nd</sup> floors had been fitted by 14<sup>th</sup> June 2017. When I visited the Tower on 28<sup>th</sup> February 2018 I noted that approximately 50% of the boxing had been stripped out. I was able to take some photographs of the boxed in riser which have been reproduced below. It will be noted that intumescent vents had not been fitted as specified in the updated design drawing.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 83 – Boxed in pipework in stairwell**

347. It will be recalled that Figure 20 includes the statement that “This project has been designed in accordance with IGEM/G/5 and T/PR/ML/4”.
348. I understand T/PR/ML/4 is Cadent Gas Ltd’s internal work procedure for Polyethylene (PE) Mainlaying pipe construction for pipes up to and including 630mm diameter. As such it is applicable to the construction of the connection to the 15” Ductile Iron main and the 90mm PE pipeline from that connection to the building entry except for the specification of a Pipeline Isolation Valve, which is contained within IGEM/G/5 and IGEM/TD/4 Edition 4. There is no evidence to suggest that there was any non-compliance with the requirements of T/PR/ML/4 and the other relevant standards relating to the external works other than the possible absence of a valve box over the PIV following trench reinstatement as discussed in paragraphs 165 – 169 above.
349. I have undertaken a review of the original and updated designs against IGEM/G/5. IGEM/G/5’s scope includes paragraph 2.3, which reads as follows:
- For the replacement of existing installations and like-for-like component replacement and where reasonably practicable, IGEM would expect adoption of this Standard. In any event IGEM would expect a risk assessment (see Sub-Section 4.2) to be carried out and appropriate mitigation actioned where indicated by the risk assessment.*
350. IGEM/G/5 has been reproduced as Appendix 5 of this report. Various topics are discussed below.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

### **Hierarchy of Options**

351. As stated by Matthew Dolan in his witness statement {MET00012711} IGEM/G/5 Edition 2 sets out a hierarchy of options with an external network with laterals supplying primary meter installations located immediately on the inside of an external wall being the preferred option. See paragraph 4.2.1.4 of IGEM/G/5 for a full description of the hierarchy of options.

### **Design Risk Assessment Documentation**

352. Paragraph 4.2.1.1 of IGEM/G/5 states that a risk assessment shall<sup>39</sup> be carried out. Appendix 3 of IGEM/G/5 provides further information on the risk assessment process including a list of topics that should be considered.

353. I do not believe that an adequate risk assessment was carried out for the original design.

354. I note that the risk assessment for the updated design does not explicitly consider:

- Thermal expansion and contraction;

The comments space adjacent to the topic is blank in the updated version of the document {TRI000001218} even though the riser will be over 40m high.

- Access to valves and for future inspection and maintenance;
- Risk of vandalism;
- Adequacy of ventilation of the riser from where it exits the basement to the top of the building;
- Adequacy of ventilation of the branch in each lobby;
- Mitigation of the risk created by the holes in the stair/lobby compartment wall prior to the completion of the boxing;
- The potential impairment of the means of escape from the flat by locating the repositioned gas meter on or adjacent to the sole means of escape from the flat<sup>40</sup>;

---

<sup>39</sup> The use of the term “shall” in IGEM standards is discussed in paragraph 128 above. See also paragraphs 1.4 and 1.3 of IGEM/G/5.

<sup>40</sup> See Clause 5.2.3.1 of IGEM/G/5

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Ventilation of the repositioned meter installation and installation pipework within the flat.
355. As mentioned in paragraphs 338 and 344, the fourth spreadsheet in the CDM Design Risk Assessment Document {TRI000001218} is generic with a sub-section of just three questions/tick boxes devoted to multi-occupancy buildings. I do not believe it is adequate for use on multi-occupancy building replacement projects.
356. I am of the opinion that an adequate design risk assessment checklist for multi-occupancy buildings will include significantly more than three topics for consideration in order to meet the four design objectives listed in paragraph 329. In addition to the three topics already identified in the CDM Design Risk Assessment Document, such a list of topics, which is not exhaustive and I recognise that not all of them are applicable to Grenfell Tower, should include:
- Flooding;
  - Third party damage;
  - Pipework support;
  - Effect of an Energy Centre/boosters on pipe sizing;
  - Electrical insulation/equipotential bonding;
  - Corrosion;
  - Thermal expansion and contraction;
  - Vulnerability of occupants should they need to access their ECVs;
  - Means of escape in the event of fire;
  - Access for inspection and maintenance;
  - Valves including access to them and security;
  - Thermal cut off devices and excess flow valves;
  - Ventilation of ducts and shafts;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Meter banks <sup>41</sup> - Ventilation and potential sources of ignition;
- Marking of pipes and signage;
- Other gas supplies into the building and resulting scope for confusion.

357. In conclusion, I do not believe that the requirement of having an adequate design risk assessment process has been achieved.

### **Repositioned Gas Meter**

358. Gas supplies and hence repositioned gas meters were provided to the flats ending in number “2” on the 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup> and 21<sup>st</sup> floors. The meter installations of the flats on the 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> floors were still intact i.e. undamaged, on my visit of 30<sup>th</sup> May.

359. Paragraph 5.2.3.1 of IGEN/G/5 <sup>42</sup>addresses the siting of meters in or adjacent to the sole means of escape from the flat. Either the meter shall be enclosed in a cupboard which is at least 30 minutes fire resistant to BS 476 and which has a self-closing door or a Thermal Cut Off device (TCO) shall be fitted.

360. I note from Matthew Dolan’s witness statement to the Inquiry pursuant to Rule 9 of The Inquiry Rules 2006 {TRI00001797} that:

*“the location of the meter installations was determined by the surveyor [Simon Boyle] and [tRIIO] designer who were both trained on IGEN/G/5 by DNVGL. As such, Holland Gas had no involvement in determining the location of the meter installations as per section 5 of IGEN/G/5”*

361. Not all flats had cupboards in the position in which the meters were repositioned. For example in flat no 22 on floor 5, the area in question had been made into an alcove for the bedroom.

---

<sup>41</sup> IGEN considers rooms containing meter banks to fall under DSEAR. See Section 5.4 of IGEN/G/5.

<sup>42</sup> As discussed in paragraph 103, IGEN standards are expected to be referenced in a GT’s Safety Case. Compliance with IGEN standards would be evidence in respect of goal setting regulations and articles in primary and secondary legislation such as the Gas Safety (Management) Regulations, Pipeline Safety Regulations and section 3 of the Health and Safety at Work Act 1974.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 84 – Repositioned Gas Meter in Flat No. 22 {MET00016651}**

362. None of the surviving cupboards appear to have had self-closing<sup>43</sup> doors and I observed no evidence that the cupboard walls or doors were at least 30 minutes fire resistant to BS 476. See Figure 85 for a photograph of a typical cupboard door.

---

<sup>43</sup> It is my understanding that a door fitted with rising butt hinges does not meet the criteria to be classed as a self closing door.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 85 – Cupboard for Repositioned Gas Meter in Flat No. 52 {MET00016558}**  
(Note rising hinges and non-closure of door)

363. No Thermal Cut Off devices (TCO) appear to have been fitted.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 86 – Repositioned Gas Meter Installation in Flat No. 182 {TRI000001733}**

364. None of the design documents make reference to the requirement for meters fitted in or adjacent to the sole means of escape from the flat either being enclosed in a cupboard which is at least 30 minutes fire resistant to BS 476 and which has a self-closing door or having a Thermal Cut Off device (TCO) fitted. Given Matthew Dolan's statement in {TRI00001797} reproduced in paragraph 360 above, which clearly places the responsibility for determining the meter position and compliance with section 5 of IGEM/G/5 on to the designer, I believe this non-conformance is indicative of a lack of thoroughness in the design process.
365. However, while I am not an expert in fire dynamics and other experts are better placed to consider the spread of fire at the tower, I do not believe that the non-conformance in paragraph 364 above is likely to have had a material effect on the events of 14 June 2017, other than to prolong the fire during the daytime, as discussed in response to Instruction 3 above. That is particularly so given my understanding that the fire penetrated flats from outside the building and the gas meters were located well away from the inside of the outside walls of the building.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**Breach of Fire Compartment Wall & Fire Stopping Materials**

366. The wall of the stairwell, which is understood to be a fire compartment or protected shaft, was breached on the 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup> and 21<sup>st</sup> floors (see Figure 80). The holes were oversized and not fire stopped in order to provide ventilation to the ducts formed by the boxing in of the pipework in the lobbies.

367. It will be recalled that in his witness statement {MET00012711}, Matthew Dolan makes a number of statements pertaining to this issue, including the following:

- *... the entry between the protected shaft (stairwell) and the common landing needed to be unsealed within the boxing for ventilation purposes.*
- *The entry between each floor needed to be unsealed within the boxing for ventilation purposes.*

368. As can be seen from Appendix 5, this aspect of the design is not compliant with section 6 of IGEM/G/5 and the following paragraphs in particular:

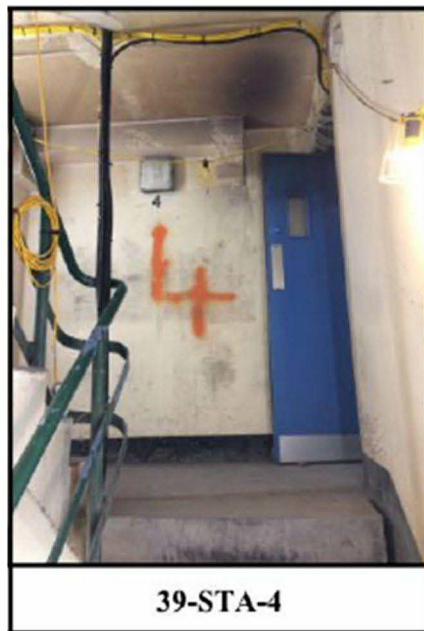
- 6.1.3; *Any network pipeline shall be installed so as not to impair the structure or the fire resistance of any part of the structure of the building, for example compartment walls, methane barriers or the damp proof course (DPC).*
- 6.1.4: *Where required to be fire resistant, materials and/or protection shall be in accordance with BS 476-20, 21, 22 and 23 or BS EN 1366-3, and 4, as appropriate.*
- 6.1.11: *Where network pipelines are installed such that it passes through a cavity wall or solid floor:*
  - *it shall be by the shortest practicable route*
  - *it shall be enclosed in a sleeve and not contain mechanical joints*
  - *the annulus between pipe and sleeve shall be sealed with a fire resistant, flexible material, so as to prevent the passage of gas. Sealing shall be at both ends where internal walls and floors are penetrated.*
  - *the annulus between the sleeve and wall, and/or sleeve and floor, shall be sealed so as to prevent the passage of gas, with a fire resistant material*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- *allowance shall be made for normal movement of the pipe and the building.*
  - 6.4.3.9; *Any pipeline riser or lateral shall be sleeved where it passes through any element, for example floor or wall, of a building*
  - 6.4.3.10. *Any pipeline riser or lateral (or its duct if fitted) shall be fire stopped between fire compartments. The method should permit thermal movement of pipe*
369. In addition, the roof of the Community Centre store cupboard/floor of the stairs between the second and third floors and the wall between the utility duct and the Community Centre store cupboard were also breached (see Figure 23). Matthew Dolan in his witness statement acknowledges that “*There were also **problems with ventilation in the location of the original riser in the utility shaft***” i.e. the same utility shaft used as the route from the basement to the second floor where the pipe exits the duct into the Community Centre store cupboard (see Figure 22).
370. Whilst the fire safety implications of these breaches, including the non-completion of the boxing in programme, is being investigated by another expert to the Inquiry, Dr Barbara Lane, I have examined relevant photographs in Section C2 of Appendix C {BLAR00000018} of her report to the Inquiry. I have also examined photographs of the pipework and walls, that were taken on 30<sup>th</sup> May 2018 and which had been exposed in the interim time period following the removal of the boxing. The photographs together with my observations are as follows:



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
4<sup>th</sup> Floor



Boxing appears to have been intact at the time of the fire. Photograph {MET00016596} indicates that smoke did not enter the boxing and hence stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.

**Report of:**  
**Specialist Field:**  
**Prepared for:**  
**5<sup>th</sup> Floor**

**Rodney Hancox**  
**Gas Engineering**  
**Grenfell Tower Inquiry**



37-STA-5





**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Boxing appears to have been intact at the time of the fire. Photograph {MET00016751} indicates that smoke did not enter the boxing and hence stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.

## 6<sup>th</sup> Floor



Boxing appears to have been intact at the time of the fire. Photograph {MET00016726} indicates that smoke did not enter the boxing and hence stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.

**Report of:**  
**Specialist Field:**  
**Prepared for:**  
**7<sup>th</sup> Floor**

**Rodney Hancox**  
**Gas Engineering**  
**Grenfell Tower Inquiry**



Boxing appears to have been intact at the time of the fire. Photograph {MET00016619} indicates that there was no smoke present in the duct at this level at the time of the fire.



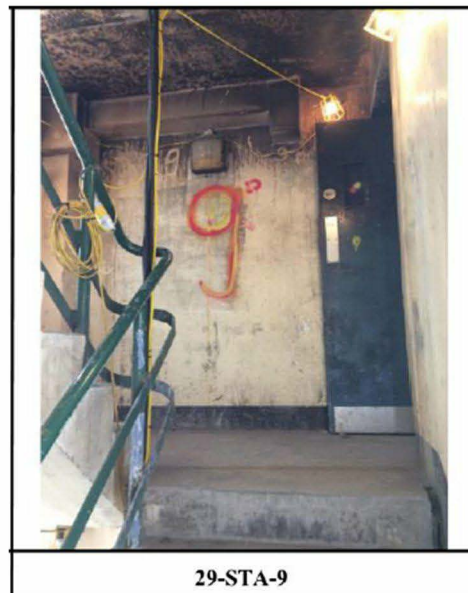
**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**8<sup>th</sup> Floor**



Boxing appears to have been intact at the time of the fire. Photograph {MET00016685} indicates that smoke did not enter the boxing and hence stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**9<sup>th</sup> Floor**



Photograph {MET00016722} indicates that smoke entered the boxing from the lobby at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**10<sup>th</sup> Floor**



27-STA-10



Photograph {MET00016576} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**11<sup>th</sup> Floor**



Photographs {MET00016747} and {MET00016559} indicate that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.

## 12<sup>th</sup> Floor



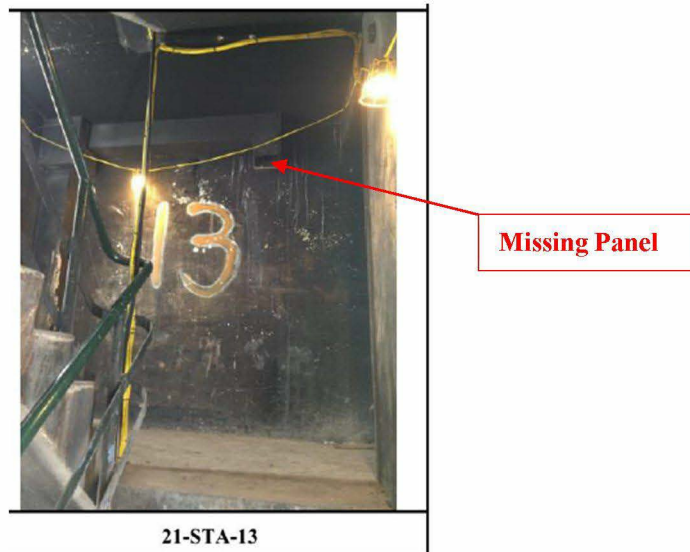
23-STA-12



Photograph {MET00016606} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**13<sup>th</sup> Floor**



Photograph {MET00016560} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

As there was a missing panel at the time Dr Lane's team carried out its inspection, it is possible that the boxing may not have been intact at the time of the fire. If the panel had not been in place on 14<sup>th</sup> June then smoke would have been able to enter the stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.

#### 14<sup>th</sup> Floor



01/10/2019

174

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Photograph {MET00016580} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.

## 15<sup>th</sup> Floor





**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Boxing appears to have been intact at the time of the fire. Photograph {MET00016616} indicates that there was a significant amount of smoke present in the duct at this level at the time of the fire.

#### **16<sup>th</sup> Floor**



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Photograph {MET00016518} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.

### 17<sup>th</sup> Floor



13-STA-17



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Photograph {MET00016516} indicates that smoke entered into and/or exited from the boxing at this level via the oversized penetration of the compartment wall through which the gas pipe passed. Boxing appears to have been intact at the time of the fire. There is no reason to suspect that smoke was able to enter the stairwell at this level from the boxing.

### 18<sup>th</sup> Floor



11-STA-18

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Boxing appears to have been intact at the time of the fire. There was no penetration of the compartment wall at this level.

Photograph {MET00016533} indicates that there was some smoke present in the bottom half of the duct at this level at the time of the fire.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**19<sup>th</sup> Floor**



9-STA-19



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

Boxing appears to have been intact at the time of the fire. There was no penetration of the compartment wall at this level.

Photograph {MET00016729} indicates that there was a little smoke present in the bottom half of the duct at this level at the time of the fire.

## 20<sup>th</sup> Floor



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Boxing appears to have been intact at the time of the fire. There was no penetration of the compartment wall at this level.

Photograph {MET00016727} indicates that there was very little smoke present in the duct at this level at the time of the fire.



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry  
21<sup>st</sup> Floor



Photograph {MET00016549} indicates that smoke entered the boxing from the lobby at this level via the oversized penetration of the compartment wall through which the gas pipe passed. I note the vertical section appears to have been smoke free.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

As there was a missing panel at the time Dr Lane's team carried out its inspection, it is possible that the boxing may not have been intact at the time of the fire. If the panel had not been in place on 14<sup>th</sup> June then smoke would have been able to enter the stairwell via the oversized penetration of the compartment wall through which the gas pipe passed.

## **22<sup>nd</sup> Floor**



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



Boxing appears to have been intact at the time of the fire. There was no penetration of the compartment wall at this level.

Photograph {MET00016728} indicates that there was some smoke present in the duct at this level at the time of the fire.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry  
**23<sup>rd</sup> Floor**



Boxing in had not been completed at this level at the time of the fire.

371. With respect to the question of smoke being able to enter the stairwell via the oversized penetrations of the compartment wall through which the gas pipe passed, I noted that

- at levels 13 and 21 the boxing in the stairwell did not appear to be completely intact when Dr Barbara Lane's photographs were taken in early November 2017. Panels on the underside of the boxing at the point where the lateral exits the stairwell appear to be missing. Consequently, assuming the panels had not been removed in the period between the dates of the fire and when the photographs were taken, I believe it is possible that smoke could have entered the body of the



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

stairwell via the oversized penetrations of the compartment wall through which the gas pipe passed at these levels during the fire.

- at levels 4, 5, 6, 8, 9, 10, 11, 12, 14, 16 and 17 the boxing appears to have been intact when Dr Barbara Lane's photographs were taken in early November 2017. Consequently, I believe it is unlikely that smoke would have entered the body of the stairwell via the oversized penetrations of the compartment wall through which the gas pipe passed at these levels during the fire.
- at levels 7, 15, 18, 19, 20, 22 and 23, laterals were not required and hence those compartment walls were not penetrated.

372. The question has been raised as to whether smoke from one lobby could have travelled to another lobby via the oversized holes and boxing within the stairwell.

373. Neither I on my visits nor CORGI Technical Services during their survey for the Metropolitan Police Service as recorded on {MET00016762}, observed any evidence of interim fire stopping of any of the penetrations of the stairwell/lobby wall by the pipeline.

374. Whilst acknowledging that Dr Barbara Lane will be considering this question in detail, I believe, given the evidence of smoke staining contained in the photographs in paragraph 370 above, that it is highly likely that smoke would have travelled from one lobby to another.

375. The question has been raised also as to whether the change in the configuration of the fire compartmentation brought about by the installation of Residential Gas Supply No.2 and its "boxing in" in the lobbies required approval by Building Control under the Building Regulations. Whilst it is my understanding that a gas pipeline is not a controlled service as defined in the Building Regulations,<sup>44</sup> I would stress that I am not an expert in Building Regulations law. Hence, I do not express an opinion on this question.

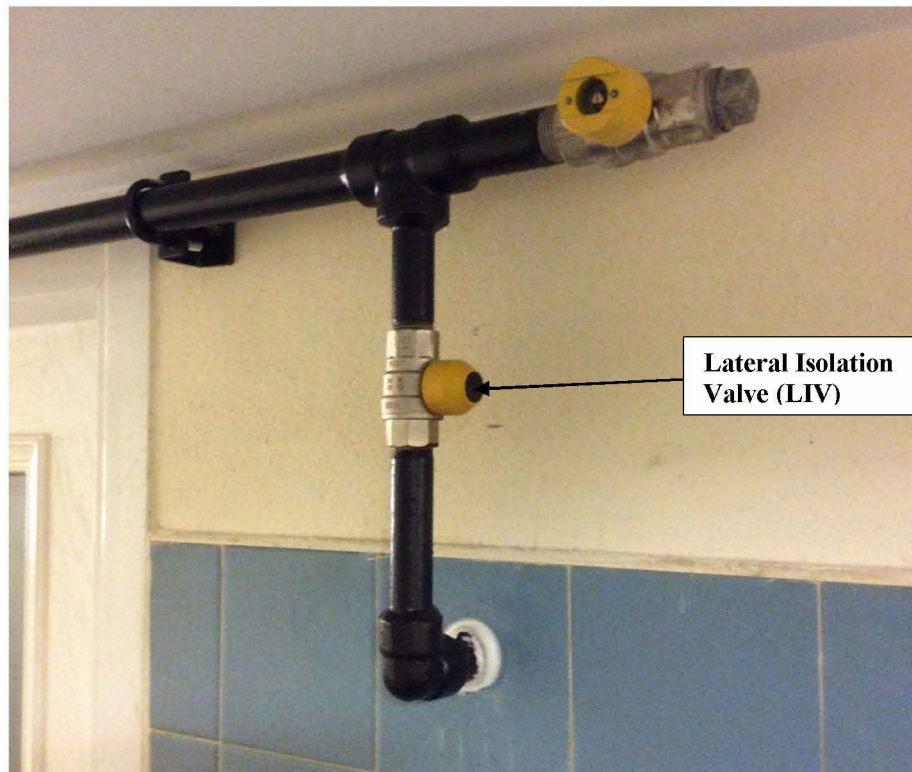
---

<sup>44</sup> It is my understanding that in the Building Regulations, a controlled service is one in relation to which Parts G (sanitation & water), H (drainage & waste disposal), J (combustion appliances & liquid fuel systems), L (energy conservation) and P (electrical safety) of Schedule 1 of the regulations imposes a requirement.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

376. Each of the service entries into the flats from the lobbies were also breaches of a compartment wall. However, in each case which I observed, the service entry had been sleeved and sealed with what appeared to me to be fire stopping material.



**Fig. 87 – Service Entry into Flat ending in “2”. {CAD00001897}**

377. Matthew Dolan in his witness statement {MET00012711} states that

*The boxing-in of the pipes consisted of 12 mm uniboard, manufactured by Enviroboards. These were fire boards, which were fire resistant. The boards were screwed to battens, which were fitted to the walls and ceilings. Express Builders used Fire Mate Sealant (an emulsion acrylic based sealant used for sealing joints in fire walls) to seal the joints and the screws. K&S used Hilti sealant around the laterals going into the flats.*

378. Both Cadent Gas Ltd and tRIIO have disclosed details of fire stopping materials, as follows:

- Everboard 12mm uniboard – literature states that it provides 88 minutes integrity to BS 476 Part 22 {TRI000001377};

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Everflex Firemate – literature states that tests have been carried out against BS EN 1366-4 giving up to 5 hours fire integrity {TRI000001280};
- Hilti CP 606 Firestop Sealant - literature states that tests have been carried out against BS 476-20 and BS EN 1366-4 giving up to 4 hours fire integrity {TRI000000002}. Whilst the relevant standard for fire integrity tests of penetration seals is BS EN 1366-3, the literature also indicates that the material is suitable for use as a penetration sealant for metal pipes going through walls even though BS EN 1366-3 is not quoted therein.<sup>45</sup>

There is no evidence either to confirm or to dispute the claim that these materials were used throughout the works.

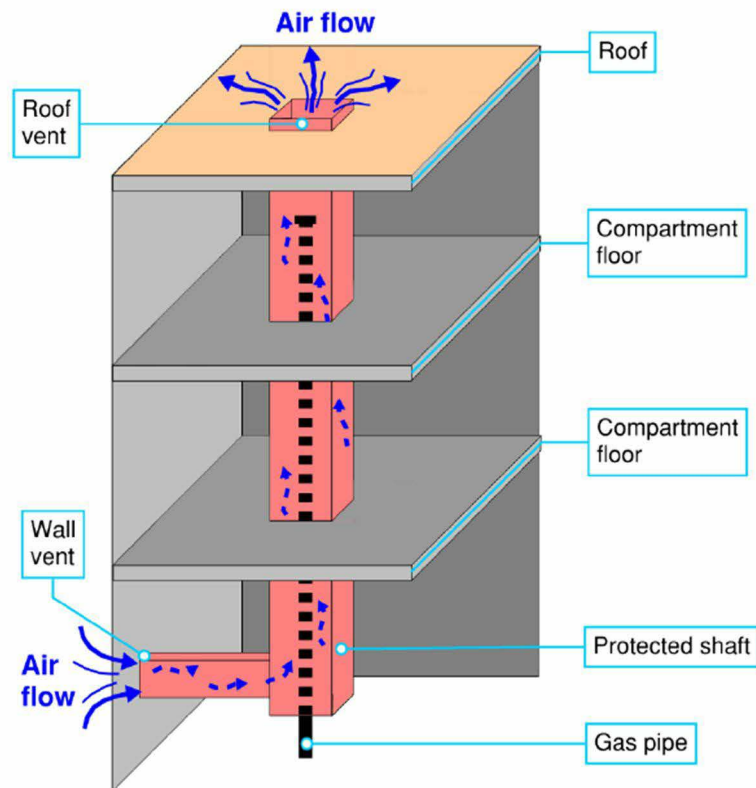
### **Ventilation and Boxing of Pipework in Stairwell**

379. I note that it was decided to box in the pipework in the stairwell because it contained flanged joints (see Figure 26) and hence it could not be deemed to be either all welded steel or screwed steel pipe, which is the criteria set by paragraph 8.40 of Approved Document B2 for the installation of gas pipes in a protected shaft. Consequently, the pipework needed to be separated completely with fire resistant construction from the stairwell and be installed in a ventilated protected shaft in its own right, as illustrated by the following diagram used by Dr Barbara Lane in her evidence to the Inquiry on 18<sup>th</sup> June 2018.

---

<sup>45</sup> {CAD00002890} is an e-mail from Antony Stewart of Hilti to K&S stating that 240 minutes fire rating can be achieved for up to 30mm [gap] and a depth of 10mm of the material.

## Ventilation of a shaft containing a gas pipe



**Fig. 88 - Diagram of Ventilated Protected Shaft Containing a Gas Pipe**

380. As stated in paragraph 301 above, the purpose of ventilation is to disperse any minor credible leaks before the gas in air mixture builds up to a flammable mixture. Ventilation of gas network pipes is legally required by Regulation 6 of the Dangerous Substances and Explosive Atmospheres Regulations and Regulation 12(3) and Part 4 of Schedule 1 of the Regulatory Reform (Fire Safety) Order 2005.
381. Such a ventilated protected shaft as is depicted in Figure 88 above
- Requires sufficient air to be able to enter the bottom of the shaft from outside;
  - Requires the air to be able to exit the shaft at the top to the outside;
  - Requires the air flow from bottom to top not to be impeded and to be sufficient to ensure that in the event of reasonably foreseeable gas leak the gas concentration within the shaft shall be no more than 25% of the Lower Flammable Limit;
  - Shall be at least 120 minutes fire resistant;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Shall be able to be inspected internally such that in the future Cadent Gas Ltd can comply with Regulation 7 of the Pipeline Safety Regulations.
382. With respect to sufficient ventilation air being able to enter the bottom of the shaft, I note that Simon Boyle in his survey report of 1<sup>st</sup> November 2016 (Appendix 8 & {CAD00000054}) states that:
- “Once the riser has been installed the riser could be segregated from the mechanical air extraction [in the lobby] by being boxed in. There is a route out to fresh air through the basement and [I] would assume a route out through the top floor. (No access to roof as locked.)”.*
383. On visiting site I noted that there was no discernible ventilation<sup>46</sup> from outside to the bottom of the stairwell.
384. Neither the initial nor the updated design includes any detail or description as to how the pipe between the basement and the bottom of the stairwell was to be ventilated. There is no recognition of the basement, which, as it contains boilers, is a “place of special fire hazard”, being a fire compartment in its own right and hence needed to be sealed from the rest of the building. Neither is there any detail or description as to how the “Ventilated protected shaft” containing the gas riser and contained within the stairwell was to be ventilated from low level.
385. Similarly there is no reference to the need for vents conforming either to Table 1 of BS 8313 or Table 7 of IGEN/G/5 in the utilities duct(s) between the ground floor and the second floor. Neither have any bespoke calculations using the equations in either BS 5925 or IGEN/SR/25 been disclosed as an alternative to the vent sizes quoted in Table 1 of BS 8313 or Table 7 of IGEN/G/5.
386. On visiting site I noted that the utilities duct rising from the ground floor level to Level 2 (see Figure 22) did not, in any way, have any ventilation to outside in accordance with Section 12 of BS 8313.
387. The store cupboard adjacent to the Community Meeting Room was fully enclosed and no air vents were observed i.e. it was an unventilated void.

---

<sup>46</sup> It should be noted that at least two residents, Ahmed Elgwhary {IWS00000988} and Eamon Zada {IWS00000989} have advised the Inquiry that ventilation in the stairwell was reduced significantly following the refurbishment work.



Report of: Rodney Hancox  
Specialist Field: Gas Engineering  
Prepared for: Grenfell Tower Inquiry

388. A schedule of boxing in {CAD00002313} has been disclosed.

Grenfell Tower				
Floor	Location	Lateral	Boxing	Riser
Basement	4" supply then reduces to 2"			
Ground	welded Riser Supply 2" passing through to next level	Not Required	Yes	No
1	welded Riser Supply 2" passing through to next level	Not Required	Yes	Utility shaft
2	welded Riser Supply 2" passing through to next level	Not Required	Yes	Utility shaft
3	welded Riser Supply 2" passing through to next level	Not Required	Yes	Utility shaft
4	welded Riser Supply 2" passing through to next level	Not Required	Yes	Utility shaft
5	Communal area	Yes	No	Yes
6	Communal area	2 Yes	14 Yes	Yes
7	Communal area	3 Yes	No	Yes
8	Communal area	No	No	Yes
9	Communal area	4 Yes	No	Yes
10	Communal area	5 Yes	No	Yes
11	Communal area	6 Yes	No	Yes
12	Communal area	7 Yes	No	Yes
13	Communal area	8 Yes	No	Yes
14	Communal area	9 Yes	No	Yes
15	Communal area	10 Yes	No	Yes
16	Communal area	No	No	Yes
17	Communal area	11 Yes	No	Yes
18	Communal area	12 Yes	No	Yes
19	Communal area	No	No	Yes
20	Communal area	No	No	Yes
21	Communal area	No	No	Yes
22	Communal area	13 Yes	No	Yes
23	Communal area	No	No	Yes
24	Communal area	No	No	Yes

Fig. 89 - Schedule of Boxing in {CAD00002313}

389. From Fig 89 it can be seen that the boxing in i.e. the construction of the “ventilated protected shaft” containing the gas pipe covered floors 4 to 23 only and it is noted that there is no mention of extending the “ductwork” to enable ventilation to enter the shaft at low level.

390. With respect to the requirement for the ventilation air to be able to exit the shaft at the top to the outside, I note that in his witness statement, Matthew Dolan states that

- *Globe Scaffolding Limited (Globe), was contracted to install scaffolding ... .. to allow safe access for the installation of the boxing-in around the new vertical riser from the 20<sup>th</sup> [sic] Floor up to the roof vent, a distance of approximately 7 metres.*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 90 – The Roof from 23<sup>rd</sup> Floor of the Stairwell {CAD00001975}**

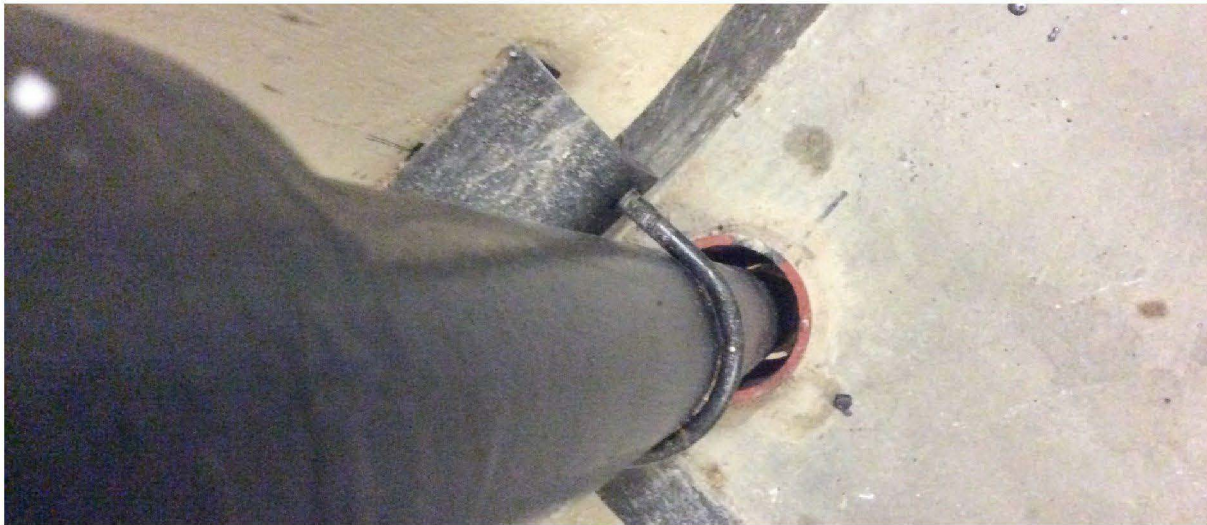




**Fig. 91 – Roof Vent**

391. Globe Scaffolding produced a design for the scaffolding. However, no design has been presented for the ventilation of the top of the boxing to the roof vent.
392. With respect to the requirement for the ventilation air flow from bottom to top not to be impeded and to be sufficient to ensure that in the event of reasonably foreseeable gas leakage the gas concentration within the shaft shall be no more than 25% of the Lower Flammable Limit, I note that there has been no disclosure referencing the need for vents conforming either to Table 1 of BS 8313 or Table 7 of IGEN/G/5. Neither have any bespoke calculations using the equations in either BS 5925 or IGEN/SR/25 been disclosed as an alternative to the vent sizes quoted in those tables.
393. I also note that originally sleeves were installed where the riser went through the stair floors. However, as can be seen from Figure 92 below and Figures 23 and 26 above those sleeves were not sealed.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 92 – Unsealed Sleeve in Floor {CAD00001910}**

394. I understand that the gap between the sleeve and the pipe was left unsealed to enable ventilation air to travel from the bottom to the top of the duct in the stairwell. No calculations have been disclosed by tRiIO to demonstrate that the area of the annular gap was sufficient to ensure that in the event of credible gas leakage the gas concentration within the shaft would be no more than 25% of the Lower Flammable Limit.
395. As shown in the annotated photograph below (Figure 93), the concrete floor between the walls and the red lines form an obvious impediment to the air flow between each floor. Once the decision had been taken to enclose the riser in a shaft, the floor remaining within the shaft should have been cut out to as near the full cross sectional area as practicable so as to comply with the second paragraph of paragraph 8.41 of Approved Document B.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 93 – Retained Floor Impeding Air Flow Up Through Riser Shaft**

396. I acknowledge that the evidence presented by Figures 92 and 93 above indicates the presence of some ventilation throughout the shaft, although the question remains in respect of its sufficiency to disperse a credible gas leak.
397. With respect to the boxing being at least 120 minutes fire resistant, I note from {TRI000001377} that the Everboard 12mm uniboard literature states that it provides 88 minutes integrity to BS 476 Part 22 and not 120 minutes. See paragraph 320 above and Matthew Dolan's Witness Statement {MET00012711}.
398. With respect to provision for future inspection and maintenance of the pipeline within the shaft, no evidence has been disclosed by tRIIO to indicate that future inspection and maintenance was considered in the design or construction of the boxing
399. It has already been noted that the updated design drawing, Figure 76 {TRI000001223}, included an annotated photograph, Figure 75 {TRI000001206}, specifying the installation of an intumescent vent on the underside of the horizontal

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

boxing in the vicinity of the Branch Isolation Valve. It should be noted that no reference is made to the use of intumescent vents in IGEM/G/5 Edition 2.

400. From my site visits, the schedule of boxing in {CAD00002313} and from viewing the photographs in Section C2 of Appendix C of Dr Barbara Lane's report {BLAR00000018}, it is evident that:

- The boxing in of the pipework in the stairwell from level 4 to level 22 to form the “ventilated protected shaft” had been completed;
- The boxing in of the pipework in the stairwell at level 23 to the roof vent to complete the “ventilated protected shaft” had not been designed or completed;
- The boxing in of the pipework in the lobby of level 5 had been completed (see also Figure 77 {TRI000001439} above);
- The boxing in of the pipework in the lobbies of the other levels had not been completed;
- Low level ventilation into the “ventilated protected shaft” was from the bottom of the stairwell and not from outside. It was poor at best;
- Ventilation would have been impeded significantly where the “ventilated protected shaft” went through each floor in the stairwell, see Figures 92 and 93.

401. I am of the opinion that the ventilation of the riser and laterals had not been the subject of a sufficiently rigorous design process and that the design was not and would not on completion have been compliant with IGEM/G/5 Edition 2, BS 8313, paragraphs 8.40 and 8.41 of Approved Document B and the Regulatory Regime described above.

402. Whilst acknowledging that it is highly likely that smoke would have travelled from one lobby to another, I am of the opinion that the deficiencies in the ventilation of the boxing in the stairwell did not add fuel to the fire on 14<sup>th</sup> June 2017.

### **Expansion and Contraction**

403. The riser itself in the vertical plane is over 40 metres high. As such Figure 25 of IGEM/G/5 Edition 2 indicates that “special design conditions apply” and the expectation is that bespoke expansion and contraction calculations and/or the provision of flexible type 1 or type 2 metallic hoses to BS EN ISO 10380 should be

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

considered in the design. No evidence has been provided to indicate that expansion and contraction was considered as part of the design.

### **Integrity of Pipeline**

404. I inspected the pipework in the stairwell and in each of the lobbies, where installed, visually. I found no evidence to suggest that any of the riser or lateral pipework exposed to the fire on the 14<sup>th</sup> June 2017 failed from the point of view of containing the gas in the pipe.

### **Protection from Corrosion**

405. As discussed in paragraphs 242 and 279 – 282 above, exposed threads which have not been properly protected pose a medium to long term risk of failure due to corrosion. From photographs and observations on site it can be seen that the pipework was painted including in the majority of cases where there were exposed threads.
406. However, there were some cases of unprotected exposed threads as evidenced by the following photograph {CAD00001718}.



**Fig. 93 – Unprotected Exposed Threads on Otherwise Protected Pipe {CAD00001718}**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

407. I am of the opinion that this is a minor non-compliance which had no bearing on the events of 14<sup>th</sup> June 2017.

## **Valves**

408. Section 7 of IGEM/G/5 Edition 2 i.e. Appendix 5 of this report, addresses the role and installation of valves. Reference should also be made to Figure 28 – Diagrammatic Representation of Valves in Multi-occupancy Buildings above, when considering the valves installed in Residential Gas Supply No.2.
409. As discussed in paragraphs 162 - 164 and 170 above, I am satisfied that a Pipeline Isolation Valve was installed at the time of construction in accordance with IGEM/G/5.
410. The Inlet Isolation Valve (IIV) is shown in Figure 21 above and its role is discussed in paragraphs 133 - 134 and 176 - 177 of this report.
411. It is noted that in the absence of a ladder, the valve was not accessible either to Cadent Gas Ltd personnel or the Emergency Services or a KCTMO's competent person in an emergency. Given that an IIV is not an "Emergency Control" as defined in the Pipeline Safety Regulations 1996 I do not believe its relative inaccessibility constitutes a regulatory non-compliance. On the other hand I believe the inaccessibility constitutes poor practice and non-compliance with the third bullet point<sup>47</sup> of paragraph 7.4.2 of IGEM/G/5 Edition 2.
412. In addition, signage as specified in the 8<sup>th</sup> and 9<sup>th</sup> bullet points of paragraph 7.4.2 of IGEM/G/5 was not present.
413. Lock shut Branch Isolation Valves (BIVs) were installed on each branch/lateral coming off the riser in the stairwell. See Figure 75 above. Future access to them for maintenance purposes would have involved unscrewing the boxing. I believe they were compliant with section 7.5 of IGEM/G/5 Edition 2.
414. Lock shut Lateral Isolation Valves (LIVs) were installed on each lateral supplying flats ending in "2". See Figure 87 above. As with the BIVs future access to them for

---

<sup>47</sup> The 3<sup>rd</sup> bullet point is "be accessible for maintenance purposes".



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

maintenance purposes would have involved unscrewing the boxing. I believe they were compliant with section 7.6 of IGEM/G/5 Edition 2.

415. Residential Gas Supply No.2 terminated at the Emergency Control Valves within the individual flats. See Figures 27, 84 and 86. The ECVs were compliant with the regulatory and standards regime outlined in the response to Instruction No.1 above.
416. The absence of excess flow valves (EFV) and thermal cut off devices (TCO) has already been discussed in paragraphs 133 and 359 - 365 above.

### **Installation Pipework**

417. Copper installation pipework to BS 6891 was installed by Holland Gas Ltd who were sub-contracted to K and S Pipelines LLP.

418. Matthew Dolan in his witness statement {MET00012711} states that

- *Of the 13 affected flats with a lateral pipe, flats 12 (Floor 1<sup>48</sup>) [sic], 22 (Floor 2) [sic], 32 (Floor 3) [sic], 52 (Floor 5) [sic], 62 (Floor 6) [sic], 92 (Floor 9) [sic], 102 (Floor 10) [sic], 142 (Floor 14) [sic] and 182 (Floor 18) [sic] had their gas supply reinstated on the following dates:*

*Flat 12 - 16 February 2017* (See {TRI000001785})

*Flat 22 - 9 March 2017* (See {TRI000001734} and {TRI000001735})

*Flat 32 - 22 February 2017* (See {TRI000001737})

*Flat 52 - 26 January 2017* (See {TRI000001723})

*Flat 62 - 10 March 2017* (See {TRI000001730})

*Flat 92 - 22 February 2017* (See {TRI000001738})

*Flat 102 - 2 February 2017* (See {TRI000000962})

*Flat 142 - 9 March 2017* (See {TRI000001729} & {TRI000001731})

*Flat 182 - 8 March 2017* (See {TRI000001733})

---

<sup>48</sup> Flat No. 12 was on the 4<sup>th</sup> floor and Flat no 182 was on the 21<sup>st</sup> floor etc. In his Rule 9 witness statement {TRI00001797} Matthew Dolan corrected the floor numbering from residential floor numbers to actual floor number as used by the Inquiry so as to avoid confusion.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- *Flats 72 (Floor 7) [sic], 82 (Floor 8) [sic], 112 (Floor 11) [sic] and Flat 132 (Floor 13) [sic] had gas supplied to the ECV, which was capped, but no further because:*
  - *Flat 72 had a leak identified on the existing outlet pipework (tRIIO made this safe and notified the resident so they could arrange for it to be addressed as this pipework was owned by the resident, rather than Cadent, so did not fall within tRIIO's scope);*
  - *Flat 82 decided to have an electric oven fitted;*
  - *Flat 112 did not have a gas meter;*
  - *Our internal works engineer had not been able to gain further access to Flat 132.*
- *Holland Gas and the Internal Works Engineers completed internal inspections in accordance with Gas Safe requirements on the dates set out above.*
- *The internal soldered pipework was inspected by site managers from tRIIO and Holland Gas in March 2017. Minor findings were noted and rectified relating to the internal works including one instance of a lack of sleeving on pipework and two instances of minor earth bonding issues. There were also two occurrences of existing cookers missing chains and the customers were advised so they could remedy this. tRIIO does not address existing problems found within properties due to Gas Safe requirements, rather such issues must be flagged to the customer so that they may instruct a third party to deal with these.*
- *On 16 February 2017, a worker engaged by Holland Gas to relocate the gas meter within Flat 12 mistakenly drilled through a panel, above a door, containing asbestos within the flat. This was picked up when a carpenter despatched to carry out boxing-in work in Flat 12 discovered debris on 27 February 2017. tRIIO was made aware of the incident on 27 February and immediately engaged LAB UK to carry out an asbestos background air test. T&S Environmental was also instructed to attend site the same day to carry out an emergency clean up and to arrange the disposal of the asbestos containing materials.*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

419. The asbestos incident in Flat 12, whilst a very serious health and safety non-compliance in itself, in my opinion did not have any bearing on the events of 14<sup>th</sup> June 2017.
420. I understand that the melting point of copper pipe is 1082<sup>0</sup>C. The solder used to join copper pipes will melt at the significantly lower melting point temperature of 228<sup>0</sup>C {CAD00002870}. It is therefore likely that in some of the flats above the 11<sup>th</sup> floor there may have been some minor gas leakage from joints in the copper pipe some time after the fire had been well and truly raging within the flat. I am of the opinion that this would have had little or no bearing on the events of 14<sup>th</sup> June 2017.
421. I am of the opinion that the various non-conformances associated with the installation pipework as mentioned by Matthew Dolan would not have had any bearing on the events of 14<sup>th</sup> June 2017.

## **Materials**

422. The standards for steel pipe quoted in IGEM/G/5 Edition 2 are GIS/L2 and for diameters up to and including 50mm, BS EN 10255. GIS/L2 is a Gas Industry Standard covering steel pipe in sizes from 21.3 mm to 1219 mm outside diameter for maximum operating pressures up to 7 bar and it is supplementary to BS EN 10208-1.
423. The steel pipe industry is truly global and there are numerous national and international standards bodies trying to keep pace with changes in the market place. In practice, unless a manufacturer receives a large order for pipe conforming to GIS/L2 it is very unlikely that a pipeline constructor will be able to purchase pipe to that standard. However, pipe is manufactured both for specific projects and for pipe stockists to certain popular, usually American, standards such as those of the American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME) and the American Petroleum Institute (API).
424. It is common practice in the British Gas Industry to use ASTM A106 Grade B/API 5L pipe in lieu of GIS/L2 pipe for gas distribution pipelines with a maximum operating pressure up to 7 bar, not least because small quantities of such pipe are readily

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

available from pipe stockists. ASTM A106 Grade B/API 5L<sup>49</sup> pipe is also used for pipelines operating at much higher pressures.

425. A similar situation exists in respect of steel fittings. The gas industry standard quoted in IGEM/G/5 is GIS/F7 which is supplementary to a number of British Standards including BS 3799 – Specification for steel pipe fittings, screwed and socket welding for the petroleum industry. The equivalent American Society for Testing and Materials standard is ASTM A105.
426. The ASTM A106, API 5L and ASTM A105 standards are quoted in the IGEM standards for high pressure gas transmission and gas distribution, namely IGEM/TD/1 and IGEM/TD/3. In other words, pipe and fittings to these standards are used in gas networks conveying gas at much higher pressures than that pertaining at Grenfell Tower.
427. K & S Pipelines LLP, tRIIO's construction sub-contractor, provided materials advice notes to tRIIO as part of its construction completion and records pack. The materials advice notes {TRI000001362} – {TRI000001367} inclusive and {TRI000001381} not only include details of the specification against which the pipe and fittings were purchased but they also included materials inspection and test certificates.
428. I understand that the melting point of steel pipe and fittings to these standards is in the region of 1450<sup>0</sup>C – 1500<sup>0</sup>C and hence would have contained the gas within the pipe during the fire.
429. Not being a steel pipe expert, I have only been able to undertake a cursory examination of the advice notes for the materials and associated inspection and test certificates. From that examination I have concluded that the steel pipe and fittings used in the construction of Residential Gas Supply No.2 complied with ASTM A106 and ASTM A105 respectively. As such they were more than appropriate for the installation. Consequently, I am of the opinion that the steel pipe and fittings used were compliant with the Pipeline Safety Regulations and IGEM/G/5.

---

<sup>49</sup> I have been given to understand that steel line pipe to this standard accounts for approximately 80% of global sales.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

430. Should the Inquiry wish to have a more detailed examination made of the pipe and fittings used then it will be necessary for it to engage an expert in the field of steel pipe material selection and welding.

431. I observed that the lateral isolation valves (LIV) and the consumers' emergency control valves (ECV) were standard gas industry ball valves to GIS/V7 Part 3. GIS/V7 Part 3 includes the following table which has been reproduced as Figure 94 below:

Application	Sizes (inches)	Type	Required valve standard	Connections	Lever colour and material	High temperature resistance
Medium pressure emergency or meter control valve outside building	½ X 19mm	Ball Valve	EN 331: 1998 class MOP 5 Straight or right angled	Inlet – BS21:1985 female thread and Outlet – EN ISO 10806:2003 male thread and cap is EN ISO 6806:2003 female thread	Amber BS4800, 08 C 35 and pressed steel handle	Not required to be High temperature resistant as only installed outside buildings
Medium pressure emergency or meter control valve outside building	1" X 1", 1" X 2" and 2" X 2"	Ball valve	EN 331: 1998 class MOP 5	Inlet – BS21:1985 female thread and Outlet – BS21:1985 female thread	Amber BS4800, 08 C 35 and pressed steel handle	Not required to be High temperature resistant as only installed outside buildings
Low Pressure emergency or meter control valve inside or outside building	¾ to 1	Ball valve	EN 331: 1998 class MOP 0.5 BS 1552:1995	Inlet – BS 21:1985	Red BS 4800, 04 E 53 for ball valves. Pressed	the valve shall comply with requirements of the Building Regulations; BS:2013 Internal fire spread requirements and the test requirements of BS 1552:1995 with a test temperature rise of 800°C above ambient temperature for 30 mins (maximum of 850°C test temperature).
	¾ to 1	Plug valve	MOP 200mbar	female thread and Outlet - BS 746:2005	steel for ¾ & 1" plug valves	
	1¼ to 2	Ball or Plug Valve	EN 331:1998 class MOP 0.5 for ball or BS 1552:1995 MOP 200mbar for plug valves	male thread and cap is female BS 746:2005 thread.	and black heart malleable iron in grey for plug valves over 1"	
Gas Emergency Security Valve for use on service riser or laterals in buildings such as flats (needs resetting by key if turned off)	¾ to 1	Ball valve	EN 331: 1998 class MOP 0.5	BS 21:1985 female thread both ends	Yellow BS4800, 10 E 53 pressed steel	High temperature resistant to EN 1775:2007, Annex A, procedure B
	1-1/2"	Ball valve	EN 331: 1998 class MOP 0.5	BS 21:1985 female thread both ends	Yellow BS4800, 10 E 53 sheath pressed steel	High temperature resistant to EN 1775:2007, Annex A, procedure B
	2"	Ball valve	EN 331: 1998 class MOP 0.5	BS 21:1985 female thread both ends	Yellow BS4800, 10 E 53 sheath pressed steel	High temperature resistant to EN 1775:2007, Annex A, procedure B

**Fig 94 – Valve types, their uses, pressure ratings and thread types**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

432. Consequently, I am of the opinion that from a materials perspective, the valves used were compliant with the Pipeline Safety Regulations and IGEM/G/5.
433. I have already discussed the fire resistance of the components used in the meter installations in paragraph 238 above. It will be recalled that gas meters to BS EN 1359 and pliable connectors to PRS/6 are fire resistant for 30 minutes. Meter Regulators, which are of an aluminium alloy construction, are manufactured in accordance with PRS/3, which does not include any reference to fire resistance testing.
434. I observed, particularly in flats where meter installations were not affected by the fire, that standard meter installation components had been used. Therefore, I believe that they were compliant with the Gas Safety (Installation and Use) Regulations and BS 6400 Part 1 in particular.
435. However, both the HSE guidance to the Gas Safety (Installation and Use) Regulations (HS(L)56) and BS 6400 Part 1 specify that gas meters installed within buildings shall be fire resistant. There is no mention in either document of fire resistance of the other components making up a meter installation i.e. pliable connectors and regulators. I note that Table A6 of Approved Document B defines non combustible materials and that one of the lines in the table refers to pipes. Table 14 of Approved Document B notes that steel and copper pipes are non-combustible. It does appear to me that with Approved Document B referring to the fire resistance of pipes on the one hand and HS(L)56 and BS 6400 Part 1 referring to the fire resistance of meters on the other hand and with none of them referring to the fire resistance of pliable connectors and regulators, there may be a disconnection between the different regimes which the Inquiry may wish to consider further.

## **Construction**

436. Since before the demerger of British Gas in 1996 the welding of steel pipe with maximum operating pressures up to 7 bar has been covered by a specification known as T/SP/P1. The successors to British Gas including Transco, National Grid and Cadent Gas Ltd have continued to use this specification, updating it as and when necessary. Included in this specification are the following topics:

Report of: **Rodney Hancox**  
Specialist Field: **Gas Engineering**  
Prepared for: **Grenfell Tower Inquiry**

- Production and approval of welding procedures by an independent body;
- Test samples and their examination;
- Welder approval by an independent body;
- Equipment and electrodes;
- Mix of pipe and fittings;
- Inspection including non-destructive testing (NDT).

437. I am aware that T/SP/P1 is compatible with Section 3.5.2 of IGEM/G/5 Edition 2.

438. On completion of their work K and S Pipelines LLP compiled a "completion file" {CAD00002121}. It included:

- A production welding record of the visual inspection of all welds;

### Inspection of Production Welding Record



Welding Inspector	M. G. Russell (B Gas 0153)	Project	IMGM 170186
Site Address	Grenfell Tower Grenfell Walk London W11 1TE		
Date	24-2-2017	Description	T-SP-P1
Welder	E. Lawrence + (i) B. S. R. R. R. R.	Welding Specification	T-SP-P1
Client	K&S	Welding Procedure	KS 24- KS 27

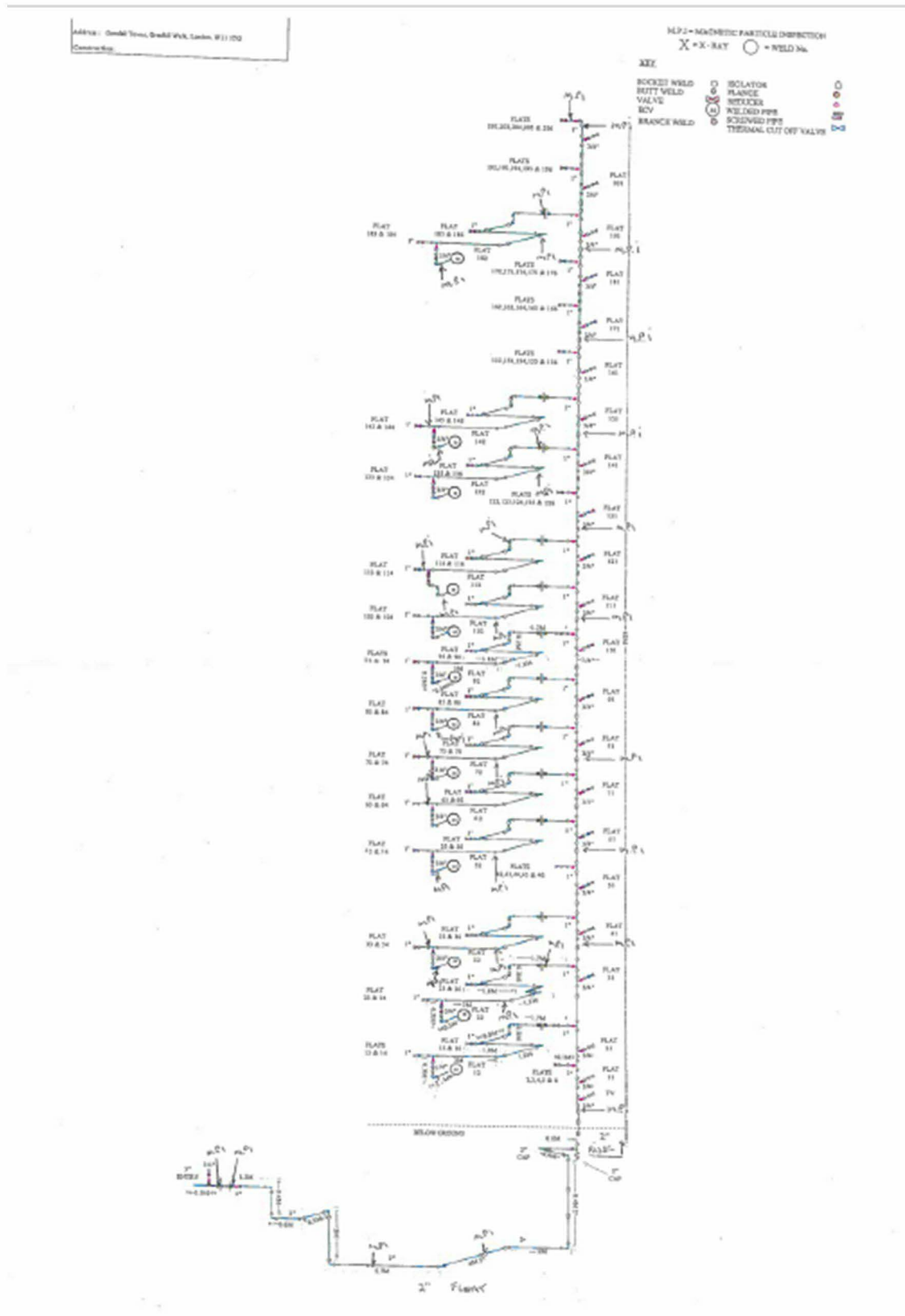
Location	Size	No. of Welds	Weld Type	Visual Inspection	MPI	X-Ray One	X-Ray Two	X-Ray Three	X-Ray Four
ENTRY	3"	2	Filler-Flange	2	2	-	-	-	-
"	3/4"	1	Branch	1	-	-	-	-	-
Basement Flue	2"	1	Butt	1	-	-	-	-	-
"	"	29	Socket	29	2	-	-	-	-
Riser	2"	132	"	132	10	-	-	-	-
Offtakes	1"	26	Filler-Flange	26	3	-	-	-	-
"	"	164	Socket	164	15	-	-	-	-
"	3/4"	64	"	64	6	-	-	-	-

Client		Welding Inspector	M. G. Russell
Signature		Signature	M. G. Russell

**Fig 95 - production welding record**

- A diagram showing where Magnetic Particle Inspection (MPI) was carried out;

<b>Report of:</b>	<b>Rodney Hancox</b>
<b>Specialist Field:</b>	<b>Gas Engineering</b>
<b>Prepared for:</b>	<b>Grenfell Tower Inquiry</b>



**Fig. 96 – Diagram including location of MPI inspections**



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Welding procedures;
- Welder qualification records;
- Test weld reports;
- Magnetic Particle Inspection Reports on 10% of the welds.

439. Notwithstanding that I am not a steel pipe materials and welding expert, I am of the opinion that the welding of the pipework was compliant with the T/SP/P1 standard and hence believe it was compliant with the Pipeline Safety Regulations and IGEM/G/5.
440. I have already noted in paragraph 404 that in the case of screwed joints, there were some cases of unprotected exposed threads as evidenced by Figure 93 {CAD00001718}. However, as stated in paragraph 407, I am of the opinion that this is a minor non-compliance, which had no bearing on the events of 14<sup>th</sup> June 2017.
441. The “completion file” {CAD00002121} included pressure test certificates. Successful pressure tests at 350 mbar were carried out on the network pipeline in accordance with Section 12 of IGEM/G/5 and IGEM/TD/3 as follows:
- Riser and branches/laterals to flats numbering 22, 32, 52, 62, 72, 82, 102, 112, 132, 142 and 182 on 25<sup>th</sup> January 2017;
  - Branch/lateral to flat number 12 on 16<sup>th</sup> February 2017;
  - Branch/lateral to flat number 92 on 20<sup>th</sup> February 2017.
442. The 90mm PE pipework external to the building was also tested successfully at 350 mbar on 25<sup>th</sup> January 2017.
443. The pipework in the stairwell and in each of the lobbies where it was installed has been visually inspected. No evidence has been found to suggest that any of the riser or lateral pipework exposed to the fire on the 14<sup>th</sup> June 2017 failed from the point of view of containing the gas in the pipe.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry



**Fig. 97 – Pipework on 21<sup>st</sup> Floor after the Fire**

444. The worst damage to the plastic valve shrouds occurred on the 21<sup>st</sup> floor i.e. outside flat no. 182<sup>50</sup>. Even there, I did not observe any sign of any split or rupture of the pipework or any other indication that the pipe upstream of the meter installations had contributed to the fire at any time.

---

<sup>50</sup> The repositioned meter installation in Flat No. 182 was unaffected by the fire. See Figure 86.  
01/10/2019

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **Residential Gas Supply No. 2 Conclusions**

445. My review of the design and construction of Residential Gas Supply No. 2 has identified the following deficiencies:

- Inadequate design risk assessment process;
- The repositioned gas meter installations were not enclosed in a cupboard which was demonstrably 30 minutes fire resistant and with a self closing door or were not fitted with a thermal cut off device;
- Breaches in the wall between the stairwell and the lobbies were not intended to be sealed. (This was due to the proposed “reconfiguration of the stairwell’s fire compartmentation”);
- Breaches in fire compartmentation walls and floors between the basement and the bottom of the stairs were not fire stopped;
- The oversized holes in the stairwell wall were not temporarily sealed during construction pending completion of the boxing in the lobbies i.e. breaches were left in the fire compartmentation during the reconfiguration of the stairwell’s fire compartmentation;
- The ventilation of the shaft/ducts containing the riser and laterals was not and would not on completion have been compliant with either legislation or standards;
- No provision for expansion and contraction;
- Unprotected exposed threads were left;
- No provision was made or arranged for future access to the IIV;
- Lack of signage near the IIV.

446. I am of the opinion that the ventilation of the riser and laterals had not been the subject of a sufficiently rigorous design process and that the design was not and would not on completion have been compliant with IGEM/G/5 Edition 2, BS 8313, Approved Document B and the Regulatory Regime described above. Consequently, I believe that the safest course of action open to Cadent Gas Ltd, once the option of running the replacement riser and laterals up the outside wall of the building had been ruled out by KCTMO, was to refuse to replace the pipeline on grounds of being

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

unable to comply with current legislation and standards and to compensate the residents accordingly.

447. In conclusion, I am of the opinion that the following non-compliant elements of the design and construction of Residential Gas Supply No. 2 are relevant to the events of 14<sup>th</sup> June 2017:

- Lack of a ladder providing access to the IIV and associated signage;
- Unsealed breaches of fire compartment walls i.e. between the stairwell and each lobby;
- Continued use of aluminium alloy meter regulators compliant with a standard which does not contain a reference to fire resistance.

448. I do not consider the other identified non-conformances discussed above to be relevant to the events of 14<sup>th</sup> June 2017.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

**Supplementary Instruction - Consider Issue No.6 – Inspections, in the Inquiry’s List of Issues in so far as the questions relate to the inspection of the gas infrastructure at Grenfell Tower on and before 30<sup>th</sup> September 2016.**

449. Issue No.6 in the Inquiry’s List of Issues is headed “Inspections”. The individual questions are as follows:
- (a) What fire and other relevant inspections (including building control inspections) were carried out:
    - i. During the recent renovations; and
    - ii. Between the completion of the recent renovations and the fire?
  - (b) What were the relevant conclusions/reports from those inspections and by whom were they carried out?
  - (c) Pursuant to what criteria were such inspections carried out, how frequently and by what personnel?
  - (d) Were the inspections compliant with all relevant standards?
  - (e) Were the fire and other safety inspections system (including any criteria applied) reasonably fit for purpose?
  - (f) Who carried out the inspections, how were they trained and were they competent to do so?
  - (g) What was the system for implementing conclusions/recommendations following such inspections?
  - (h) Was that system operated properly or at all?
450. In so far as relevant inspections of the gas infrastructure upstream of the Emergency Control Valves is concerned, Regulation 13 of the Pipeline Safety Regulations 1996 is applicable. That regulation reads as follows:
- The operator shall ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair.*
451. In May 2002 and after discussions with the Health and Safety Executive (HSE), Transco, one of Cadent Gas Ltd’s predecessors, embarked upon a process of proactively inspecting, monitoring and maintaining internal metallic supplies to blocks of flats containing 6 or more storeys. The process was specified in a document

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

T/PR/LC21 – Procedure for Inspection, Maintenance and Monitoring of Internal Metallic Supplies to High Rise Buildings {CAD00002018}.

452. The intention was to inspect all high rise buildings of 6 storeys and above containing a gas supply within five years at a rate of approximately 20% per annum. Priority was to be given to buildings not previously inspected. Subsequent inspections were to be carried out at a frequency not exceeding ten years.
453. This procedure was updated and became a Management Procedure in October 2005 {CAD00002021} after Transco had become National Grid (Gas). The document was further updated in April 2007 {CAD00002222} and April 2008 {CAD00002266}.
454. In January 2011 the Health and Safety Executive served National Grid Gas with an Improvement Notice (ref no 303084600) in relation to the arrangements for the inspection of natural gas pipelines that National Grid Gas operated and that were located at multi-occupancy buildings greater than five storeys. The Notice stated that National Grid Gas had failed to ensure that risks to members of the public, posed by the deterioration of said pipelines was as low as reasonably practicable. (See section 7 of T/PL/LC/20: {CAD00001983}).
455. The LC21 management procedure was updated in April 2012 {CAD00002268} with assistance from the HSE. Inspection intervals were to be determined on a risk basis and there was to be a maximum interval of 10 years between inspections.
456. The LC21 management procedure was further updated in August 2014 {CAD00002223} and May 2016 {CAD00002072}.
457. The current management procedure, which is supported by T/PR/LC/34 – Work Procedure for High Rise Building Surveys and Risk Assessments and which is aimed primarily at the personnel carrying out the surveys, may be summarised as follows:
- Identify the “responsible person” for the building and arrange access for inspection;
  - Carry out a leakage survey and visually inspect as much of the gas infrastructure up to the individual ECVs as practicable;
  - Record the details;
  - Assess the report;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- Arrange for specialist inspectors to assess any identified severe corrosion if appropriate;
- Review inspection frequency and arrange for any identified remedial works to be carried out.

458. The first recorded survey carried out at Grenfell Tower was undertaken on 19<sup>th</sup> September 2008 (see {CAD00002989}). The surveyor identified Pipeline Isolation Valves and 4 risers, which suggests that he gained access to the basement. He also gained entry to two flats, numbers 164 and 166. Bare steel pipe without any signs of corrosion was observed.
459. A further survey was attempted in March 2015 (see {CAD00001977} & {CAD00002973}). It was not completed as the surveyor was “unable to gain access” as can be seen from the Figure 95 below.

High Rise Building Assessment Form

Property Name/Number		Grenfell Tower	
Street/Road		Grenfell Road	
Town/City		LONDON	
Postcode		W11 1TQ	Patch
Building co-ordinates		Easting	523906 Northing 180963

Ownership				
Local Authority <input checked="" type="checkbox"/>	Housing Association <input type="checkbox"/>	Private landlord & tenants <input type="checkbox"/>	Individually owned Private <input type="checkbox"/>	Unknown <input type="checkbox"/>
Contact details				

Reason LC21 Survey Not Undertaken	
Unable to complete in THREE visits <input type="checkbox"/> Invalid address <input type="checkbox"/> Unable to gain access <input checked="" type="checkbox"/> Less than 6 storeys <input type="checkbox"/> No gas <input type="checkbox"/> Gas to SEPARATE central boiler room ONLY <input type="checkbox"/> I&C ONLY <input type="checkbox"/> Other <input type="checkbox"/>	Comments: Unable to carry out survey due to ongoing building works. Works completion date is October 2015.

Building ID	28924
Year of previous survey	
ID of previous survey	
KEY ACTION POINTS	

Completed by (PRINT) Burdury Date 31/3/15 Signed [Signature]  
 Checked by (PRINT) \_\_\_\_\_ Date \_\_\_\_\_ Signed \_\_\_\_\_

**Fig. 98 – High Rise Building Assessment Form from 2015 {CAD00002973}**

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

460. A survey was carried out in September 2016. The end date was the 30<sup>th</sup>. The spreadsheet on which the results were recorded {CAD00000031} contained the following information:

- Service No.1 supplies a riser (R1) in the basement and which in turn supplies 4 risers (R(2), R(3), R(4) and R(5);
- Riser 2 (R2) feeds two further Risers (R(6) and R(7) which have been isolated due to leaks found on the survey at flats 22 and 32. (Subsequently riser R(7) was recommissioned as it was not leaking);
- 49 out of the 120 flats potentially using gas i.e. 41%, were accessed;
- Severe corrosion was observed on the lateral in flat 42 and moderate corrosion was observed on the lateral in flat 142, both of which are also supplied from R(6);
- Severe corrosion was observed on the lateral in flat 165 and moderate corrosion was observed on the lateral in flat 105, both of which are supplied from R(9);
- Localised dampness was observed throughout the building and a bad water leak with the potential to cause damage to the gas pipeline was noted in flat 56, which is supplied by R(3);
- Natural ventilation was not adequate;
- Pipes were not sleeved; they were concreted into each floor;
- There was no provision for thermal expansion and contraction;
- Service No.2 supplies a rotary meter in the basement which in turn fuels the boilers supplying communal heating for the estate;
- No PIVs were present on either “Service”.

461. At the time of the survey Cadent Gas Ltd believed that riser R(2) split into two at the 4<sup>th</sup> floor where it fed riser R(6) and R(7) and that riser R(4) also split into two at the 4<sup>th</sup> floor where it fed risers R(8) and R(9). Riser R(9) was the one believed to be supplying flats ending in 5. However, as discussed in paragraph 46 above, CORGI Technical Services traced each of the risers emanating from the basement and they established that it was the two 3” risers which were the ones which split into two at



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

the 4<sup>th</sup> floor and not the two 2<sup>nd</sup> ones. Consequently, I believe that at the time of the survey there was some confusion as to the configuration of the original set of risers once they left the basement and supplied gas to the individual flats.

462. A HAZOP review was undertaken on the 5<sup>th</sup> December 2016 (see {CAD00000225} and {CAD00002995}). Both documents contain a report which includes the following:

- The condition of the supply pipes and risers are satisfactory.
- “The severe corrosion on the laterals is thought to be due to water leaking from a resident’s water pipe”.
- The risers have been cut off where leaks have been found.
- “If the severe corrosion on L3 and L6 are repaired the score for the building will reduce to below 210,000 (i.e. the threshold for annual as opposed to a 5 yearly inspection period)”.
- An LC/33 (i.e. specialist severe corrosion) survey will be conducted on the corroded laterals.
- The target completion date for works is the end of December 2016. The LC21 procedure states that where severe corrosion is reported, a corrosion assessment shall be carried out within one month of it being reported.
- Action Item No.1 – “Laterals L3 and L6 have severe corrosion; please investigate”;
- Action Item No.2 – “Supply pipes S1 and S2 have no PIV; please investigate”.

463. James Harrison, in his witness statement to the Inquiry, dated 19<sup>th</sup> October 2018 ({CAD00002985}), stated that:

*“...the surveyors also identified “moderate’ and “severe” corrosion on the pipework within the Tower. Cadent’s policies and procedures define the different categories of corrosion as follows:*

- a. Moderate corrosion — Does not significantly affect the integrity of the pipe;*
- b. Severe — has the potential to affect the integrity of the pipe (note: but does*

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*not necessarily do so);*

*c. Extreme — Constitutes significant damage that directly affects the integrity of the pipe, requirement additional impact resistance as part of a repair or replacement.”*

*“When severe corrosion is detected during a survey of a building, the surveyor shall contact the MOBs Network Lead who shall arrange for a more detailed corrosion assessment to be undertaken within 14 calendar days. The more detailed corrosion assessment is known as the LC/33 survey, ...”*

*“The LC/21 survey is a visual inspection whereas the LC/33 survey is a more detailed inspection of the risers [and laterals] to determine their integrity and continued fitness. During a LC/33 survey, the surveyor will inspect the riser surface, determine the category of corrosion before taking any remedial action required. The remedial action ensures the integrity of the riser is satisfactory to allow for a minimum 5 year inspection frequency... .. The surveyor will inspect the pipework and if the wall thickness of the pipework is within the permitted parameters, as defined in the LC/33 Management Procedure, the surveyor will paint the pipework with specialised paint which will remedy the issue of corrosion. If the corrosion has penetrated the pipework so that it is too thin to be repaired, the condition of the pipework will be rechecked until [such time as] the pipe is cut out or the whole riser is replaced.”*

*“At the date of the first HAZOP meeting held on 5 December 2016, a LC/33 assessment had not yet been completed. At the meeting it was agreed that Mark Petty, the MOBs Supervisor for North London, would arrange for a LC/33 survey to be undertaken if such a survey had not already taken place. For the avoidance of doubt, the LC/33 survey was to be undertaken to inspect the severe corrosion which had been identified on one location on one of the risers<sup>51</sup>; Cadent’s policies and procedures does [sic] not require immediate action to be undertaken in respect of the moderate corrosion that had been identified. However, the assets would continue to be surveyed as part of the rolling survey process; in the case of the Tower, the following year.”*

---

<sup>51</sup> {CAD00002995} states very clearly that severe corrosion had been identified on the lateral in flat no. 165 and not on the riser.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

*“Following the HAZOP meeting on 5 December 2016, Mark Petty allocated the LC/33 survey to one of his First Call Operative engineers whose role it is to carry out LC/33 surveys. We have spoken with the engineer and he recalls attempting to complete the LC/33 survey on at least two separate occasions. However, he was unable to gain access to inspect the relevant pipework. On the first occasion, he was not able to enter the Tower itself as a security fob was required to enter the Tower. On the second occasion, a caretaker allowed him access into the Tower. However, the surveyor was unable to gain access to the individual flat where the corrosion had been identified in order to carry out his more detailed inspection of the pipework. He sought assistance from the Tenant Management Organisation office located under the railway arches near the Tower, but they were not able to facilitate access. On that second occasion, when the surveyor was able to gain entry into the Tower itself, the surveyor undertook a “letterbox check” which is when a probe is inserted through a letterbox to test for any gas leaks; no gas leaks were detected.”*

*“Where a surveyor is having difficulty in accessing a building or individual flats to complete a survey, three attempts to gain access should be made on separate days over a two week period. Following the three attempts, the surveyor records the details (dates, times, addresses, etc.) on the survey form and flags “no access” to the Customer Specialist.”*

*“At the time of the fire, the surveyor had still not been able to gain access to the Tower in order to complete the LC/33 survey, and the survey was still outstanding.”*

464. From the above I note that:

- The LC/33 surveyor does not appear to have received any support for the arrangement of access to the flat(s) where severe corrosion had been observed by the LC/21 surveyors;
- The LC/33 severe corrosion survey did not take place;
- No preventative maintenance, such as rubbing down and repainting, is contemplated where superficial or moderate corrosion is observed on a LC/21 survey;

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

- No action appears to have been taken to locate and expose valve boxes over the PIVs expected to be still in place on the Landlord Supply and Residential Gas Supply No.1 given that they had been observed in 2008 (see {CAD00002989}).
465. With respect to the thrust of the questions listed in paragraph 449 and which have not been answered above in respect of the survey carried out in September 2016, I am of the opinion that:
- The LC 21/LC 34 survey carried out in September 2016 was compliant with Cadent Gas Ltd's own procedures as well as with section 13 of IGEM/G/5 Edition 2;
  - The current LC 21/LC 34 inspection process was reasonably fit for purpose;
  - The absence of preventative maintenance where moderate corrosion is observed is a weakness given that the next LC 21/LC 34 survey may not take place for a further 5 years. Therefore, I believe that at the very least, the process for determining the risk ranking for the building and the frequency of future inspection needs to be kept under constant review by risk specialists<sup>52</sup>;
  - The system for implementing the follow up/close out of conclusions/actions from the LC 21/LC 34 survey did not operate as intended.
466. In the absence of any detailed information on the training and competence assessment of the surveyors I am unable to form a definitive opinion on their training and competence. Having made that observation and notwithstanding the apparent confusion regarding supplies to flats ending in the number 1, I would comment that the content of {CAD00000031} suggests that the surveyors were probably competent to conduct a LC/21 survey in accordance with LC/34.

---

<sup>52</sup> I am aware that the HSE, as part of its Gas Safety Case inspection regime, are reviewing each Gas Transporter's High Rise Building inspection procedure and, where applicable, any risk ranking/prioritisation methodology it may be using. At the end of July 2018 the HSE circulated a copy of its Topic Inspection Pack for High Rise Buildings, which is intended to be used by its Inspectors, to all Gas Transporters and other relevant parties.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **Recommendations**

467. The Inquiry has invited me to make recommendations covering the supply of gas as relevant to the issues which I have addressed in this report. Accordingly, I submit the following recommendations to the Inquiry.

### **Replacement/Decommissioning Riser Programme**

468. Many high and medium rise blocks of flats were designed and constructed prior to the effective introduction of the Gas Safety Regulations 1972, which required pipes to be sleeved through walls and floors and not to be placed in unventilated voids. To my knowledge there are a significant number of blocks of flats in London, Scotland Central Belt and other cities in the United Kingdom of similar vintage and with the same sleeving and ventilation issues as exhibited by Residential Gas Supply No.1.
469. Therefore, I believe the Inquiry should recommend the Gas Transporters and by implication other interested parties such as the HSE, Ofgem and Local Authorities and Housing Associations with private gas networks have a replacement/decommissioning programme for internal risers and laterals that are not compliant with the Gas Safety Regulations 1972.

### **Accessibility of Pipeline Isolation Valves**

470. The problem of PIV valve boxes being “lost” when re-surfacing or landscaping works are carried out has been known about in the Gas Industry for years. The events of 14<sup>th</sup> June 2017 have brought attention to it.
471. Current inspection practice is to check the accessibility of the PIV at the same time as the rest of the gas infrastructure for the block of flats is inspected. This can be as infrequent as 10 years, which in my opinion is too long.
472. I am aware that under Regulations 4(3) and 9(1)(e) of the Gas Safety (Management) Regulations 1996, each Gas Transporter is required to undertake a thorough review of its Gas Safety Case every three years and is required to submit a report of that review to the Health and Safety Executive. As I believe 3 years is a suitable frequency for checking the accessibility of PIVs and the submission of 3 yearly report to the HSE provides a suitable opportunity for a progress report to be made, I believe the Inquiry should recommend the HSE mandate each Gas Transporter to carry out a 3 yearly PIV

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

accessibility inspection programme and progress on that inspection programme should be reported upon in the 3 yearly report.

#### **Standard for Excess Flow Valves and Thermal Cut Off Devices.**

473. As discussed in paragraph 133 above, Excess Flow Valves (EFV) may be specified where a risk assessment shows that there is a significantly higher risk than normal of theft or vandalism relating to meter installations or appliances that could result in an open ended pipe discharging gas into the flat.
474. Thermal cut off devices (TCO) may also be specified following design risk assessment. As discussed in paragraph 356, the fitting of a TCO is one mitigation mentioned in paragraph 5.2.3.1 of IGEM/G/5 for the risks associated with installing a gas meter installation in a sole means of escape within a dwelling. The other mitigation being installing the meter installation in a cupboard which is at least 30 minutes fire resistant and which has a self closing door.
475. From Table 4 it can be inferred that there were open ends aggravating the fire at two flats where the meter installations had been resited on the sole means of escape from the flat, namely Nos 92 and 102 on the 12<sup>th</sup> and 13<sup>th</sup> floors respectively. It is possible that if TCOs had been fitted such aggravation of the fire would not have occurred.
476. Currently there is no British or Gas Industry Standard for Excess Flow Valves and Thermal Cut Off Devices. There are German standards for both fittings, DIN 30652-1 for Excess Flow Valves and DIN 3586 for Thermal Cut Off Devices. There is an American standard, ASTM F2138, for Excess Flow Valves.
477. I believe the Inquiry should recommend the Gas Industry, associated manufacturers and British Standards Institution produce a standard suitable for use in the United Kingdom.

#### **Fire Resistance of Domestic Meter Installation Components**

478. As discussed in paragraph 435 above, both the HSE guidance to the Gas Safety (Installation and Use) Regulations (HS(L)56) and BS 6400 Part 1 specify that gas meters installed within buildings shall be fire resistant. There is no mention of fire resistance of the other components making up a meter installation i.e. pliable

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

connectors and regulators. It does appear that there may be a disconnection with fire resistance requirements in Appendix A of Approved Document B.

479. I believe the Inquiry should recommend the Gas Industry and associated manufacturers ensure that the standards for the components of the domestic meter installation other than the meter itself address fire resistance.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

## **Summary**

480. This report to the Grenfell Tower Inquiry 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 Tower contributed to the spread of fire and/or the conditions inside Grenfell Tower on the night of 14 June 2017.
- d) In so far 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 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.

481. There are 3 separate gas supplies or pipelines entering the building. There is a 10” steel gas service believed to have been installed when the building was built between 1972 and 1974 supplying gas to boilers in the basement. This has been termed the “Landlord Supply”.

482. A 4” screwed steel pipeline which was also installed when the building was built supplies gas in 6 risers to each flat for cooking purposes. This has been termed Residential Gas Supply No.1.

483. A 90mm PE pipeline was installed to replace one of the risers which had been cut off because it had been found to be leaking during a programmed inspection by Cadent Gas Ltd in 2016 – 2017. This has been termed Residential Gas Supply No.2. This replacement pipeline went up the protected stairwell and into each of the lobbies where residents in flats ending in the number 2 used gas.



**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

484. Each pipeline should have a Pipeline Isolation Valve (PIV) located outside the building that should be able to be operated under normal circumstances. None of those PIVs have been located. However, the area in which they should have been was not accessible on the 14<sup>th</sup> June 2017 because of burning debris falling from the building.
485. Gas supplies to the Tower were isolated at 23.40hrs on 14<sup>th</sup> June. Isolation had involved 3 separate cut and cap operations.
486. One of the original 2” steel risers was ruptured sometime during the fire. At least 18 and probably 26 or more gas meter installations were damaged giving rise to “open ends” feeding the fire in addition to the ruptured riser. The entrance doors of most of the dwellings involved were found to be missing after the fire.
487. I have concluded that the gas supply to the boilers in the basement and the boilers themselves did not have any particular relevance to the events of 14<sup>th</sup> June 2017.
488. I have concluded that the following non-compliant elements of the design and construction of Residential Gas Supply No. 1 at the time of construction in the period 1972 – 1974 are relevant to the events of 14<sup>th</sup> June 2017:
- Lack of corrosion protection particularly where there were exposed threads;
  - Pipes not sleeved and fixed rigid in each floor, assuming installation was carried out after 1<sup>st</sup> December 1972;
  - No provision for thermal expansion.
489. I have concluded that the following non-compliant elements of the design and construction of Residential Gas Supply No. 2 are relevant to the events of 14<sup>th</sup> June 2017:
- Lack of a ladder providing access to the IIV and associated signage;
  - Unsealed breaches of fire compartment walls;
  - Continued use of aluminium alloy meter regulators compliant with a standard which does not contain a reference to fire resistance.
490. I have also concluded that other non-compliances detailed within the report are not particularly relevant to the events of 14<sup>th</sup> June 2017.

**Report of:** Rodney Hancox  
**Specialist Field:** Gas Engineering  
**Prepared for:** Grenfell Tower Inquiry

491. I have noted that a reasonably fit for purpose survey was carried out on the gas supply infrastructure in September 2016. However, the follow up/close out of conclusions/actions from that survey does not appear to be robust in that the investigation of the absence of PIVs and a follow up corrosion survey have not been carried out.
492. Finally, I have made some recommendations to the Inquiry that have implications for the wider Gas Industry.