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Metropolitan Police Service
SCO4 Forensic Services

C/O James McQuen.
MPS Investigator.
Operation Northleigh
Homicide and Major Crime Command (SCO1)

May 31st, 2018.

Dear Martin and Jim,

RE: Updated Summary Report; Gas Installations at Grenfell Tower

Please see below a summary report on CORGI Technical Services findings.

Introduction

The Metropolitan Police Service (MPS) requested an investigation into the gas installations within Grenfell Tower following a serious fire, the fire took place on the 14th June 2017.

Grenfell Tower is in North Kensington, Inner London. The tower was managed on behalf of Kensington and Chelsea London Borough Council by Kensington and Chelsea Tenant Management Organisation (KCTMO).

The 24-storey tower block was designed in 1967. It was constructed by contractors A E Symes of Leyton and took 2 years to complete (1972-74). The property contained 120 one- and two-bedroom flats. The upper 20 of 24 storeys had six dwellings on each floor, comprising of: lounges, kitchens, bathrooms and bedrooms. Originally the lower four storeys were used for non-residential purposes. Later, two of the four lower floors were converted to residential use, bringing the total to 129 apartments, housing up to 600 people.

Grenfell Tower over the years has undergone major renovations, which included the decommissioning of one of the original gas service risers and a new one being installed in 2017.

Information provided by MPS

At Grenfell Tower, there were 2 service riser systems each supplied by a separate external gas pipe:

1. One service riser systems (comprising of initial 4 vertical pipes, 2 of which split out to create 6 service risers in total) which was installed during the original construction of the building in 1974.
2. A second service riser system (comprising of one vertical pipe) which was installed in 2017, following the isolation of one of the original service risers.

Areas to investigate as agreed with MPS

Having been commissioned by MPS, our investigation was to answer the following three questions as required by the Metropolitan Police Service. The final report will draw

conclusions and offer opinions based on findings, as to;

- a) whether there is evidence to suggest that Grenfell Tower may have experienced abnormal provision of gas prior to the fire?
- b) whether there is evidence to suggest that the design, quality or condition of the gas infrastructure at Grenfell Tower is deficient?
- c) whether there was a significant release of gas from any part of the gas supply (excluding destruction of appliances causing gas release at pipe termination)?

Pictures to aid the reading of this report are to be provided by the Metropolitan Police Service, relevant pictures can be found in the full report.

Inspection Team

The inspections were undertaken by the CORGI Technical Services Team, comprising of;
Mr Chris Jones
Mr Trevor Batt
Mr Mark Duffy
Mr John Gregory
Mr Kevin Winship

Reference Documents

Legislation/Regulations;

- Health and Safety at Work Act (HSWA) 1974
- Gas Safety Management Regulations (GSMR) 1996
- The Pipeline Safety Regulations (PSR) 1996
- Gas Safety Regulations (GSR) 1972
- Gas Safety (Installation and Use) Regulations (GSIUR) 1998
- Dangerous Substance and Explosive Atmosphere Regulations (DSEAR) 2002

Standards;

- TD4 Laying of Steel and Ductile Iron Gas Service Pipes Edition 1 1973
- TD4 Laying of Steel and Ductile Iron Gas Service Pipes Edition 4 2007
- IGEN/G/5 Gas in Multi Occupancy Buildings 2nd Edition 2012
- IGEN/UP/2 Installation pipework on industrial and commercial premises 3rd Edition 2014
- BS6891 Low pressure gas pipework in domestic premises
- BS6172 installation of domestic gas cookers
- BS6400-1 Domestic sized gas meters – low pressure

Documents Provided by MPS;

23/11/17 from Martin Tucker; (further information -Grenfell tower)

- Crime Scene manager request (Maps & diagrams of the gas installation in and around Grenfell Tower)
- Figure 3 (tower riser map)

2/2/18 from Martin Tucker; (Operation Northleigh)

- Document reference J1656_4QODXG_000 Report Initial Findings 180131 (WSP Engineers report)

8/2/18 from James McQuen; (plan of gas riser)

- Figure 3. (note; same as previously supplied by MT)

27/2/18 from James McQuen; (further question -Grenfell tower)

- Records of gas pressures -Latimer Road Notting Hill

2/3/2018 from James McQuen; Reference CORGI Requested Images

- Photographs provided of inspection areas by MPS
- Reference: 2575110
- Reference: 2576173
- Reference: 2596498
- Reference: 2596499
- Reference: 2596689
- Reference: 2618842
- Reference: 2623427
- Reference: 2627389
- Reference: 2632559
- Reference: 2633009
- Reference: 2633562

9/5/2018 from James McQuen; Reference 2633009 Valve Sequence

- Additional photographs of inspected areas
- Reference: 2596758
- Reference: 2596772
- Reference: 2596773
- Reference: 2596774
- Reference: 2633009
- Reference: 2596758 pdf
- Reference: 2596772 pdf
- Reference: 2596774 pdf
- Reference: 2633009 pdf

23/5/2018 from James McQuen; (gas supply details from Cadent)

- CAD00000945 - Grenfell Tower reinst defect (valve)Additional photographs of inspected areas
- CAD00001615 - Photo of reinstatement over new service
- CAD00001616 - Photo of reinstatement
- TRI000001417 - As Laid External Works Drawing

23/5/2018 from James McQuen;

- Additional photographs of inspected areas
- Reference: 2633537 pdf
- DSC 001 to DSC 0047

The Metropolitan Police confirmed that at approximately 00.54 hours on the 14th June 2017, the Emergency Services received a report of a fire at Grenfell tower. As a result of their attendance at the scene, the Fire Brigade called National Grid (Cadent) who attended at 03.48 hours on the 14th June 2017.

Incident Timeline

In respect of gas cessation, the timeline is as follows;

Grenfell Incident Timeline (reported by MPS)		
Date	Time (BST)	Event
14/06/2017	00:54	Fire reported to Emergency Services
14/06/2017	03:48	Cadent on site advised to standby by LFB
14/06/2017	07:45	Cadent formally asked to disconnect gas
14/06/2017	11:30	Cadent established excavation sites and LFB gave go ahead to move machines to site. Advised LFB that gas would be disconnected by 19:00-20:00
14/06/2017	13:30	Cadent started excavation
14/06/2017	15:50	Cadent attempt to turn off gas in basement (Manager Jason Allday). Identified too dangerous after risk assessment due to water level and electricity still live to building so isolation attempt aborted. Unable to isolate gas at SIV's outside building as too close and falling debris
14/06/2017	20:00	Cadent isolated 2 mains supplies. 180mm main turned off at Grenfell Road & 4inch main turned at Testerton Walk
14/06/2017	21:20	Cadent identified 3rd main supply (15inch) at Station Walk
14/06/2017	23:40	Cadent turned off 15inch supply at Station Walk
15/06/2017	3:30	Cadent capped supply Station Walk

Summary Overview

MPS commissioned questions;

- (a) **whether there is evidence to suggest that Grenfell Tower may have experienced abnormal provision of gas prior to the fire?**

Having analysed the data as provided by Cadent to MPS, a comparison was made of the recorded pressures within the surrounding gas mains in the days and weeks preceding the fire. With a direct comparison of the same times and day, 1 and 2 weeks prior to the fire.

It was concluded, that there were no significant changes in the gas supply pressures in the vicinity of Grenfell Tower before or during the fire.

- (b) **whether there is evidence to suggest that the design, quality or condition of the gas infrastructure at Grenfell Tower is deficient.**

The inspection identified that the existing and new gas installations have installation defects not commensurate with the relevant regulations & standards applicable at the time of their installation;

Existing Installation Defects; (relevant to the original gas installation, circa 1974)

- Property isolation and installation isolation valves (PIV & IIV) on supply to building not fitted in an accessible location for emergency access and use. Line diagrams of pipework layout also not provided. (existing installation). In main report reference will be made to pictures of the faults as identified.

- **Applicable regulation at the time of installation Gas Safety Regulations 1972**

42. Where installation pipes supplied from primary meters are installed in a building for the supply of gas to which a service pipe of internal diameter of more than 2 inches is installed and the supply of gas is required for purposes other than domestic use-

(a) a valve or cock shall be properly fixed in a conspicuous and readily accessible position in the following cases: -

(i) in the case of a building having two or more floors to which gas is supplied, in the incoming installation pipe to each such floor; and

(ii) in the case of a floor of a building having self-contained areas to which gas is supplied (whether or not the building has more than one floor), in the incoming installation pipe to each such self-contained area;

(b) a line diagram shall be attached to the building in a readily accessible position as near as practicable to the primary meter indicating the position of all installation pipes, meters, meter controls, valves or cocks, pressure test points, condensate receivers and electrical bonding.

- **Applicable regulation at the time of installation: TD4 Laying of Steel and Ductile Iron Gas Service Pipes 1973**

6.5.1 Every service pipe should terminate at the meter with a meter control of the standard type normally used by the gas undertaking.

6.5.2 In addition, a service cock or valve should be fitted if any of the following conditions apply:

(a) The service pipe has a nominal size of 54 mm or 2 inches or more.

(b) A hazardous trade is carried on in the building or the area in which it is situated.

(c) The building or the form of construction of the service pipe form a special risk.

(d) The service pipe is a common service supplying two or more primary meters.

The service cock or valve should be of a type approved by the gas undertaking, and fixed in a position outside but as near as practicable to the property boundary and should be fitted with a surface box and cover.

When, by reason of special circumstances (e.g. in blocks of flats or buildings with large forecourts), a service cock or valve is fixed within the property boundary, it should be placed outside the building in a readily accessible position.

7.1.3.5 A service valve should be fitted in the service pipe supplying every riser in an accessible position outside the building.

Existing Installation Defects; (relevant to the original gas installation, circa 1974)

Service riser not correctly supported and not continuous from base to final point. In addition, positioned in unventilated ducts (existing installation). In main report reference will be made to pictures of the faults as identified.

- **Applicable regulation at the time of installation: TD4 Laying of Steel and Ductile Iron Gas Service Pipes 1973**

7.1.3.1 Every riser should be supported at its base by a duck foot or similar flanged device, capable of supporting the total weight of the riser. (See Figure 19.) This should preferably be sited on the building foundation or on a properly constructed raft or pillar. Where this is not practicable the support should be located no higher than the level of the first floor of the building.

7.1.3.3 The riser should rise in a vertical line from its point of support to its highest point without any changes in direction. The riser should be secured clear of the duct wall with suitable pipe clips to prevent lateral movement. These should permit thermal movement

and on no account should the riser be clamped at these supports. Where the riser passes through each floor, a sleeve should be provided. No joint should be sited within the sleeve. The sleeve should be suitably plugged to produce a 'fire stop' in accordance with building regulations.

7.1.3.4 Wherever possible, the use of a ventilated duct to accommodate the riser is recommended. (See the British Standard Code of Practice CP 413 'Design and construction of ducts for services'.) Ducts should be so sited that pipework may be inspected, and any work carried out with a minimum of inconvenience to the consumer.

Existing Installation Defects; (relevant to the original gas installation, circa 1974)

Pipework not correctly protected, sleeved or sealed, no provision for lateral or vertical expansion (existing installation). The full report provides reference pictures of the faults as found.

- **Applicable regulation at the time of installation: Gas Safety Regulations 1972**

Regulation 7(2a & b);

(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 floor and so as to allow normal movement of the pipe.

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.

Regulation 12;

No service pipe shall be installed in such a way as to impair the structure of any building nor so as to impair the fire resistance of any part of its structure.

- **Applicable regulation at the time of installation: TD4 Laying of Steel and Ductile Iron Gas Service Pipes 1973**

6.2.7 Where the service enters a building through a solid floor or a load-bearing or cavity wall, a sleeve of non-corrodible material should be built into the wall, the internal diameter of the sleeve being at least 25 mm (1 in) greater than the external diameter of the service pipe. When underground, the ends of the sleeve should project not less than 25 mm (1 in) beyond the finished wall surfaces.

6.2.8 A similar sleeve, though not necessarily projecting beyond the finished surface, may be provided when a service pipe or riser passes through any partition wall or floor.

7.1.3.3 The riser should rise in a vertical line from its point of support to its highest point without any changes in direction. The riser should be secured clear of the duct wall with suitable pipe clips to prevent lateral movement. These should permit thermal movement and on no account should the riser be clamped at these supports. Where the riser passes through each floor, a sleeve should be provided. No joint should be sited within the sleeve. The sleeve should be suitably plugged to produce a 'fire stop' in accordance with building regulations.

New Installation Defects; (relevant to recently installed pipework 2017)

Property Isolation and Installation Isolation Valves (PIV & IIV) on supply to building not fitted in an accessible location for emergency access and use. In main report

reference will be made to pictures of the faults as identified.

- **Applicable regulation at the time of installation:** relevant to when installed:
Gas Safety (Installation and Use) Regulations (GSIUR) 1998

Regulation 9

(3) Where a person installs an emergency control which is not adjacent to a primary meter, he shall immediately thereafter prominently display on or near the means of operating the control a suitably worded notice in permanent form indicating the procedure to be followed in the event of an escape of gas.

- **Applicable regulation at the time of installation:** TD4 Laying of Steel and Ductile Iron Gas Service Pipes Edition 4 2007

P1.5.13 Inlet Isolation Valve

P1.5.13.1 where required by IGE/G/5, an IIV shall be located near to the point of entry of a service to enable that part of the building complex being fed by the service to be isolated for maintenance or safety reasons.

- **Applicable regulation at the time of installation:** IGE/G/5 Gas in Multi Occupancy Buildings 2nd Edition 2012

7.3.1 Where a network pipeline supplies a multi-occupancy building, a Property isolation valve (PIV) shall be installed outside the building to enable isolation of the building complex.

The location of 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*

7.4 Inlet Isolation Valve (IIV) enables that part of the building complex being fed by an internal pipeline to be isolated for maintenance or safety reasons.

7.4.1 an IIV shall be located near to point of entry of a network pipeline into a multi-occupancy building.

8.3.3 An isolation valve shall be installed as close to point of entry as practicable, and in any case within 2m of the entry point

New Installation Defects; (relevant to recently installed pipework 2017)

Pipework not correctly sleeved & sealed, no provision for lateral or vertical expansion. In main report reference will be made to pictures of the faults as identified.

- **Applicable regulation at the time of installation:** Gas Safety (Installation and Use) Regulations (GSIUR) 1998

Regulation 18

(1) No person shall install any installation pipework in any position in which it cannot be used with safety having regard to the position of other pipes, pipe supports, drains, sewers, cables, conduits and electrical apparatus and to any parts of the structure of any premises in which it is installed which might affect its safe use.

Regulation 19

(1) No person shall install any part of any installation pipework in a wall or a floor or standing of solid construction unless it is so constructed and installed as to be protected

against failure caused by the movement of the wall, the floor or the standing as the case may be.

(2) No person shall install any installation pipework so as to pass through a wall or a floor or standing of solid construction (whether it contains any cavity) from one side to the other unless -

- (a) any part of the pipe within such wall, floor or standing as the case may be takes the shortest practicable route; and
- (b) adequate means are provided to prevent, so far as is reasonably practicable, any escape of gas from the pipework passing through the wall, floor or standing from entering any cavity in the wall, floor or standing.

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

Regulation 20

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

Regulation 24

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

- (a) a valve is installed in the pipe in a conspicuous and readily accessible position; and
- (b) a line diagram in permanent form is attached to the building in a readily accessible position as near as practicable to -
 - (i) the primary meter or where there is no primary meter, the emergency control, or
 - (ii) the gas storage vessel,
 indicating the position of all installation pipework of internal diameter of 25 mm or more, meters, emergency controls, valves and pressure test points of the gas supply systems in the building.

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

Applicable regulation at the time of installation: IGE/G5 Gas in Multi Occupancy Buildings 2nd Edition 2012

6.1.11 where network pipelines are installed such that it passes through a cavity wall, solid wall or solid floor

- It shall be 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 fire resistant, flexible material, so as to prevent passage of gas
- The annulus between sleeve and wall, and or sleeve and floor, shall be sealed so as to prevent the passage of gas, with fire resistant material.
- Allowance shall be made for normal movement of the pipe and the building

6.1.12 Network pipelines shall not be installed in an unvented void space, unless continuously contained in a gas tight metallic sleeve through the void.

6.1.15 Any network pipeline shall be installed in a position so as to allow adequate access for installation, inspection, maintenance and repair. Wherever possible, working in a confined space shall be avoided.

6.1.16 where there is more than one network pipeline entering a common area of a building a warning notice shall be placed at each entry stating that further network pipelines into the building exist.

6.1.17 Consideration shall be given to the provision of a line diagram at each building entry / IIV, depicting the dwellings served by that particular network pipeline.

6.4.3.3 any common stairwell, or other protected shaft, containing a network pipeline that is itself not contained in a sealed duct ventilated directly to outside, shall be ventilated directly to outside air.

6.4.3.4 any network pipeline incorporating a screwed or other joint capable of developing a leak (excluding a screwed joint on the inlet of an ECV that is located within an individual dwelling) shall be ventilated directly to outside air.

(c) Whether there was a significant release of gas from any part of the gas supply (excluding destruction of appliances causing gas release at pipe termination).

With reference to the analysis undertaken to support question (a). It was concluded, that there were no significant changes in the gas supply pressures in the vicinity of Grenfell Tower before or during the fire.

As a result of a riser joint disconnecting, due to pipework heat distortion, and the melting of meter pressure regulators there would have been uncontrolled releases of gas into the Tower during the fire. Escaping gas, at pressures between 21.65 mbarg & 26.77 mbarg would have provided a fuel source for combustion.

It is therefore likely, that there would have been a significant uncontrolled release of gas into the building until the gas supplies were isolated externally. All gas supplies turned off by 23:40 on the 14th June 2017.

- 1 installation was identified as having a ruptured gas riser.
- 26 installations were found with Emergency Control Valve (ECV) in the ON or partially position with an open end
- 18 had melted or holed meter regulators
- 8 were found with meter or meter and pressure regulator removed

Findings

All data shown below is based upon the findings of the inspections carried out in December 2017, January, February, March and May 2018.

Grenfell Tower gas installation comprises of the following;

Three network supplies enter the basement of the building (two existing and one new, (installed 2017)

Installation as found;

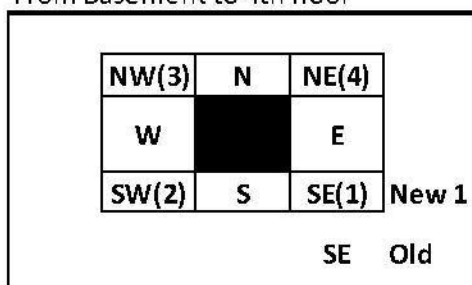
- One existing 12inch steel (measured after IIV) supply to gas meters in basement to feed Plant Room boilers for heating & hot water

- One existing approx. 6inch steel supply (unable to confirm actual size, reported by MPS to be 4inch steel) to basement splitting at high level into four vertical risers from the basement through the building.
 - 2 x 3inch steel
 - 2 x 2inch steel

One new (installed 2017) 3inch reducing to 2inch steel (from IIV) through basement to replace a decommissioned 2inch riser, the decommissioned riser was capped off at ground floor.

There are a total of five risers from the basement that supply the building

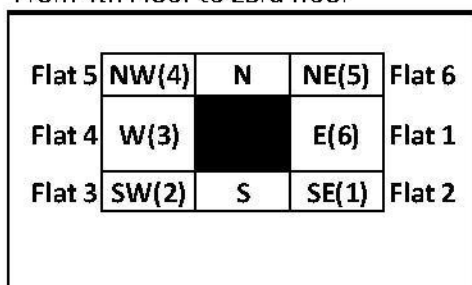
From Basement to 4th floor



- SE - original riser (decommissioned)
- SE (1) - new riser, replaces decommissioned riser
- SE - original riser capped off on the ground floor, SE (1) replaces this supply through building.

The four risers split into six from fourth (4) floor;

From 4th Floor to 23rd floor



- SW (2) splits at fourth floor level to become W (3) & SW (2) on higher floors.
- NE (5) splits at fourth floor level to become E (6) & NE (5) on higher floors

Methodology

The inspection of the gas systems within Grenfell Tower was intended to be undertaken on a floor by floor basis. Following our initial 'Risk Assessment' it was agreed in consultation with MPS that the CORGI Technical Services would inspect on a riser by riser basis, with the basement being inspected separately.

The basement of the Tower was inspected to assess the gas supplies provided. There were 3 gas supplies entering the building all entering below ground, but at high level within the basement, the newest supply (installed 2017) was measured at 4.73m above the basement floor level.

Each riser was inspected individually as far as access allowed, it was also our intention to inspect and assess each flat that the gas risers passed through. This included an assessment of the installation within those flats also.

The risers were visually inspected where access was made possible. There were a number of locations where risers could not be inspected, due to access panels or boxing, not being removed during the inspection period. In addition, it was not possible to fully inspect all installations in all flats due to debris piled over gas installations, or gas installations having been removed to permit the provision of building supports.

Statistical Data

No assumptions have been made.

Gas Supplies in Basement

Within the basement there are 3 gas supplies, all at high level, the newest supply (installed 2017) was measured at 4.733m above the basement floor level. Found not to be readily accessible, due to its location.

Due to site materials such as scaffolding and storage containers, the Property Isolation Valves (PIV) and their positions could not be determined externally.

There was no line diagram drawing within the basement to enable understanding of the actual pipework layout within the building.

- 1 x 12inch Steel with IIV at low level. Metered supply to communal boiler room. Supplying 3 redundant boilers & 3 new boilers. The supply for the boiler plant was routed through an electric solenoid valve. The activation and control of which is to be determined by others.
- 1 x 6inch Steel supply (no IIV) (unable to confirm actual size, reported by MPS to be 4inch steel) Supply branching with 4 service risers with individual Branch Isolation Valves (BIV) all located at high level. (SE- 4.74m; NE- 4.55m; SW- 4.55m; NW- 4.51m;)
- 1 x 3inch Steel with IIV located at high level. (4.73m) reducing to 2inch steel after IIV. Network rising centrally in building no fire stop evident at ceiling.

Each of the supplies was fitted with Installation Isolation Valves (IIV), however, not all of these valves were readily accessible to the emergency services, due to their locations.

General main safety stats

Risers and Flats

- (a) 1 installation was identified as having a ruptured gas riser.
- (b) 26 installations were found with Emergency Control Valve (ECV) in the ON or partially position with an open end
- (c) 18 had melted or holed meter regulator
- (d) 8 were found with meter or meter and pressure regulator removed

Analysis; reference to questions above;

General main safety stats

Risers and Flats

- (a) 1 Installation was identified as having a ruptured gas riser.
 (b) 26 Installations were found with emergency control valve (ECV) in the ON or partially ON position with an open end
 (c) 18 of above installations in (b) identified with melted or had holed regulators
 (d) 8 Others found with ECV, meter or regulator removed

Q (a)

Floor	Flat
14	5
T	1

Q (b)

Floor	Flat
5	6
7	6
8	5
8	6
10	4
12	2
13	2
14	3
14	6
16	1
16	3
16	5
16	6
17	6
18	3
18	4
19	1
19	4
19	5
20	4
20	5
20	6
22	5
22	6
23	4
23	6
T	26

Q (c)

Floor	Flat
5	6
7	6
8	6
14	3
14	6
16	1
16	3
16	5
16	6
17	6
18	3
18	4
19	1
20	5
20	6
22	6
23	4
23	6
T	18

Q (d)

Floor	Flat
8	5
10	4
12	2
13	2
19	4
19	5
20	4
22	5
T	8