# The Printworks

## RIBA 3 Fire Strategy

11 August 2023

15170BC

BB7

## Revision History

| Version | Date | Author | Comments |
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| 01 | 04/08/2023 | J.Donohoe | First Issue |
| 02 | 11/08/2023 | Graeme Scott | Revised after client feedback |
| 03 | 11/08/2023 | Graeme Scott | Minor update to Figures |

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## Contents

# 1. Introduction

## 1.1 Drawings

This strategy has been based on the set of drawings produced by F3 Architects, referenced in Table 1.1.

**Table 1.1 Drawing References**

| Title | Drawing Reference | Revision | Date |
|---|---|---|---|
| Ground Floor Plan | PRINT-F3A-ZZ-00-GA-A-82127 | A2.P1 | 21.07.2023 |
| 1st Floor Plan | PRINT-F3A-ZZ-01-GA-A-82128 | | |
| 2nd Floor Plan | PRINT-F3A-ZZ-02-GA-A-82129 | A2.P2 | |
| 3rd Floor Plan | PRINT-F3A-ZZ-03-GA-A-82130 | | |
| 4th Floor Plan | PRINT-F3A-ZZ-04-GA-A-82131 | A2.P1 | |
| 5th Floor Plan | PRINT-F3A-ZZ-05-GA-A-82132 | | |
| 6th Floor Plan | PRINT-F3A-ZZ-06-GA-A-82133 | | |
| Roof Plan | PRINT-F3A-ZZ-RF-GA-A-82134 | | |

## 1.2 Limitations

This document has been produced to assess this development's compliance with Part B (Fire Safety) of the Building Regulations 2010 (as amended).

The Building Regulations deal explicitly with life safety. The aim of this report is to inform the design team of the recommended measures and to assist in design submission for approval. Whilst fire safety measures introduced for compliance with this life safety objective have a beneficial effect on reducing potential fire losses and extent of any consequential damage, it cannot be guaranteed that a fire will not start on the premises. In view of this, the opinion of the nominated insurance company and any other interested stakeholders should be sought.

Information, advice and intellectual property contained within this report is for sole use in connection with the iteration of the Printworks development detailed in Section 1.1 and cannot be used in relation to any other project. The report is not for the use of or reliance on by third parties and is considered, at all stages, to remain confidential even after issue to the client. Circulation within the design team is permitted to assist with supplementary design purposes and/or for inclusion with a broader combined regulation submission. Reproduction and wider circulation of the report should only be done in its entirety and only with the permission of the client.

Systems and measures described establish a principle on which reliance may be placed by other parts of the fire strategy. This is done so on the assumption that all work will be done using appropriate materials and in a 'workmanlike' manner, as per the Building Regulations 2010.

Whilst this document details the fundamental strategy for a safe building, there is an ongoing management obligation to ensure that not only the active and passive fire protection facilities are correctly maintained, but that there are appropriate management procedures in place to facilitate a safe evacuation in the event of a fire. This is a fundamental requirement of life safety and is enforceable under the Regulatory Reform (Fire Safety) Order 2005.

## 1.3 Fire Strategy Summary

Table 1.2 summarises the fire safety items that have been detailed in the following report. Table 1.2 also highlights any major recommendations that should be considered. It should be noted that reading Table 1.2 should not replace the reading of the complete report.

**Table 1.2 Fire strategy summary**

| Report Section | Summary |
|---|---|
| 3. Fire Safety Systems | **Alarm:**<br>- Category L1 system throughout the building<br>- Evacuation alert system to be installed in all blocks<br>**Suppression:**<br>- Automatic water fire suppression system to be installed throughout the building (Category 4)<br>**Ventilation:**<br>- Ventilation to be provided in stair cores and their lobbies. |
| 4. Means of Escape | **Evacuation Strategy:**<br>The residential areas of the building will have a stay-put evacuation strategy. Ancillary areas will evacuate, if fire is detected within them or within an apartment in the same building.<br>**Ground floor duplex clusters:**<br>- Duplex clusters have protected internal accommodation stairs, and three exit doors, one first floor to central core, and two ground on the floor.<br>**Upper floor clusters:**<br>- Single storey clusters are accessed from a corridor that leads to a protected and ventilated lobby.<br>**Studios:**<br>- Single storey studios are accessed from a common corridor that leads to a protected, ventilated lobby. |
| 5. Passive Fire Protection Systems | **Common areas:**<br>- The lobby-to-apartment travel distance limit is 7.5 m. No ventilation required for these areas as they are all provided access via a corridor.<br>-Care needs to be given when fitting out the amenity and plant areas.<br>**Compartmentation:**<br>- Elements of structure required to be 60 minutes.<br>- Further details on compartmentation in Table 5.1 |
| 6. External Fire Spread | - External walls require Class A2-s1, d0 or better classification<br>- Roof classification should be $B_{ROOF}$ (t4)<br>- Some elevations required fire-resisting construction as the external wall. |
| 7. Fire Service Access and Facilities | **Route:**<br>- Access provided to all 3 cores via Brunswick Square.<br>- Access is provided to Blocks B and C via an under croft.<br>**Facilities:**<br>- Core B is a firefighting shaft<br>- Each core has a dry fire mains outlet located within it |

## 2. Project Description

### 2.1 Development Overview

This development consists of three blocks namely block A, block B and block C, see Figure A2.1. It should be noted that these blocks do not communicate with each other at any level. Each block is served, at each floor, by a single stair core and two lifts, namely Core A, Core B and Core C. Block A has five occupiable storeys (G+3+Roof terrace), block B has seven occupiable storeys (G+6) and block C has six occupiable storeys (G+5).


**Figure A2.1 Ground floor plans of the development**

### 2.2 Development Use

The ground floor of the development consists of several shared amenity areas and two ‘Class E’ spaces. A ‘Class E’ planning space is commercial, business and service and includes areas such as shops and cafes. The upper storeys are made up of the dwellings in the form of studios and cluster accommodation and are intended to be primarily used by students. Additionally, it should be noted that clusters accessed directly from the ground floor; span two storeys and have an internal stair that can only be accessed by people in that cluster.

## 2.3 Development Height

The height of each block is outlined below in Table 2.1.

**Table 2.1 Development height**

| Building | Number of storeys (-) | Height from access to topmost occupied floor (m) |
|---|---|---|
| Block A | 5 | 12.5 |
| Block B | 7 | 18.5 |
| Block C | 6 | 15.5 |

# 3. Fire Safety Systems

## 3.1 Automatic fire detection and alarm systems

A Category L1 system, in accordance with BS5839-1:2017, should be installed throughout this development. As part of this system, a smoke detector should be provided in each habitable room and a heat detector should be installed in each kitchen. Additionally, common area detection should activate the ventilation within the building with no alarm.

A link to the fire alarm and detection system should be provided to the management responsible for the building if it is permanently staffed, or to a remote monitoring centre. In addition to this, an evacuation alert system should be provided to each block. This system should be in accordance with BS 8629:2019.

## 3.2 Automatic water fire suppression systems

A Category 4 sprinkler suppression system should be designed and installed throughout this development in accordance with BS 9251:2021.

For a suppression system in accordance with BS 9251:2021 to be suitable for this development, all areas within the development must comply with the compartment size limits in Table 4 of BS 9251:2021.

## 3.3 Smoke management

The development is split into three blocks, each are served by a separate ‘stair core’, namely Core A, Core B and Core C. Core A and Core C are both more than 11 m above ground (to the top-most floor) and are served by a single stair. Therefore, the provisions of Section 14.1.3 of BS 9991:2015 apply to each of these cores. These are that for protected corridor or protected lobby accessed dwellings, the smoke control system should have one of the following:

a. a pressure differential system; or,

b. An AOV that is sited at as high a level as is practicable on the top storey of the stairway, having a minimum free area of 1 $m^2$ and one of the following:

   i. AOVs to the exterior of the building with a minimum free area of 1.5 $m^2$, fitted in the common corridor or lobby directly adjacent to the stair at as high a level as is practicable; or,

   ii. a smoke shaft in accordance with Section 14.2.3 of BS 9991 that is fitted in the protected lobby or corridor; or,

   iii. a mechanical smoke ventilation system in accordance with Section 14.2.4 of BS 9991 that is fitted in the protected lobby or protected corridor, directly adjacent to the staircase enclosure.

It should be noted that Core B is also more than 11 m tall and is served by a single stair; however, a different set of recommendations apply to this building, as it is a firefighting shaft. These are discussed further in Section 8.3.1.

## 3.4 Emergency lighting

Emergency lighting will be provided in accordance with BS 5266 / BSEN1838.

The escape lighting should be sited to provide an appropriate luminance near each exit door and where it is necessary to emphasise potential danger or safety equipment. The following bullet points indicate some of the critical areas.

- At each exit door intended to be used in an emergency.
- Near stairs so that each flight of stairs receives direct light.
- Fire Alarm Panel.

- External Escape Routes.
- Near any other change in level.
- Mandatory emergency exits and safety signs.
- At each change of direction.
- At each intersection of corridors.
- Outside and near to each final exit.
- Near each first aid post.
- Near each piece of firefighting equipment and call point.

## 3.5 Escape signage

Fire escape signs are to be provided to guide occupants from any point in a building, via a place of relative safety (the escape route) to the place of ultimate safety (outside the building). Exit and directional signage should be provided in accordance with the requirements of BS ISO 3864-1.

Signage is provided to identify the primary escape route from each location within the building. To achieve this, the following principles have been adopted.

- At least one escape route or doorway leading to an escape route should be visible from any place within every room or enclosure.
- Where direct sight of the escape route is obstructed, additional signage to be considered.
- Escape route signage is to take precedence over all other signs.
- All changes of direction in corridor, stairways and open spaces forming part of an escape route will be marked with intermediate signs. Each intermediate door or junction will also be similarly signed.
- Signs are not to be fixed to doors or sited where they are obscured by open doors.

Escape route signs are to be sited conspicuously within the normal field of vision. The following principles, which will assist the evacuating occupants to predict the location of successive signs, should be applied:

- Signs above doors or open spaces should be mounted between 2m and 2.5m from floor level, measured to the base of the sign and be sited as close to the centre line of the escape route as practicable;
- Signs sited on walls should be mounted between 1.7m and 2m from floor level to the base of the sign;
- Signs should be sited at the same height throughout the escape route, so far as is reasonably practicable.

# 4. Means of Escape

## 4.1 Evacuation strategy

The development will adopt a ‘stay put’ evacuation strategy. For example, if a fire breaks out in one cluster / apartment; only the occupants from that cluster / apartment, and the building’s ancillary areas (including any roof terrace) should evacuate the development. Meanwhile, the other occupants of the development, in theory, remain in place. There remains potential for occupants of other flats to evacuate the building should they desire or should the Fire and Rescue Service (FRS), building manager or other authority direct them to do so.

This strategy should be carefully managed and form part of any resident’s onboarding process. For example, fire wardens should ensure the evacuation of the building’s ancillary accommodation.

## 4.2 Assembly Points

Typically, residential buildings would not require assembly points due to their ‘stay put’ strategy. However, a full building evacuation may be necessary for this block. Therefore, there would need to be sufficient space situated away from the blocks that could act as an assembly point.

## 4.3 Inner rooms

Some of the areas at the ground level of Core A are inner rooms, this is acceptable on the basis the following criteria is met:

- Occupancy does not exceed 60 for all purpose groups other than 2(a)
- It is not a bedroom.
- It is entered directly from the access rom, not via a corridor,
- No more than one access room to enter the inner room,
- Travel distances from the furthest point of the inner room to the exit of the access room does not exceed those in Table 4.1,
- Meets both of the following criteria:
    - The access room is not a place of special fire hazard,
    - It is in control of the same occupier.
- One of the following arrangements is made:
    - Walls or partitions of the inner room stop 500mm min below the ceiling,
    - The door or walls of the inner room contain a vison panel (min 0.1m$^2$) so occupants could see a fire start in the access room,
    - The access room is fitted with automatic detection and alarm system to warn occupants of the inner room if a fire starts in the access room.

## 4.4 Travel Distances

The maximum travel distances for this development are outlined in Table 4.1.

**Table 4.1 Travel distance limits**

| Area | Limit (m) | Comments |
|---|---|---|
| Ancillary accommodation | 18 | One direction of escape |
| | 45 | Alternative directions of escape |
| Distance between cluster entrance and furthest habitable room | 15 | Provided with suitable sprinklers (installed in accordance with BS9521:2021) |
| | 35 | Alternative direction of escape provided |
| Distance between lobby entrance and apartment entrance (for corridor access). | 7.5 | No ventilation required in corridor |
| Distance between studio entrance door and furthest point in the studio | 20 | Suitable suppression system (installed in accordance with BS9521:2021) is present, an LD1 detection and alarm system is installed and cooking facilities are sited away from the flat entrance door and internal route. |
| Plant room | 9 | One direction of escape |
| | 35 | Alternative directions of escape |
| Rooftop plant/terrace (in the open air) | 60 | One direction of escape |
| | 100 | Alternative directions of escape |

## 4.5 Escape from clusters and apartments

### 4.5.1 Ground floor duplex clusters

Each ground floor cluster is accessed directly from the outside (via the courtyard) and is provided with another escape route through the protected accommodation stair. This stair serves the cluster only and does not communicate with any other floor. The ‘primary’ escape is through the protected escape stair with a secondary exit in the courtyard.

The upper floor of the duplex clusters also has access to the central stair core.

It should be noted that for any internal corridor longer than 15 m, a cross-corridor door should be provided within the middle third of the corridor where alternative escape routes are provided.

Therefore, cross corridors are provided in the duplex cluster in Core C, this is shown in Figure A2.1 below. It is also acceptable for these doors to be fitted with hold open devices. This will help to maintain an open nature within the cluster and also reduce the chance of the door being held/wedged open leading to the possibility of them not operating on activation of the detection and alarm system.


**Figure A2.1 Cross-corridor door duplex cluster in Core C.**

### 4.5.2 Upper floor clusters

The upper floor clusters follow the travel distance limits set out in Table 4.1. These distances have been confirmed by the client via their REVIT model.

BS9991 advises that kitchens/dining/living areas (KDLs) should be located at the remote end of the corridor away from the entrance to the cluster. In core B, see Figure A2.3, the KDL location is located at the remote end of the corridor with the cluster entrance around the midway point of the cluster corridor, this includes the upper floor of the duplex cluster also.

To mitigate this deviation, it is proposed that a 'free swing' door closer will be fitted to the kitchen door, which will operate on activation of the detection and alarm system, this will allow for free movement and reduce the possibility of the door being held/wedged open and return to the closed position of activation of the detection and alarm system. It is also proposed that smoke seals be fitted to all doors within the clusters.

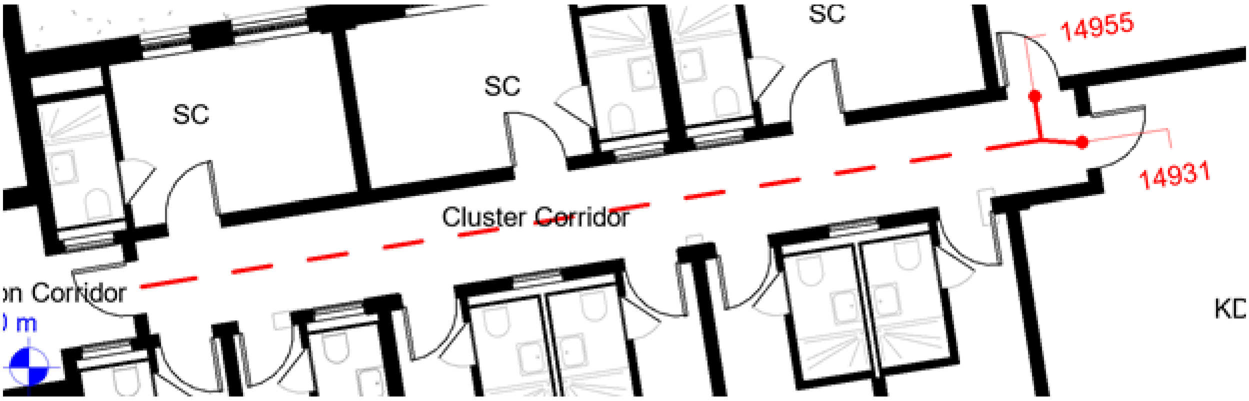


**Figure A2.2 Travel distance example within cluster**

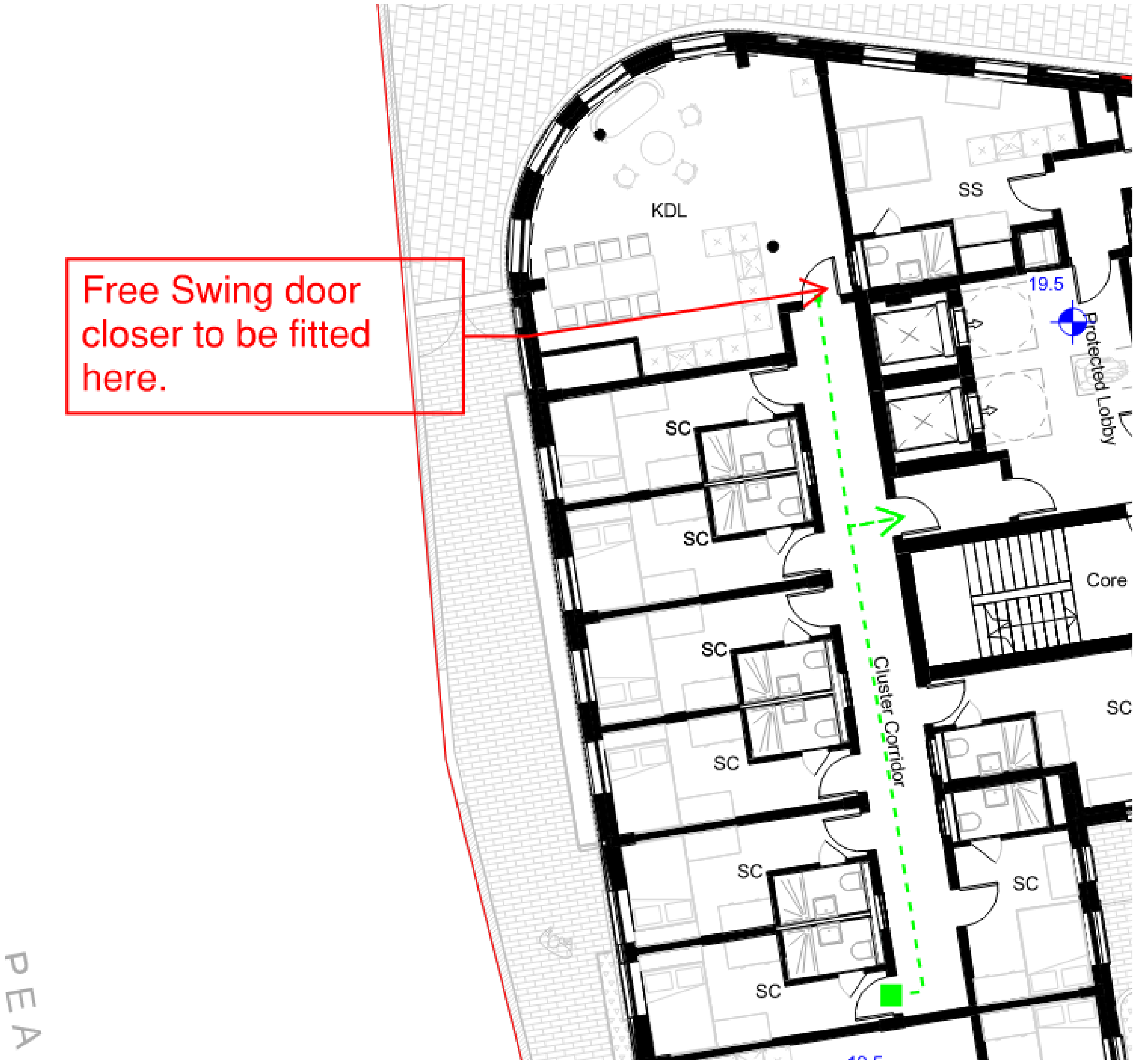


**Figure A2.3 Upper floor cluster in Core B**

### 4.5.3 Studios

Each core, above the ground level, is accessed via a common corridor to each of the studios. Each studio has an internal bathroom and will follows the limits on travel distances, see Table 4.1. The relevant limit for these studios is 20m, from the most remote part to the entrance door, this is shown in Figure A2.4.

Cooking facilities will be located away from studio's escape route. Locations of the cooking facilities will be located as such that occupants will not have to pass within 1.8m, with an additional width of ~750mm for the occupant to escape.

Calculations validating this approach can be found within Appendix A 3.

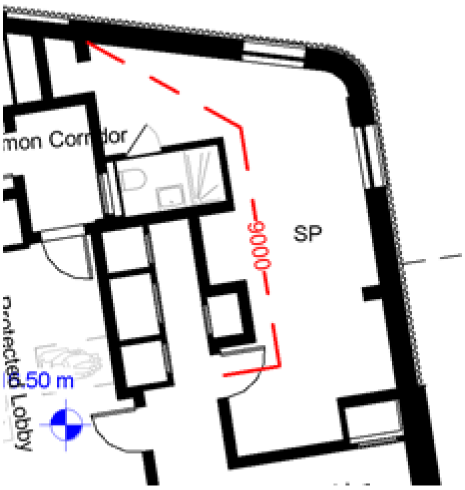


**Figure A2.4 Example of travel distance within the studios**

## 4.6 Escape from common areas

The travel distance limits for the common areas in this development are detailed in Table 4.1.

Every studio is accessed via a common corridor leading off the core's ventilated lobby. Therefore, the travel distance between the lobby entrance and studio entrance should be no more than 7.5 m. Travel distances within the common corridors are within the permitted travel distances, an example of this is shown within Figure A2.5.

Doors to areas of the building expected to hold over 60 people will be hung so they open in the direction of travel.

Block A's ground floor consists of a number of amenity areas, the occupancy numbers in these rooms will be limited to no more than 60 as they only have a single means of escape from each.

It has been noted that some of these amenity areas are also accessed via ramps. These ramps should not have an inclination exceeding 1:12.

Escape from Core B should be managed as it is designed so firefighters enter it from the south side of the core and occupants will leave via the north side of the core, see Figure A2.6. This can be done by using the appropriate directional signage.

Each core's lobby will also be kept fire sterile.

In addition, at least one evacuation lift per lift core will be provided to aid occupants with mobility impairments to evacuate.

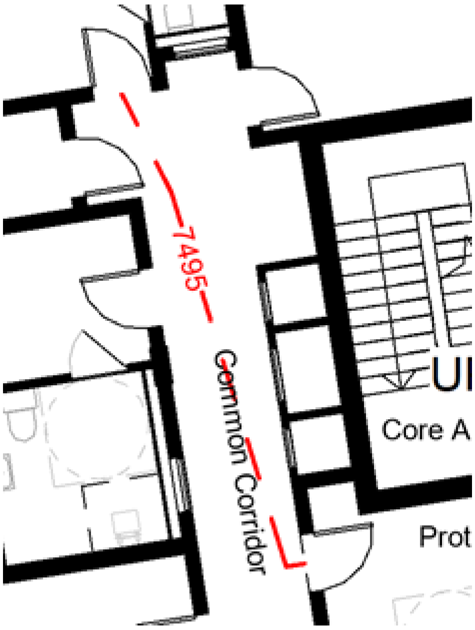


**Figure A2.5 Example of common corridor travel distance**

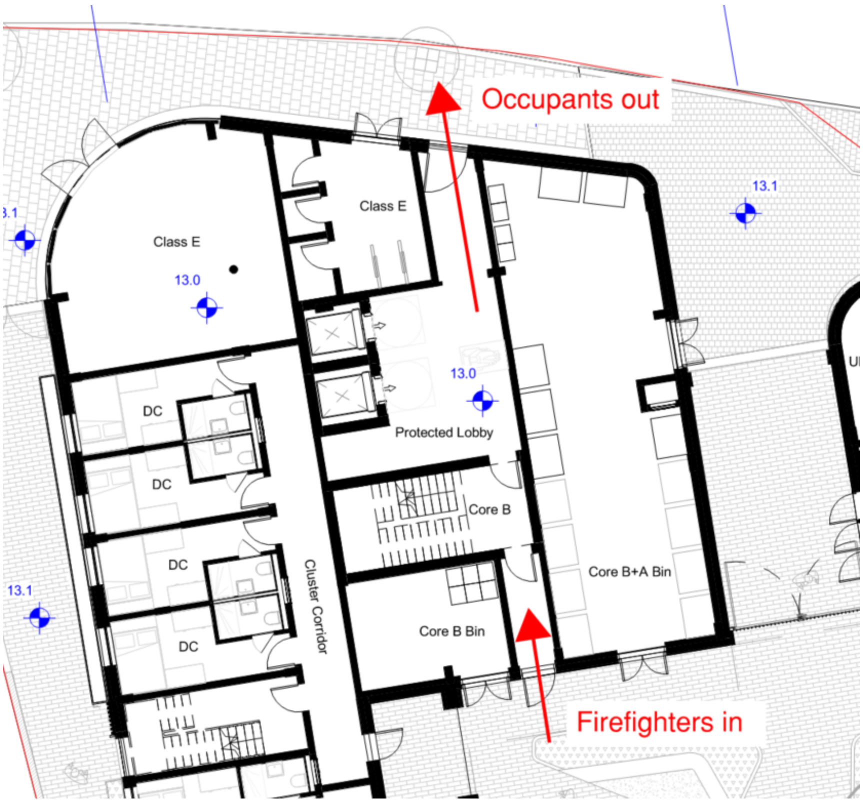


**Figure A2.6 Core B lobby design**

## 4.7 Escape from ancillary accommodation

Table 4.1 outlines the travel distance limits for ancillary accommodation, plant areas and the rooftop terrace.

### 4.7.1 Rooftop plant/terrace

Core A's roof terrace has a maximum travel distance of ~30m, as shown in Figure A2.7, this is within the permitted limit (60 m). This has been based on permitted travel distance for roof top plant in the open air, while this is not plant it is considered applicable as it is in the open air, similarly there is no limit in travel distance where deck approach is present, this also being in the open air. This area will also be limited to no more than 60 occupants due to having a single means of escape.

Core C's rooftop plant will follow the permitted travel distances within Table 4.1. Additional doors from the plant will be provided where necessary should an alternative exit be required.


**Figure A2.7 Roof terrace travel distance Core A**

### 4.7.2 Ground floor amenities

No fit out has been detailed for the amenity/ancillary areas at the ground floor, however based on their measured 'direct' distances (multiply by 1.5 to calculate travel distances) it is unlikely that any of these areas will exceed their travel distance limits when fitout is produced. This should be revaluated at the next RIBA stage when layouts have been decided. The measured travel/direct distances have been detailed in Appendix 1 (A 1).

### 4.7.3 Plant areas

The "tank" area on the ground floor of the development (Block A) has a permitted travel distance, where multiple directions of escape are provided of 35m, as the layout has not yet been finalised this would reduce to ~23m. As shown in Figure A2.8, a final exit can be reached within the 23m permitted from the furthest point of the room.

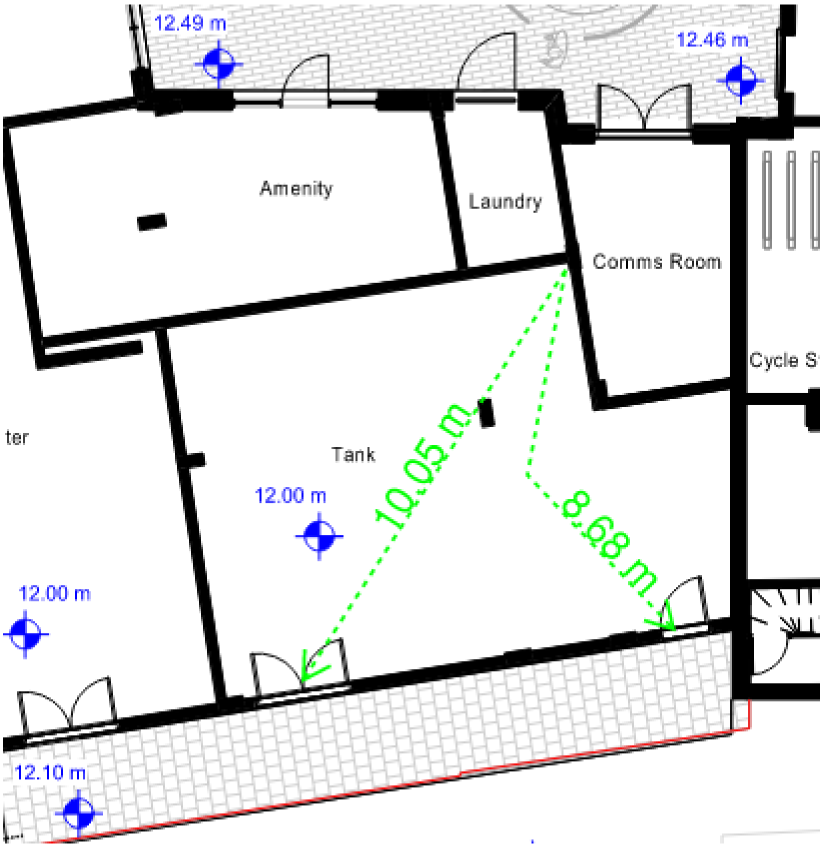


**Figure A2.8 'Tank' plant room**

## 4.8 Vertical circulation

Each core is provided with one stairwell. These can be seen, highlighted in green, in Figure A2.9. Core B's stair is a dedicated firefighting stair; where Core A and Core C's stairs are protected escape stairs.

**Figure A2.9 Stair locations**

## 4.9 Stair widths

The minimum stair widths are shown in Table 4.2. The final exits from these stairs should not narrow and should at least be the same minimum width as the respective stair.

**Table 4.2 Stair widths**

| Stair location | Type of stair | Minimum width (mm) |
|---|---|---|
| Core A | Internal escape stair | 850 |
| Core B | Firefighting stair | 1100 |
| Core C | Internal escape stair | 850 |

## 4.10 Door widths

Based on bed numbers, no more than 60 people will need to exit each storey at any time. Therefore, all doors except the final exits, will not be determined by fire requirements and likely have a minimum width requirement of 850 mm. The final exits should not narrow from the minimum width of the stair, see Table 4.2. These minimum requirements may be superseded by other requirements, for example, those linked to accessibility.

## 4.11 Disabled evacuation

To comply with policies D5(B5) of the London Plan 2021, a safe and dignified emergency evacuation for all building users should be incorporated. In the interests of fire safety and to ensure the safety of all building users, the highest standards of fire safety will be provided.

The high level of compartmentation in this development should allow disabled occupants to reach a place of safety, where they may have to wait before evacuating. It is the responsibility of the premises management to assess the needs of all potential evacuees when formulating safe evacuation plans.

At least one suitably sized evacuation lift should be provided to each lift core in accordance with Policy D5 of the London Plan. These evacuation lifts should be accessed via a ventilated lobby, and the ventilated lobby should not give direct access to any clusters or ancillary accommodation.

The refuge areas within this development should be of sufficient size to accommodate a wheelchair and to allow the user to manoeuvre into the wheelchair space, without undue difficulty. The space provided for a wheelchair in a refuge area should not be less than 900 mm x 1400 mm with access doors being at least 850 mm wide. An Emergency Voice Communication System (EVCS) should be provided to the refuge areas to alert management of people waiting in the refuges. These call points should also be in accordance with BS EN 54-11:2001+A1:2006.

# 5. Passive Fire Protection Systems

## 5.1 Test standards

Fire resisting elements selected should meet the performance standards recommended by the relevant part of BS EN 1363, BS EN 1364, BS EN 1365 or BS EN 1366.

## 5.2 Elements of structure

Based on the building's height, a degree of fire resistance should be provided to the elements of structure. Each building is less than 30 m and is sprinklered; therefore, each building should be provided with 60 minutes fire resistance to all elements of structure.

## 5.3 Applications to elements of structure

Elements of structure that are subject to protection, as mentioned in Section 5.2, include, but are not limited to:

- Beams.
- Columns.
- Floors (whether compartment floors or not).
- Compartment walls.
- Loadbearing walls (from both sides).
- An external wall structure supporting fire-resisting elements for the prevention of external fire spread.

Structural elements that are self-supporting or only provide support for a roof need not have any applied fire protection unless any of the following apply:

a. They also perform the function of a floor
b. They support life safety plant equipment
c. They are essential for the stability of an external wall requiring fire-resisting construction.

Where the stability of one element relies on the stability of another element with a lesser fire-resisting period, the higher of the two periods will be applied to both elements.

## 5.4 Compartmentation

Passive fire safety measures in terms of compartmentation will be provided throughout the development. A summary of the compartmentation requirements is provided in Table 5.1.

The fire resistance will be provided in accordance with BS EN 13501-2:2016. Where walls and floors are provided for fire compartmentation and act as elements of structure, the higher fire rating takes precedent.

It should be noted that cupboards/service duct access within the protected hall should be separated by a E 30 $S_a$ fire door.

**Table 5.1 Compartmentation and fire door summary**

| Area | Fire resistance | Comments | Fire doors |
|---|---|---|---|
| Firefighting shaft | REI 120<br>(REI 60 within the shaft) | From side remote from shaft and REI 60 from shaft side.<br>(Each side separately) | FD60S (REI 120 wall)<br>FD30S (REI 60 wall) |
| Life safety system enclosures | REI 120 | N/A | FD120S |
| Structural frame, beam or column | REI 60 | Exposed faces | N/A |
| Load-bearing wall element | REI 60 | Each side separately | N/A |
| Compartment floors | REI 60 | From underside | N/A |
| Walls separating clusters/studios from different area in same building | REI 60 | Each side separately | FD30S |
| Wall enclosing 'core' stairway | REI 60 | Each side separately | FD30S |
| Wall enclosing duplex stairway | REI 60 | Each side separately | FD30S |
| Wall enclosing refuse store, plant rooms and other ancillary accommodation (not cinemas) | REI 60 | Each side separately | As for the wall it is fitted in |
| Wall separating bedrooms and kitchen, within a cluster | REI 30 | Each side separately | Self-closer required |
| Wall separating living spaces from cluster corridor | REI 30 | Each side separately | FD30S with self-closer required. |
| Wall separating cupboard/service duct from common corridor | REI 30 | Each side separately | FD30S and kept locked shut. |
| Wall enclosing a cinema room | REI 30 | Each side separately | As for the wall it is fitted in |

## 5.5 Internal surface finishes and linings

The surface linings of walls and ceilings should meet the classifications in Table 5.2.

**Table 5.2 Classification of linings**

| Location | Classification in accordance with BS EN 13501-1:2018 |
|---|---|
| Small rooms of area not more than 4 $m^2$ | Class D-s3, d2 or better |
| Circulation spaces within dwellings | Class C-s3, d2 or better |

| Location | Classification in accordance with BS EN 13501-1:2018 |
|---|---|
| Other circulation spaces | Class B-s3, d2 or better |

Source: Section 20.1 of BS 9991

## 5.6 Protection of the final exit

Where the stair is recessed from or projected forming an internal angle by another part of the building, a fire within the building could spread, via radiation, to the protected escape stair. To prevent this, BS 9991:2015 proposes that fire resistant construction should be provided in accordance with Table 5.1. This construction should have the same classification as the structure of the building. This should be for a minimum distance of 1800mm as shown below. Should openings be located within that area they would need to be fire resistant.

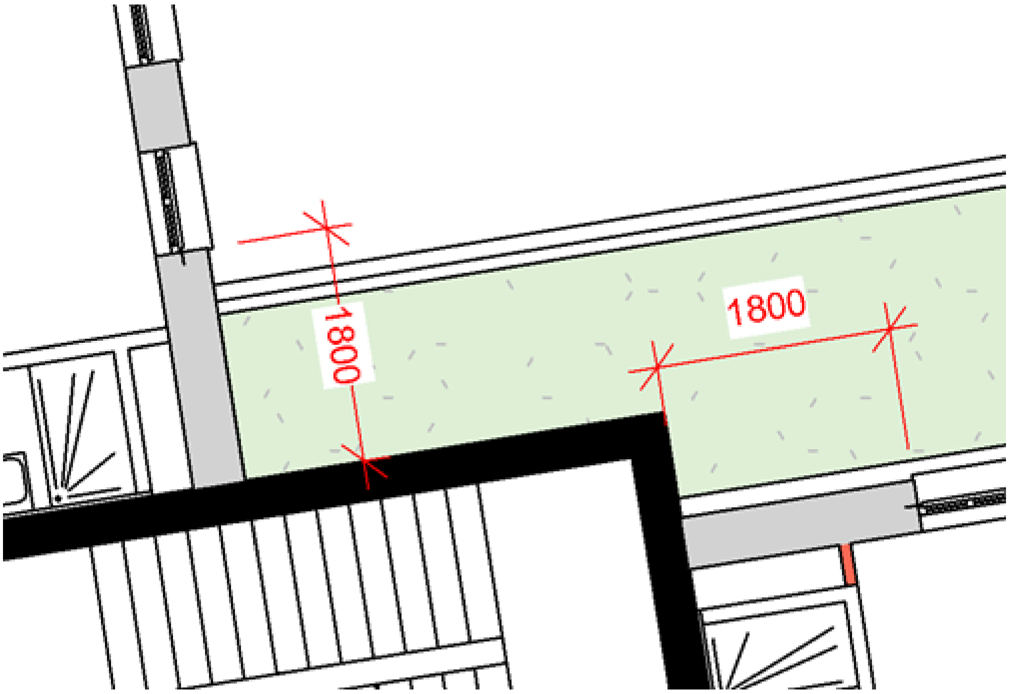


**Figure A2.1 Radiation mechanism**

## 5.7 Risk from fire underneath the accommodation.

Figure A2.2 illustrates the approximate area on the second floor, that has an undercroft. A fire load could be positioned directly underneath the accommodation. Therefore, fire resistant construction would be required to protect the residential area above from this, as outlined in Table 5.1.


Figure A2.2 Undercroft area

# 6. External Fire Spread

## 6.1 Construction of external walls

In accordance with recent changes to industry practices, BB7 recommend that each block has external surfaces comprised of Class A2-s1, d0 or better systems.

## 6.2 Construction of roof coverings

The roofs should be designed to achieve $B_{ROOF}$ (t4) in accordance with BS EN 13501-5: 2016.

## 6.3 Space separation

The external fire spread for this building has been analysed in accordance with BRE BR 187.

Appendix 2 (A 2) shows each emitter and provides an illustrative overview of the values used to calculate external fire spread. Table 1.1 outlines the relevant information for each emitter.

**Table 1.1 Emitter information**

| Emitter | Emitter dimensions (h x w) (m) | Boundary Distance (m) | Acceptable unprotected area |
|---|---|---|---|
| 1 | 3.5 x 8 | 1.9 | 64.0% |
| 2 | 3.5 x 4.3 | 2.6 | 100.0% |
| 3 | 3.5 x 5.4 | 2.7 | 100.0% |
| 4 | 3.5 x 14.5 | 6.0 | 100.0% |
| 5 | 3.5 x 5.9 | 1.9 | 82.3% |
| 6 | 3.5 x 2.1 | 3.5 | 100.0% |
| 7 | 3.5 x 9.8 | 3.5 | 100.0% |
| 8 | 3.5 x 10.3 | 2.7 | 95.5% |
| 9 | 3.5 x 4.4 | 2.5 | 100.0% |
| 10 | 3.5 x 5.3 | 1.5 | 58.7% |
| 11 | 3.5 x 8.0 | 6.6 | 100.0% |
| 12 | 3.5 x 11.2 | 2.0 | 54.6% |
| 13 | 3.5 x 9.6 | 5.7 | 100.0% |
| 14 | 3.5 x 5.6 | 5.7 | 100.0% |
| 15 | 3.5 x 14.0 | 6.7 | 100.0% |
| 16 | 3.5 x 5.2 | 2.6 | 100.0% |
| 17 | 3.5 x 2.8 | 2.6 | 100.0% |
| 18 | 3.5 x 15.0 | 2.5 | 100.0% |
| 19 | 3.5 x 12.4 | 2.4 | 100.0% |
| 20 | 3.5 x 9.8 | 2.6 | 100.0% |
| 21 | 3.5 x 9.0 | 1.8 | 52.2% |
| 22 | 3.0 x 8.0 | 2.6 | 100.0% |
| 23 | 3.0 x 5.4 | 2.6 | 100.0% |

| Emitter | Emitter dimensions (h x w) (m) | Boundary Distance (m) | Acceptable unprotected area |
|---|---|---|---|
| 24 | 3.0 x 5.4 | 2.7 | 100.0% |
| 25 | 3.0 x 7.2 | 6.0 | 100.0% |
| 26 | 3.0 x 10.8 | 1.3 | 80.6% |
| 27 | 3.0 x 4.8 | 2.2 | 100.0% |
| 28 | 3.0 x 5.0 | 3.1 | 100.0% |
| 29 | 3.0 x 14.8 | 2.5 | 100.0% |
| 30 | 3.0 x 6.4 | 1.5 | 100.0% |
| 31 | 3.0 x 17.3 | 6.6 | 100.0% |
| 32 | 3.0 x 9.6 | 1.9 | 100.0% |
| 33 | 3.0 x 14.8 | 1.9 | 96.5% |
| 34 | 3.0 x 5.7 | 5.7 | 100.0% |
| 35 | 3.0 x 6.0 | 6.7 | 100.0% |
| 36 | 3.0 x 10.3 | 2.6 | 100.0% |
| 37 | 3.0 x 4.8 | 2.5 | 100.0% |
| 38 | 3.0 x 4.8 | 2.4 | 100.0% |
| 39 | 3.0 x 4.8 | 2.4 | 100.0% |
| 40 | 3.0 x 9.8 | 2.6 | 100.0% |
| 41 | 3.0 x 9.0 | 1.8 | 100.0% |
| 42 | 3.0 x 4.2 | 6.0 | 100.0% |
| 43 | 3.0 x 12.1 | 1.6 | 90.6% |
| 44 | 3.0 x 5.4 | 5.8 | 100.0% |
| 45 | 3.0 x 4.8 | 2.5 | 100.0% |
| 46 | 3.0 x 9.7 | 2.5 | 100.0% |
| 47 | 3.0 x 14.8 | 2.6 | 100.0% |
| 48 | 3.0 x 4.8 | 1.9 | 100.0% |
| 49 | 3.0 x 6.2 | 1.9 | 100.0% |
| 50 | 3.0 x 4.8 | 2.6 | 100.0% |
| 51 | 3.0 x 9.0 | 1.8 | 100.0% |
| 52 | 3.0 x 15.2 | 2.4 | 100.0% |

# 7. Fire and Rescue Service Access and Facilities

## 7.1 Fire and Rescue Service Vehicle access

8. Where access routes need to be provided, they should be designed to accommodate dimension and mass requirements in the table below, (which is taken from London Fire Brigade – Guidance Note 29).

Fire tender vehicle tracking, carried out by Arup shows that sufficient access is provided for the tender to access the required perimeter of the development on Brunswick Square along with access to the court yard via the undercroft for Blocks B and C. Where a turning head cannot be provided the tender will not be required to reverse any further than 20m in order to leave the development.

**Table 8.1 Fire service access route specifications**

| Appliance | Minimum road width between kerbs (m) | Minimum gateway width (m) | Minimum turning circle between kerbs (m) | Minimum turning circle between walls (m) | Minimum clearance height (m) | Minimum carrying capacity (tonnes) |
|---|---|---|---|---|---|---|
| Pump | 3.7 | 3.1 | 16.8 | 19.2 | 3.7 | 14.0 |
| High Reach | 3.7 | 3.1 | 26.0 | 29.0 | 4.0 | 17.0 |

Note: the figures within Table 8.1 above are standardised, each fire authority has different vehicles. The fire authority should be contacted to confirm if the figures within the table above are sufficient.

## 8.2 Fire and Rescue Service Personnel access

Core A is accessed by the FRS directly off Brunswick Square. However, Core B and Core C are accessed via the western courtyard that leads off Brunswick Square. These access routes have been shown in Figure A2.1. It should be noted that access to Core B and Core C is provided via an undercroft, as mentioned in Section 5.7, it has been confirmed by vehicle tracking that sufficient access is provided for the tender to access and leave the courtyard via the undercroft.


**Figure A2.1  FRS personnel routes**

## 8.3 Firefighting facilities

### 8.3.1 Shafts

Block B is above 18 m; therefore, its core (Core B) is required to be provided with a firefighting shaft. As no other block is above the 18 m limit and there is no communication between cores, only Core B is required to be a firefighting shaft.

The components of this firefighting shaft are:

- A dry fire main.
- A firefighting stair, enclosed within the shaft.
- A firefighting lift, enclosed within the shaft.
- Enhanced compartmentation as outlined in Table 5.1
- Suitable smoke control system

It should be noted that a “suitable smoke control system” in this case is different to that outlined in Section 3.3. Firefighting shafts above ground level that only serve flats should be provided with a natural smoke control system as a minimum. Where a mechanical smoke control system is used, this should perform to an equal level as a natural system.

In addition to these ventilation requirements, only services associated with the firefighting shaft, such as, but not limited to, ventilation systems and lighting for the shaft, should pass through or be contained within the fire-fighting shaft.

### 8.3.2 Dry fire mains

Each core should be provided with a fire main that has an outlet at each level, as each core is either a firefighting shaft or requires it for hose coverage reasons. The outlet, at each level, should be located within the stair enclosure.

The inlet for each of the dry fire mains should be within 18 m of a fire appliance's parking space. Typically, the inlet would be visible from the fire appliance and be on the face of the building and close to the firefighting shaft's entrance point.

In addition, the fire mains should be installed in accordance with BS 9990.

### 8.3.3 Hydrants

Hydrants should be located near to the building entry points and be within 90 m of dry rising fire main inlets. Due to this being an existing site it is assumed that hydrants are located within 90m of the development, confirmation of this has also been provided in a design note from the previous stage report by Burro Happold.

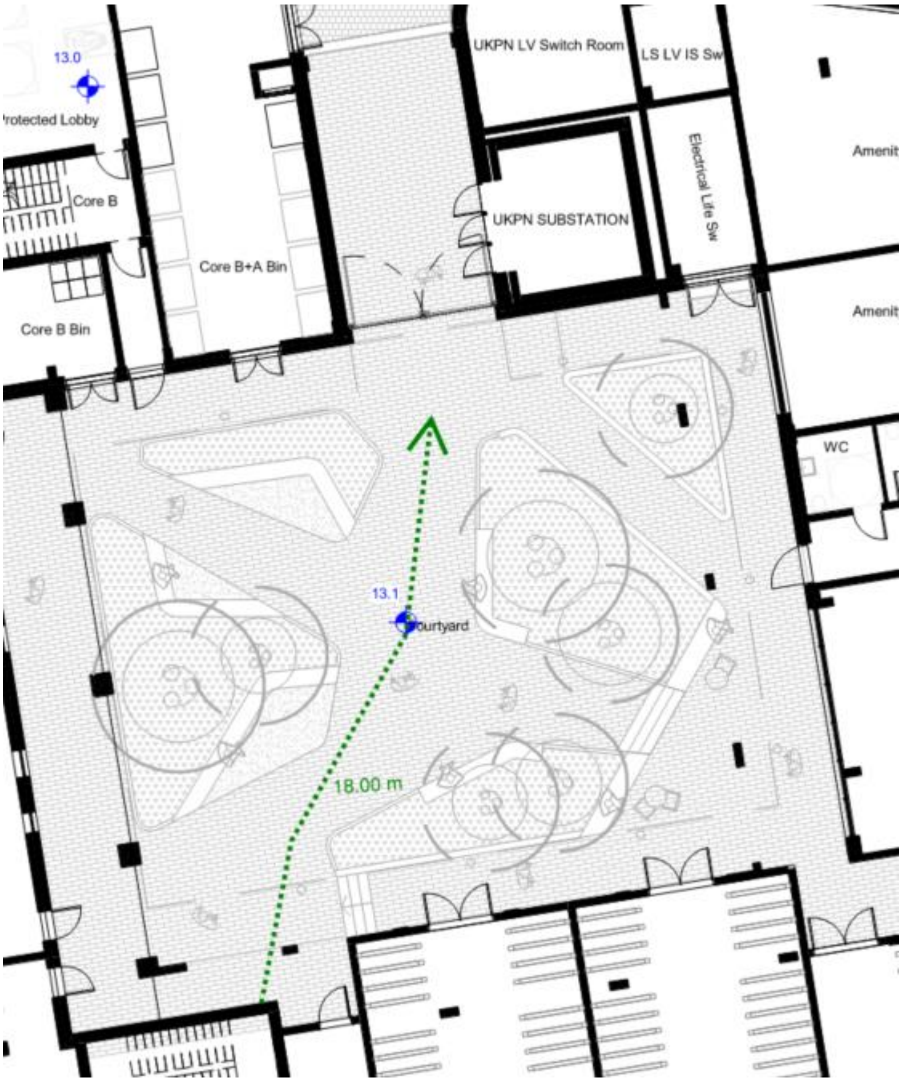


**Figure A2.2 Approximate 18 m limit from Core C's dry mains inlet**

### 8.3.4 Hose coverage

For sprinkler protected buildings, the maximum allowable hose distance is 60 m from the fire main outlet to the most remote part of the each floor plate. Based on the approximate location of the fire tenders, this is achieved across the development.


**Figure A2.3 Examples of hose routes**


**Figure A2.4 Areas accessed directly from fire appliance on ground floor.**

## 8.4 Information for the Fire Service

A secure information box should be provided for each building. The secure information box should meet all the following conditions:

a. Sized to accommodate all necessary information.

b. Easily located and identified by firefighters.

c. Secured to resist unauthorised access but readily accessible by firefighters.

d. Protected from the weather.

As well as a secure information box, wayfinding signage is required in all three blocks. This signage will help the FRS identify each floor in a block of flats with floor identification signs and flat indicator signs. Further information on this signage can be found in Section 15 of ADB.

# 9. Conclusion

This report outlines the RIBA Stage 4 Fire Safety Strategy requirements for the Printworks development and seeks to demonstrate compliance with the Building Regulations.

- Each cluster internally will be provided with a protected entrance hallway achieving 30 minutes fire rated construction and FD30 doors.
- The travel distance within the residential common corridors is within the recommendations of BS9991.
- The location of the cluster flat entrance door within core B is not in accordance with the guidance, however it is believed that suitable mitigation measures are being provided to justify this mitigation.
- All flats will be provided with category LD1 detection and alarm systems, common areas (including stairs) will be fitted with alarm and detection to category L5.
- Blocks A, B and C will be provided with an automatic sprinkler system.
- The elements of the structure for all blocks must achieve 60 minutes fire resistance in accordance with BS9991.
- Mechanical smoke extract will be provided to the stair core lobbies in each block
- Block B will be provided with a firefighting shaft and firefighting lift, all stair cores will be fitted with dry rising mains.

A full Fire Risk Assessment should be carried out prior to the building handover and be in place on occupation to meet the requirements of the Regulatory Reform Order. The assessment should be maintained and act as a record of the provision and measures, passive and active, used to minimize fire risk within and around the building.

# 10. Legislation

## 10.1 Building Regulations 2010 (as amended)

The Building Regulations 2010 (as amended), is the primary legislation controlling building work and applies to the majority of new or materially altered buildings. The fire safety requirements are given in Part B of Schedule 1 to the Building Regulations and make requirements for specific areas:

- B1 Means of warning and escape.
- B2 Internal fire spread (linings).
- B3 Internal fire spread (structure).
- B4 External fire spread.
- B5 Access and facilities for the fire service.

The recommendations contained within BS 9991:2015 have been used for the development as the benchmark for the fire safety design. It should be noted that a new version of this document is due to be issued in the near future. Where relevant, BB7 have included guidance from this document. Reference has also been made to other relevant British and European standards where appropriate.

It is important to note that, as is the case with many complex buildings/developments, it is not always possible to apply the prescriptive recommendations of fire safety guidance in full. This report may therefore propose additional 'fire-engineered' solutions which offer an alternative method of meeting the functional requirements of the Building Regulations. As with all engineered solutions, the importance of early discussion and agreement with the relevant Approval Authorities must be emphasised.

Responsibility for deciding if the requirements of the Regulations have been met rests with the building control body (Local Authority Building Control, or an Approved Inspector).

## 10.2 Construction Design and Management

UK projects are subject to the requirements of the Construction (Design and Management) Regulations 2015 (CDM). The CDM Regulations 2015 govern the management of health, safety, and welfare when undertaking construction projects. The CDM Regulations apply to all building and construction work, including the construction, alteration, conversion, fitting-out, commissioning, repair and maintenance, decommissioning, demolition, or dismantling of a structure.

When preparing or modifying a design, the designer must consider the general principles of prevention and any pre-construction information to eliminate, so far as is reasonably practicable, foreseeable risks to the health or safety of any person. These set out the principles duty holders should use to direct their approach to identifying the measures necessary to control the risks to health and safety in a particular project. The general principles can be summarised as:

- Avoiding risks where possible,
- Evaluating those risks that cannot be avoided, and
- Putting in place proportionate measures that control them at the source.

Where any recommendations contained within this report specify materials, products, or construction methods these will have been assessed, in accordance with CDM Regulations 11 and 18 (duties for designers). If these involve significant residual risks or health and safety-critical assumptions, this information will be made available to the Principal Designer. Where the architect or other consultants use all or part of this report to specify works, it is assumed they are competent in alerting the Client, Principal Designer, Designers, Contractors and Building Occupier if any issues arise under the CDM Regulations.

## 10.3 Regulatory Reform (Fire Safety) Order 2005

The Regulatory Reform (Fire Safety) Order 2005 places a general duty of fire safety care on employees, occupiers, and/or owners of businesses to provide and maintain adequate fire precautions. The legislation is supported by requiring a fire risk assessment and a fire safety plan.

The Order places a responsibility on the responsible person to carry out a fire risk assessment on the premises. This process looks to:

- Identify potential fire hazards.
- Evaluate the risk from the hazards.
- Identify who would be at risk.
- Identify an adequate level of fire precautions to compensate for the risk.

The significant findings of the fire risk assessment should be recorded if the responsible person employs five or more employees.

The fire safety management plan details the arrangements to implement, control, monitor and review fire safety standards and to ensure those standards are maintained. The plan describes the arrangements for effectively managing fire safety so as to prevent a fire from occurring and, in the event of fire, to protect people and property.

A fire safety management plan should be completed on the occupation of the premises and a fire risk assessment should be undertaken following the occupation to comply with Article 9 of The Regulatory Reform (Fire Safety) Order 2005.

The responsible person should, on occupation, provide adequate fire safety information to all eventual residents of the apartments. This could be in the form of a home user guide to include basic fire prevention measures and information regarding the fire evacuation strategy and any associated procedures (which could be tailored to the needs of the individual tenant e.g., different language). Further information that can be provided to occupiers of dwellings in residential buildings include an example fire evacuation plan.

The fire emergency plan ought to be communicated to each resident upon occupation; residents ought to have a clear understanding of what actions they should take in the event that a fire scenario impacts the evacuation strategy and they may need to evacuate the building.

## 10.4 Regulation 38

Regulation 38 of the Building Regulations requires fire safety information for a new or altered building to be passed to the responsible person at the completion of the project or on occupation, whichever comes sooner.

The aim of this regulation is to ensure that the person responsible for the building has sufficient information relating to fire safety to enable them to manage the building effectively. Regulation 38 will be achieved when the person responsible for the building has all the information to enable them to do all of the following:

- Understand and implement the fire safety strategy of the building.
- Maintain any fire safety system provided in the building.
- Carry out an effective fire risk assessment of the building.

Fire safety information should be given to the responsible person at one of the following times.

- When the project is complete.
- When the building or extension is first occupied.

**Essential information**

Basic information on the location of fire protection measures may be sufficient. An as-built plan of the building should be provided showing all of the following:

- Escape routes – this should include exit capacity (i.e. the maximum allowable number of people for each storey and for the building).
- Location of fire-separating elements (including cavity barriers in walk-in spaces).
- Fire door sets, fire door sets fitted with a self-closing device and other doors equipped with relevant hardware.
- Locations of fire and/or smoke detector heads, alarm call points, detection/alarm control boxes, alarm sounders, fire safety signage, emergency lighting, fire extinguishers, dry or wet fire mains and other firefighting equipment, and hydrants outside the building.
- Any sprinkler systems, including isolating valves and control equipment.

Details should be provided on all of the following:

- Specifications of fire safety equipment provided, including routine maintenance schedules.
- Any assumptions regarding the management of the building in the design of the fire safety arrangements.

Any provision enabling the evacuation of disabled people, which can be used when designing personal emergency evacuation plans.

## 10.5 London Plan

The most relevant policies from this guidance are Policy D12 and Policy D5, which both cover fire safety and inclusive design respectively.

## 10.6 Regulation 7(2)

Regulation 7(2) only applies to buildings with a storey at least 18 m above the ground level and which contains:

- One or more dwelling,
- An institution; or,
- A room used for residential purposes.

As Core B is taller than 18 m, the whole development is classified as a ‘relevant building’.

# A 1. Travel Distances

## A 1.1 Ground floor amenities.

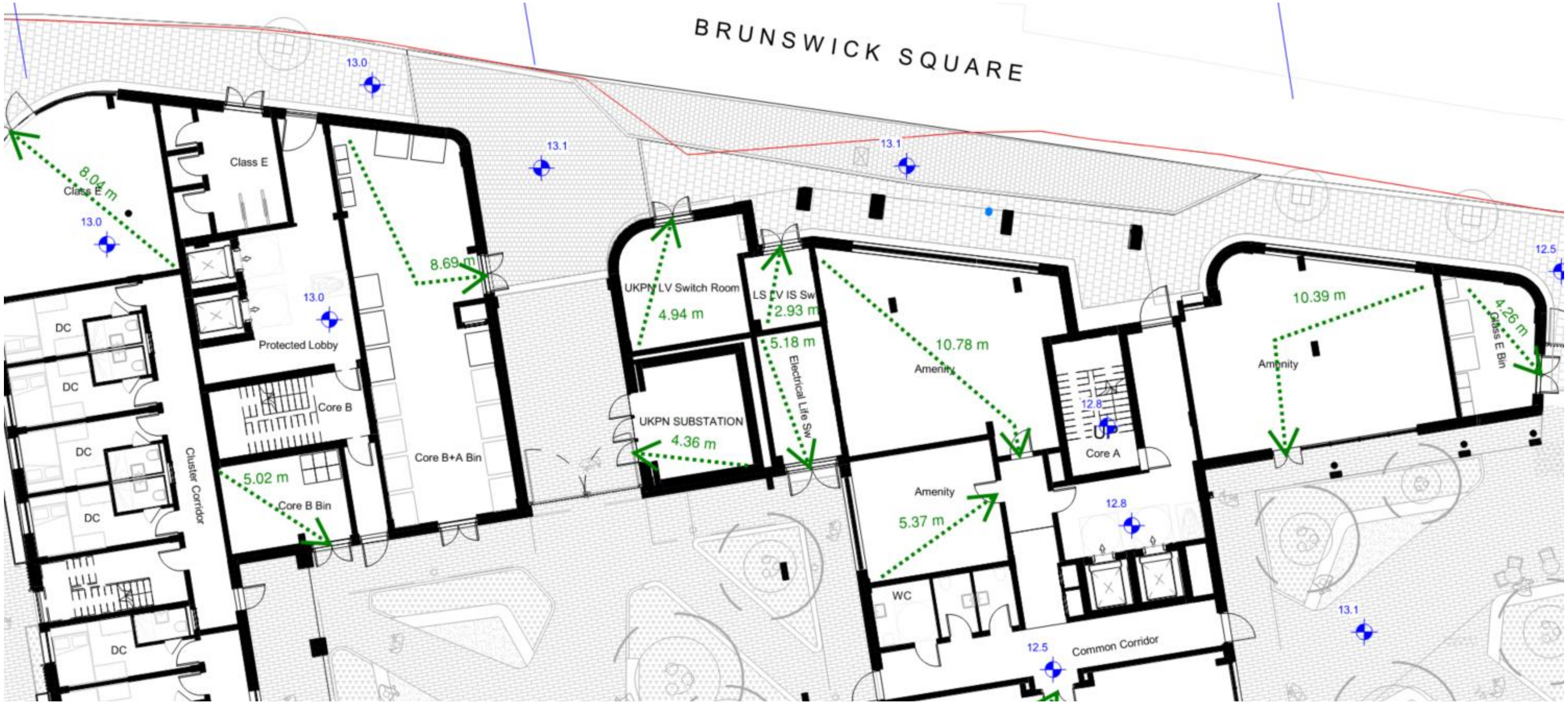


Figure A1.1 The travel distances of the ground floor amenities


**Figure A1.2 The travel distances of the ground floor amenities**

# A 2. External Fire Spread

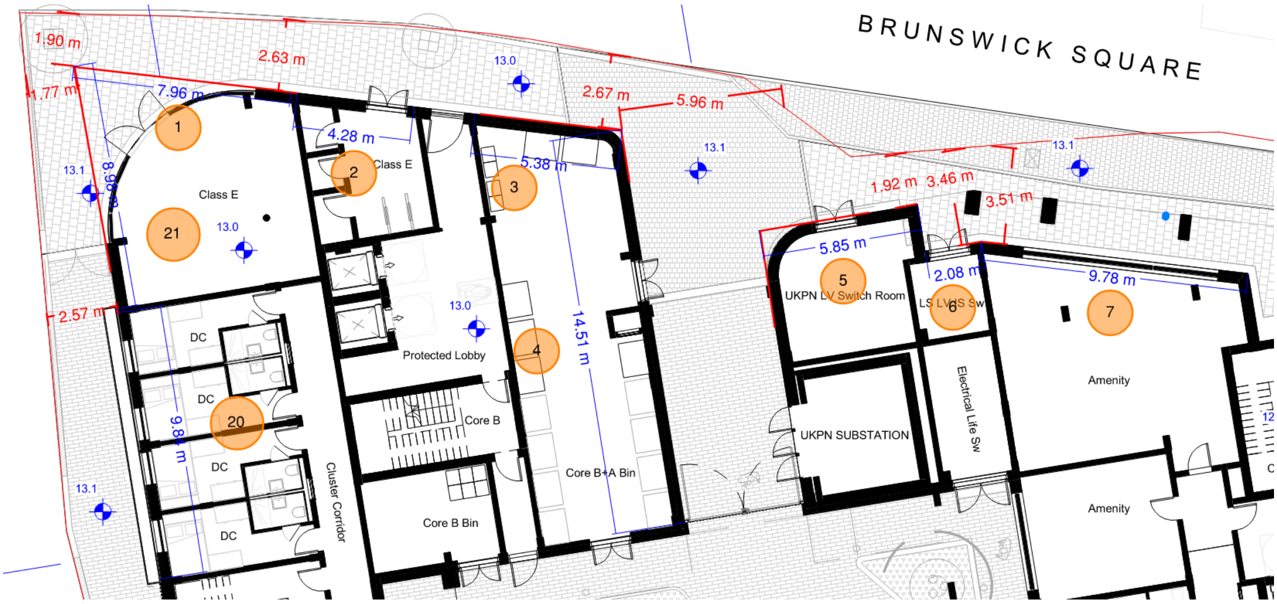


**Figure A2.1 Emitters 1-7 & 20,21**

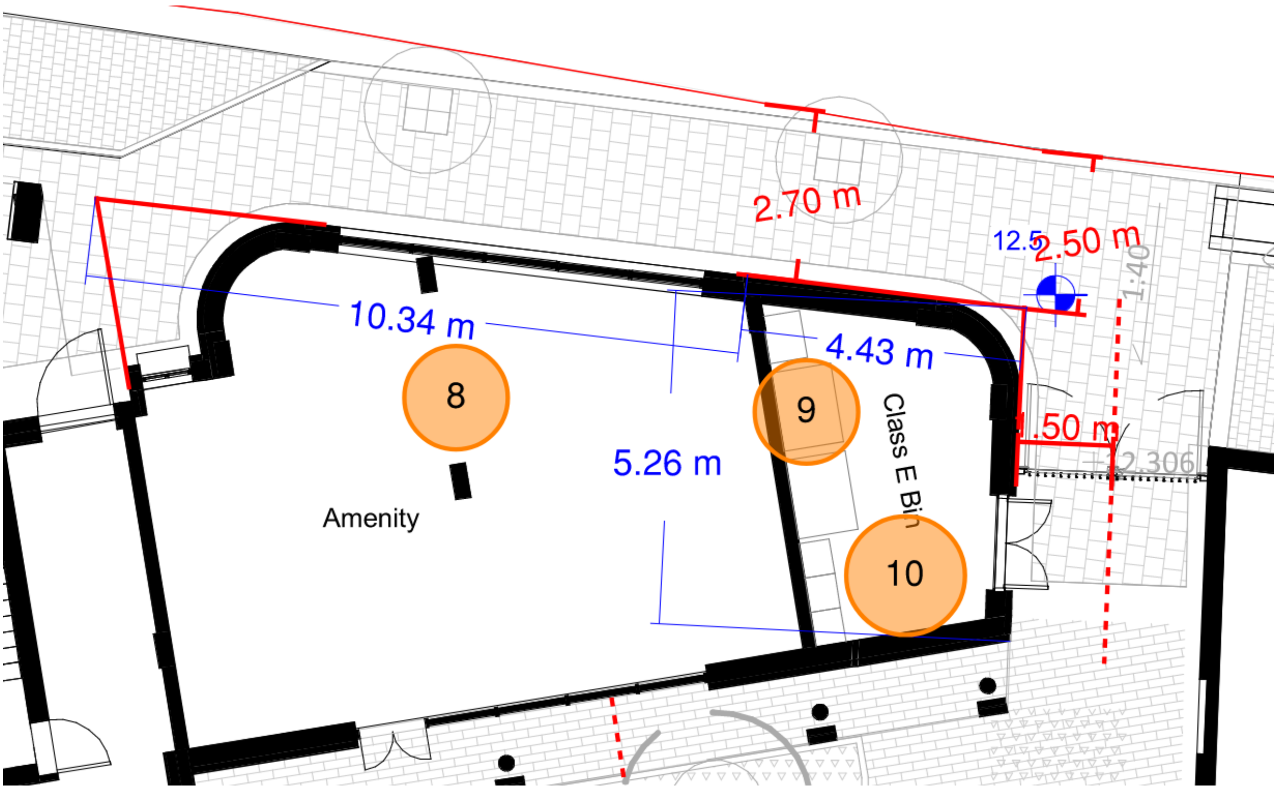


**Figure A2.2 Emitters 8-10**

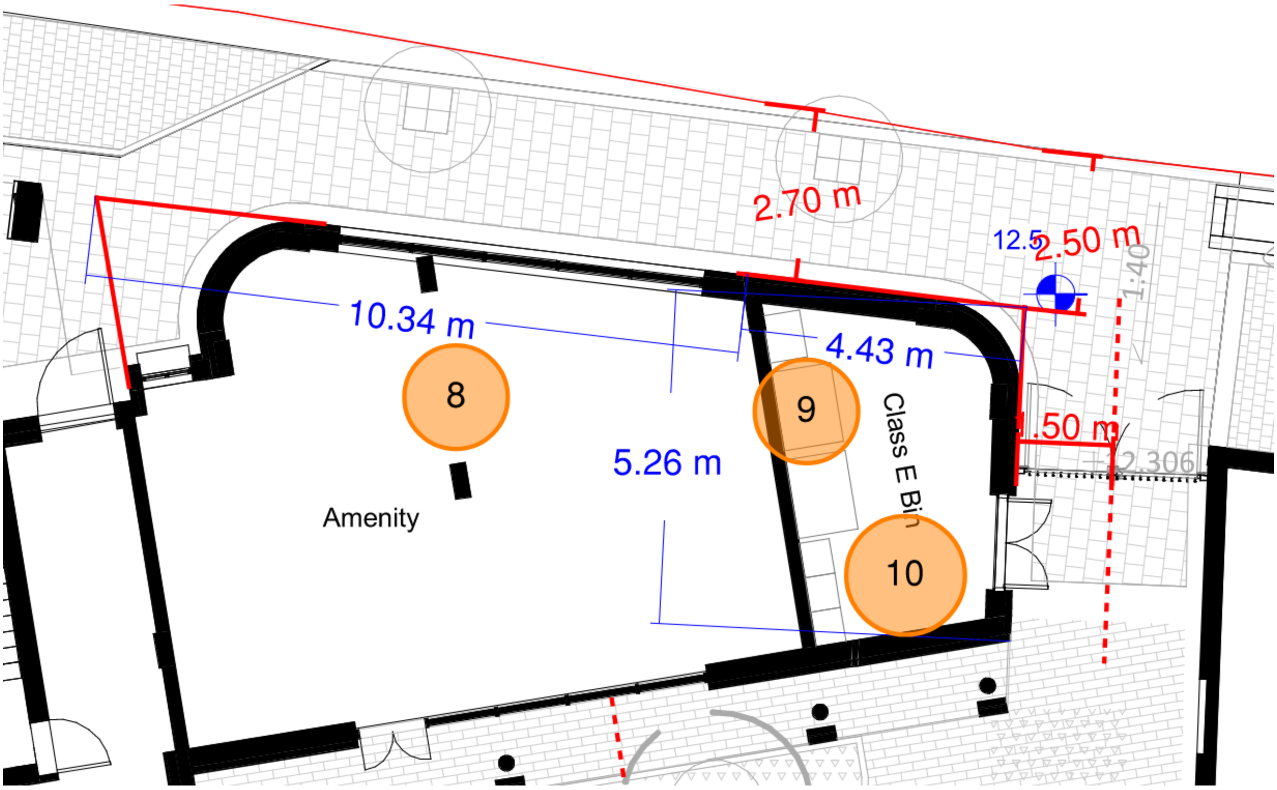


**Figure A2.3 Emitters 8-10**

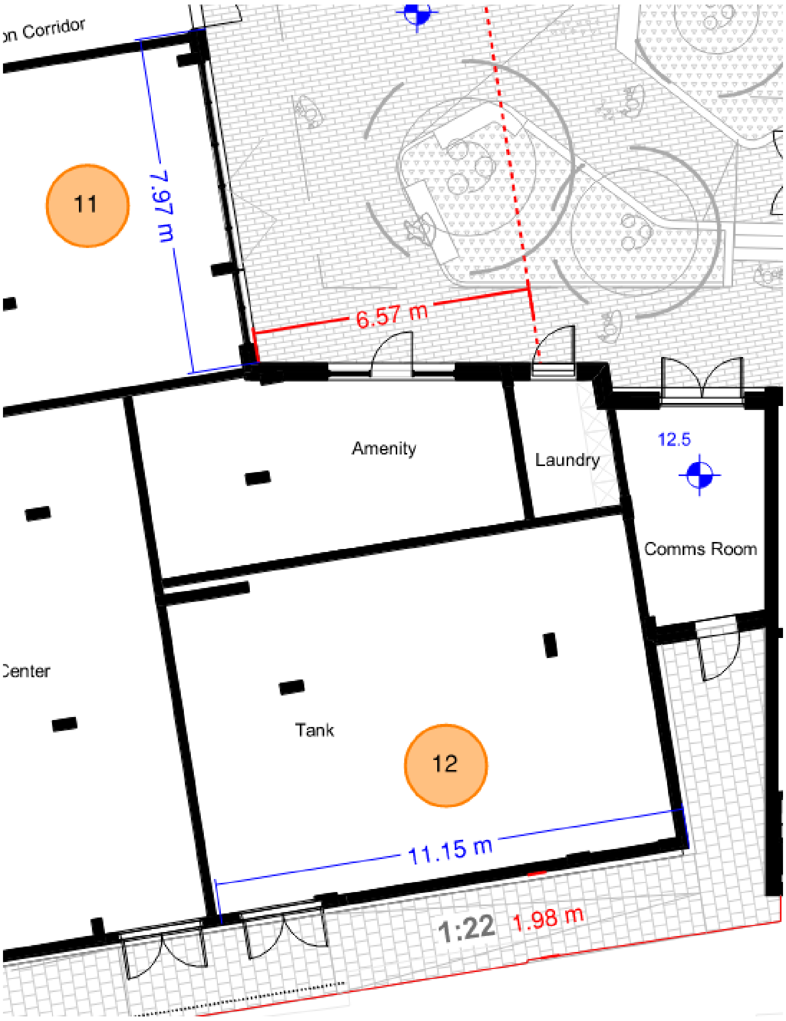


**Figure A2.4 Emitters 11 & 12**


Figure A2.5 Emitters 13-17

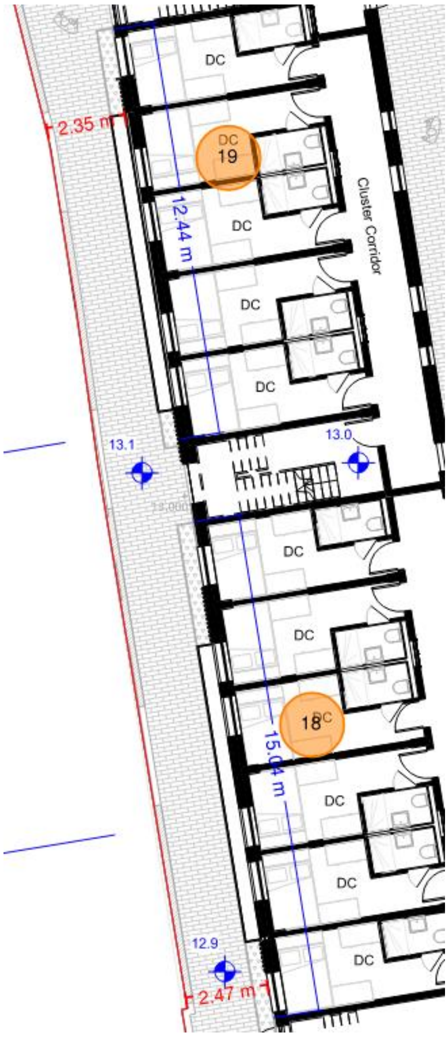


**Figure A2.6 Emitters 18 & 19**


Figure A2.7 Emitters 22-25 & 40,41

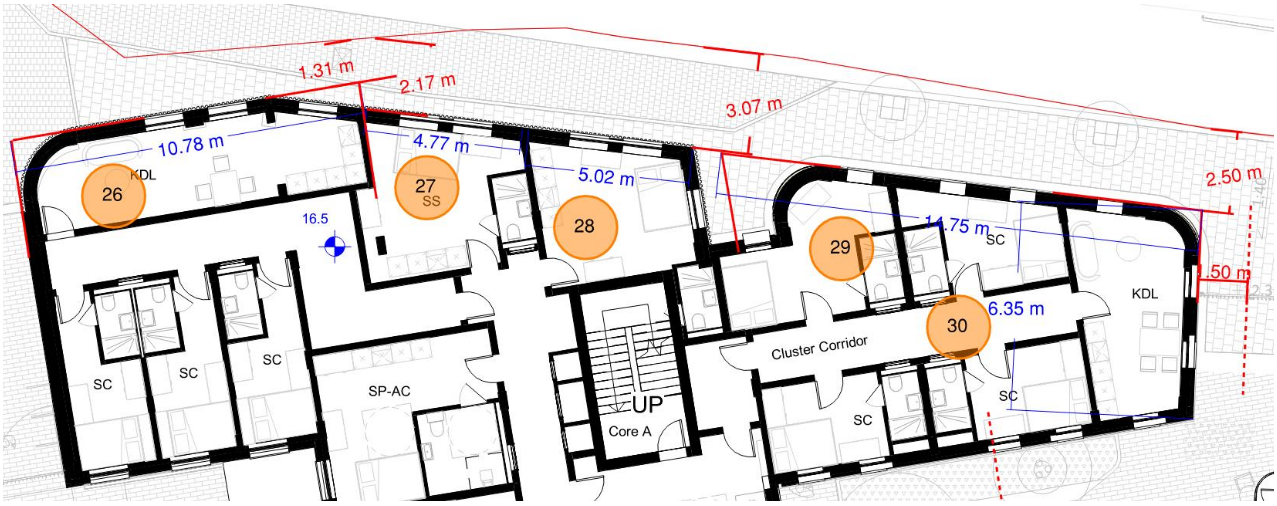


Figure A2.8 Emitters 26-30

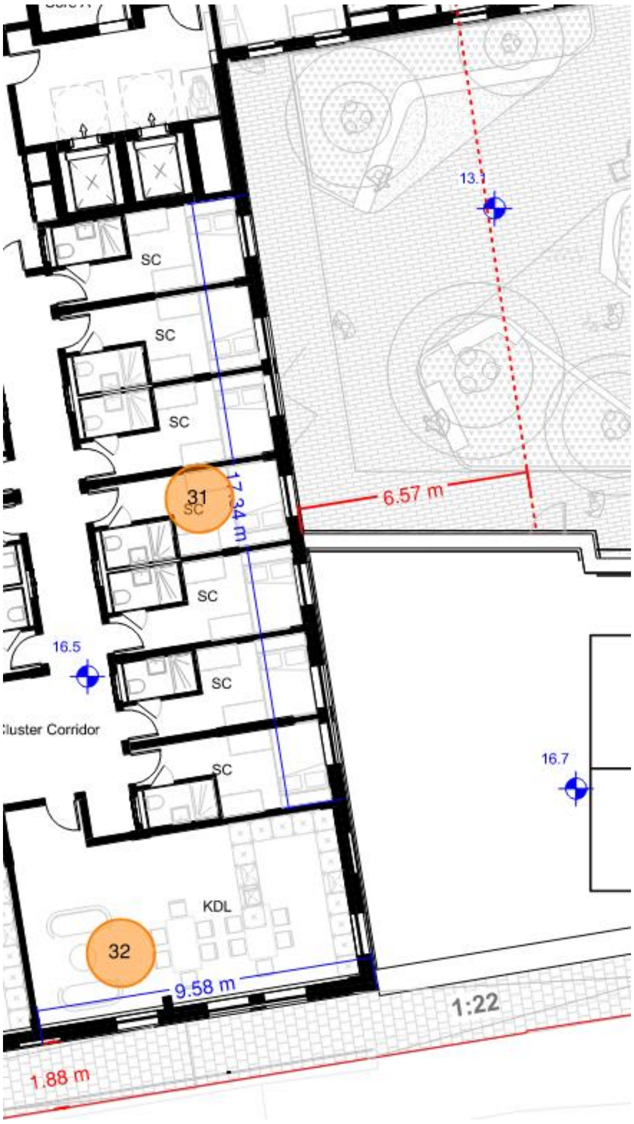


**Figure A2.9 Emitters 31 & 32**


Figure A2.10 Emitters 33-37

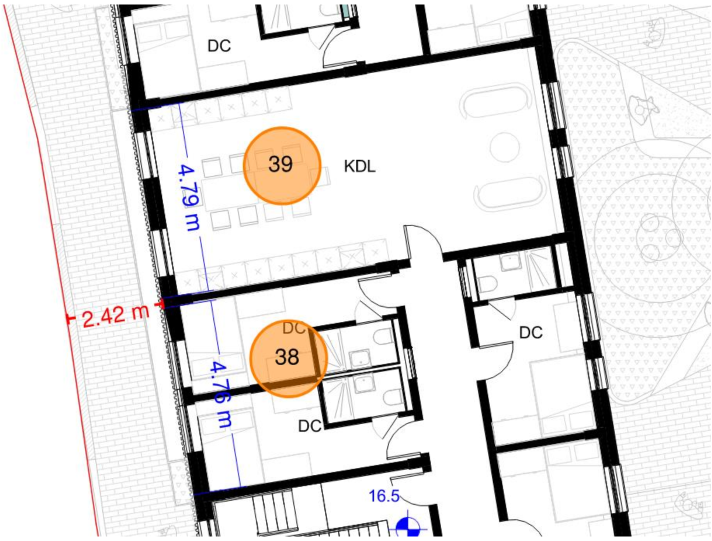


**Figure A2.11 Emitters 38 & 39**

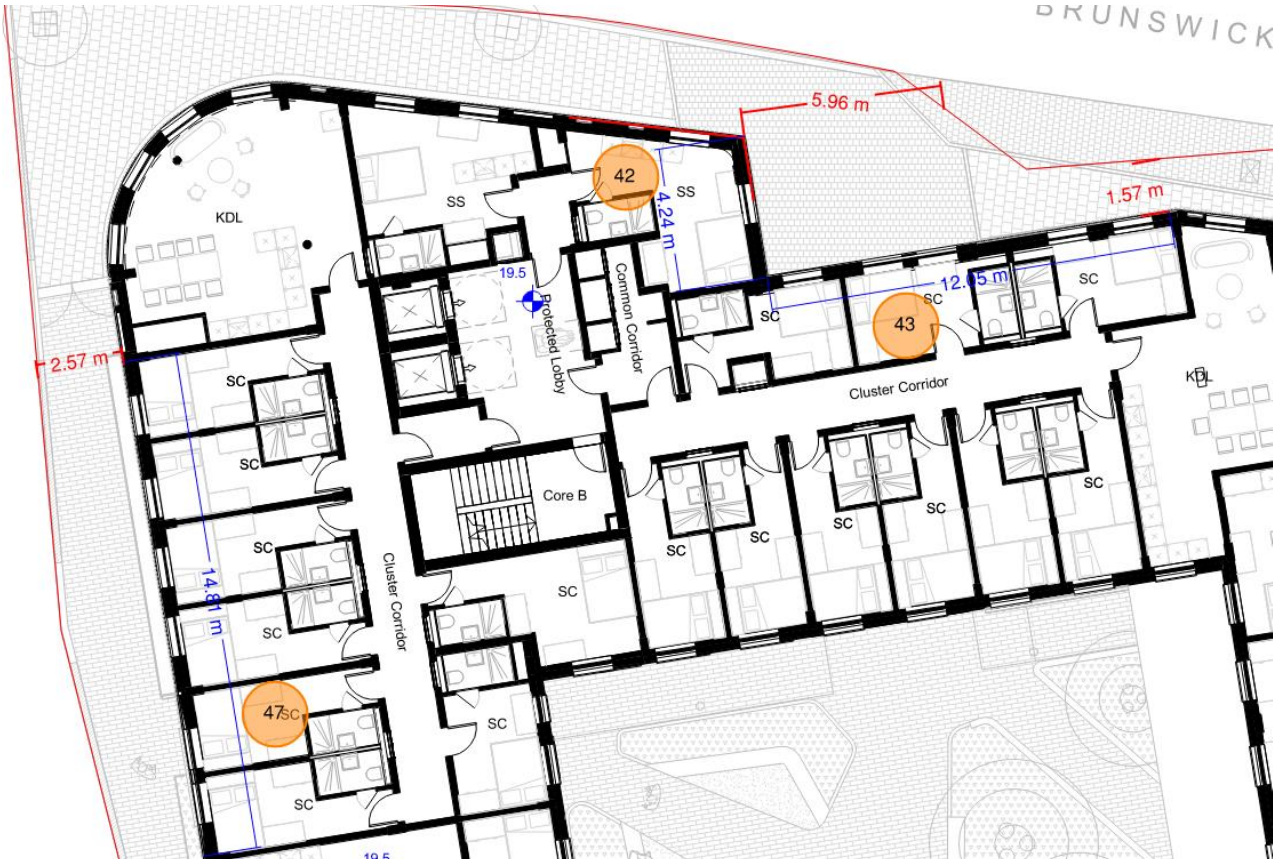


**Figure A2.12 Emitters 42,43 & 47**


**Figure A2.13** Emitters 44-46


**Figure A2.14** Emitter 48

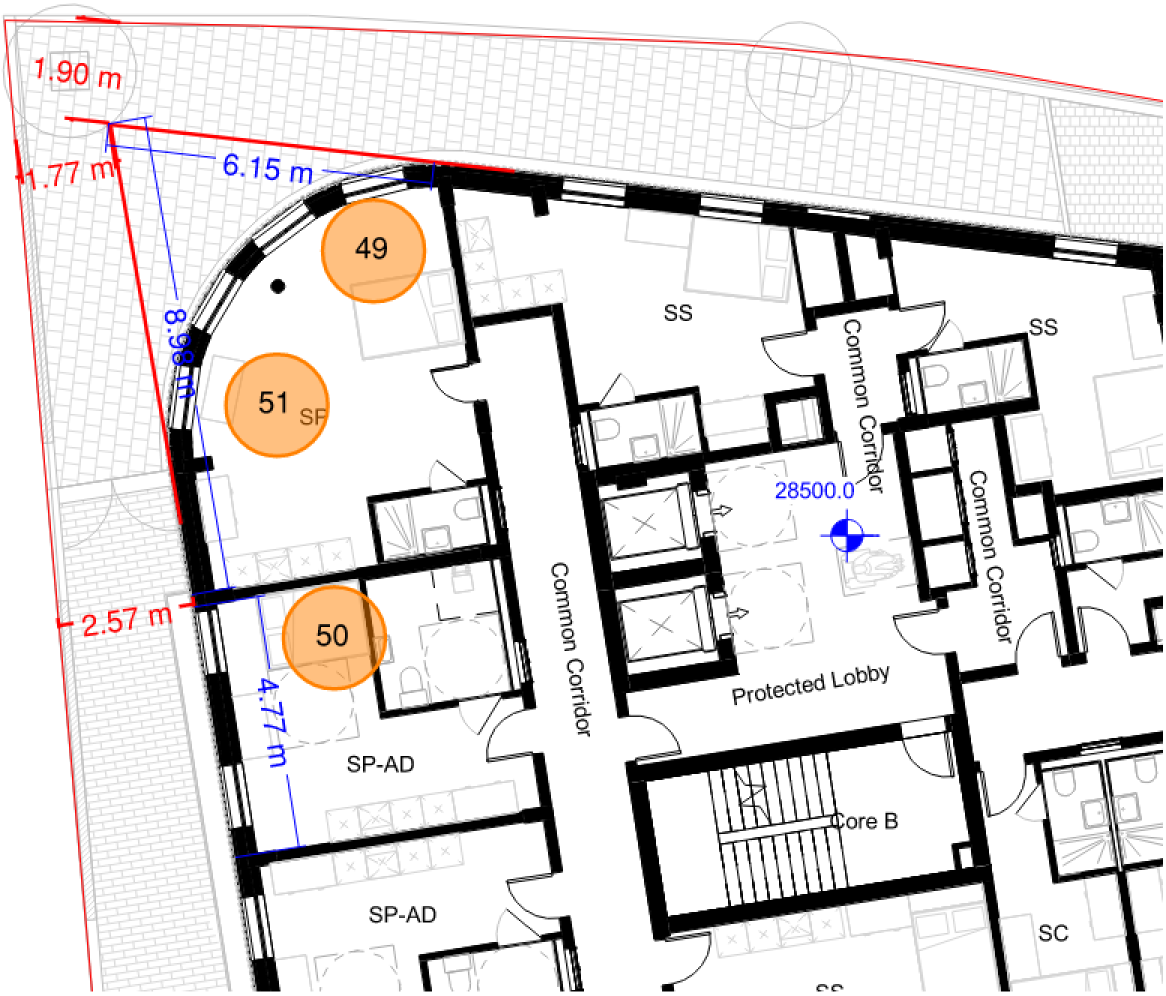


Figure A2.15 Emitter 49-51

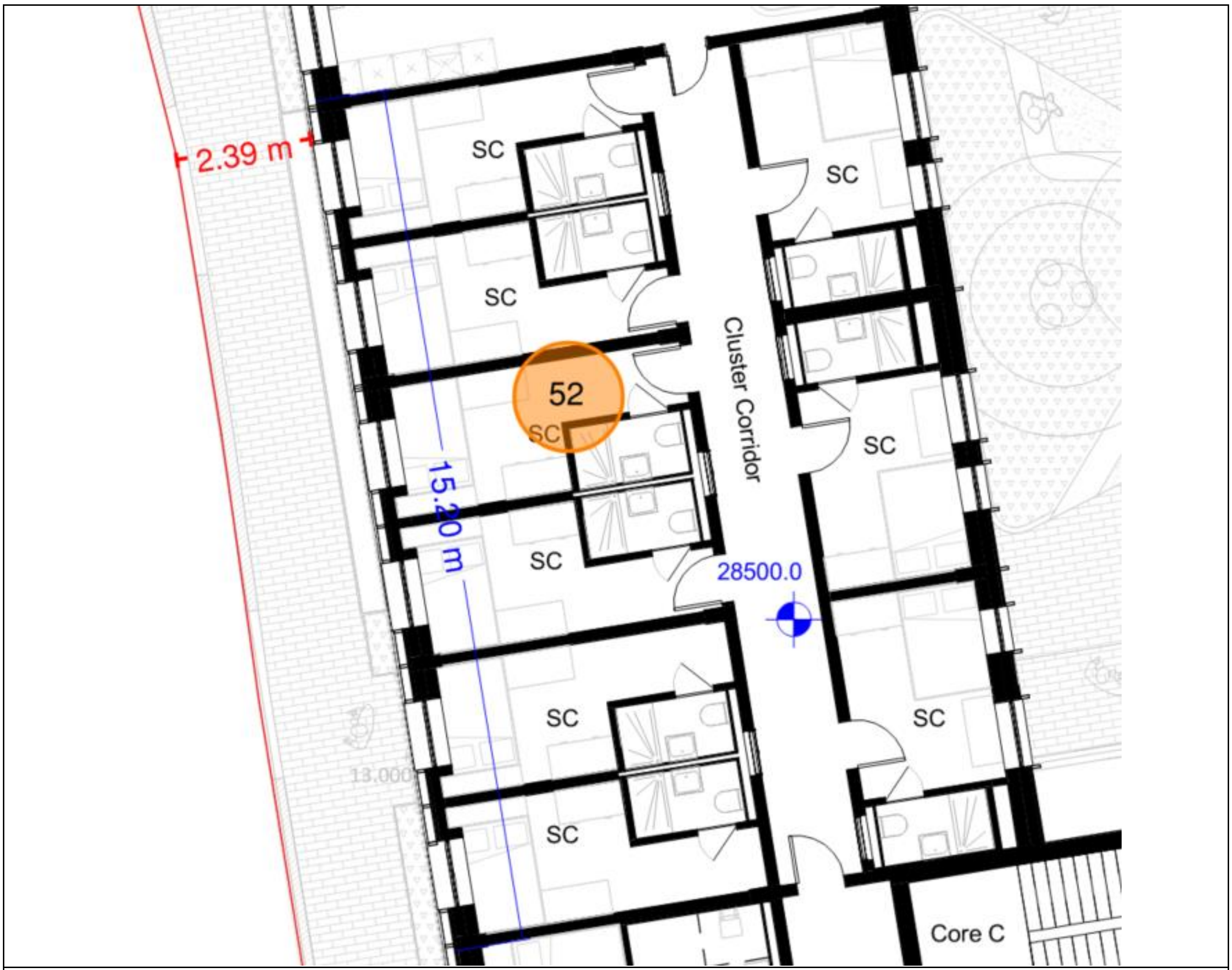


**Figure A2.16** **Emitter 52**

# A 3. Radiation Calculations for Cooking Facilities

The cooking facilities are specified have been assumed to have a maximum power of 2.0kW for the highest-powered ring as a worst-case scenario for a single hob. As 2.0kW is used in the calculations this is conservative as this will be assuming that the hob is on full power and that it is 100% efficient and all the heat is transferred straight to the fuel, without being used to heat up the pan. Calculations will be made based on a worst-case scenario pool fire based on the hob. A pool fire is chosen as this will allow for accurate estimations of pan fires. The scenario calculated will be of a 0.25m diameter pan containing cooking oil (data gathered is based on properties of olive oil as this has the highest heat of combustion) [2].

It should be noted that while these calculations are theoretical rather than experimental, this will result in estimations higher than expected in real world cases. This is since no consideration is given to heat loss from the pan etc. So, it is assumed that the fire is 100% efficient and all heat that is not radiated outwards is radiated back into the base of the fire. It also assumes that all energy provided by the hob is transferred directly to the oil with no energy lost to the pan or surroundings. It is also to be assumed that the flame from the pan is conical.

To calculate the heat release rate (HRR) of a self-sustaining oil fire i.e. the pan is on fire, but the hob is switched off the following properties of olive oil need to be considered:

- Heat of Combustion, ΔHc – 39.6 MJ/kg [2]
- Regression Rate, m'' – 0.02 kg/m2s [3]

For a 0.25m diameter, an area, Af of 0.049m2 can be calculated. The fire should be almost a perfect circle as the fuel is held in shape by the pan. A radiative heat fraction of 0.35 has been selected for this case. 0.35 has been selected as a conservative value, as materials that produce more soot when they burn have higher radiative fractions, and the value of 0.35 was taken from a plastic and wooden crib (which produce more soot than olive oil) [4].

Putting the data into the equation for heat release rate:

$$\dot{Q} = \dot{m}'' \Delta H_c A_f$$

$$\dot{Q} = 0.02 * 39.6 * 0.049$$

$$\dot{Q} = 0.0389MW$$

$$0.0389MW = 38.9kW \qquad [5]$$

This calculated result of 38.9kW is similar to the experimental results recorded by a recent study on oil fires in woks by Chow [6], where a solution of multiple cooking oils was used. Olive oil was selected for this case as it has the highest heat of combustion as listed in the SFPE handbook [2]. Using a wok of the same diameter of the theoretical frying pan used in these calculations, the control test from Chow and Xi's experiment resulted in a measured average HRR of between 24-27kW with peak HRR's nearer to the calculated value [6]. However, the peak HRR from this experimental data may have only being recorded for a fraction of a second whereas the higher HRR acquired from the calculations is assumed to be constant which has resulted in a much higher HRR overall.

It is assumed that 50% of the thermal radiation travels towards the seat of the fire. This results in a worst-case scenario as all radiation that is not heading directly out of the fire is used to supply further energy to the liquid fuel. Thermal radiation to the fire bed, $\dot{Q}$Rf can be calculated with the following equation:

$$\dot{Q}_{Rf} = \frac{F\dot{Q}_R}{2}$$

To calculate $\dot{Q}$Rf, the configuration factor, F needs to be found, which has the equation:

$$F = \frac{1}{(1+H^2)^{0.5}} \quad [7]$$

To calculate F, H needs to be found, which has the equation:

$$H = \frac{2L}{D} \text{ [7]}$$

To calculate H, Flame Length, L must be found, which has the equation:

$$L = 0.23\dot{Q}_C^{\frac{2}{5}} - 1.02D \text{ [8]}$$

Where $\dot{Q}$C is the convective fraction of heat transfer from a pool fire. Heat generated in the flame will be partly convected away by smoke flow in the plume and partly radiated to the surrounding. The fraction of heat radiated out of the flame, as stated earlier, is 0.35 which is adequate for small pool diameter. This gives us a convective fraction of 0.65.

$$L = 0.23 * (0.65 * 38.9)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = 0.582m$$

Now a value of H can be found:

$$H = \frac{2 * 0.5821}{0.25}$$

$$H = 4.657$$

NOTE: H has no units.

Now the configuration factor, F can be found:

$$F = \frac{1}{(1 + 4.657^2)^{0.5}}$$

$$F = 0.2100$$

NOTE: The configuration factor has no units.

The thermal radiation that transfers back into the fire bed can then be calculated using the configuration factor and the radiative fraction of heat transfer (0.35 multiplied by the overall HRR).

$$\dot{Q}_{Rf} = \frac{0.2100 * (0.35 * 38.9)}{2}$$

$$\dot{Q}_{RF} = 1.43\ kW$$

This means that when there is a HRR of 38.9kW in the oil fire there is 1.43kW being radiated back into the bed of the fire. As the reaction is self-sustaining it can be said that 1.43kW is enough heat to evolve the liquid fuel into gas for combustion and result in the 38.9kW HRR.

In the worst-case scenario, the hob will still be active and so the 2.0kW from the hob to the pool needs to be accounted for. It is assumed that the heat from the hob is transferred entirely into the pool fire with no loss. The 2.0kW will be defined as $\dot{Q}$S

Now that there are two heat sources available to evolve the liquid fuel into gas the original 1.43kW value changes to (QRf+Qs). Only Qs is only known now because as the HRR rate increases, the fire size increases, and so more heat is available to be radiated back into the bed of the fire. To calculate the new QRf it can be assumed to be 1.44kW initially, this will result in a much lower value for HRR, but the answer will be improved to within 1% accuracy through further calculations. The accuracy increases inverse exponentially each time the method is repeated with the new numbers.

The mass burning rate of this fire can be calculated with the follow equation:

$$\dot{m} = \frac{\dot{Q}_{Rf} + \dot{Q}_s}{L_t}$$

Lt is the specific latent heat of evaporation. The mass burn rate is linearly proportional to the heat input into the liquid. Using the values from the self-sustaining fire calculated earlier, as well as taking into account the additional 1.8kW heat source

$$\frac{1.43}{38.9} = \frac{\dot{Q}_{Rf} + \dot{Q}_s}{\dot{Q}}$$

Transpose equation to find $\dot{Q}$

$$\dot{Q} = \frac{38.9}{1.43}\left(\dot{Q}_{Rf} + \dot{Q}_s\right)$$

Using the initial 1.44kW value for $\dot{Q}$Rf the equation becomes:

$$\dot{Q} = \frac{38.9}{1.43}(1.43 + 2.0)$$

$$\dot{Q} \ = 93.31\ kW$$

Now that there is an initial estimate for HRR for the pan fire which is being supplied with heat from the hob, it can be improved upon through repeating previous steps. Finding new values for the flame length to the HRR and calculating all values repeatedly until the change in magnitude is minimal.

Second Iteration:

New Flame Length:

$$L = 0.23 * (0.65 * 240.27)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = \ 0.933\ m$$

New H:

$$H = \frac{2 * 0.905}{0.25}$$

$$H = \ 7.47$$

New F:

$$F = \frac{1}{(1 + 7.47^2)^{0.5}}$$

$$F = \ 0.133$$

New $\dot{Q}$Rf:

$$\dot{Q}_{Rf} = \frac{0.133 * (0.35 * 93.31)}{2}$$

$$\dot{Q}_{Rf} = 2.168\ kW$$

With the new $\dot{Q}$Rf found, a new estimate of HRR can be calculated:

$$\dot{Q} = \frac{38.9}{2.168}(2.168 + 2.0)$$

$$\dot{Q} \ = \ 113.44\ kW$$

Then the method is repeated again to increase accuracy:

Third Iteration

New Flame Length:

$$L = 0.23 * (0.65 * 113.44)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = 1.03m$$

New H:

$$H = \frac{2 * 1.03}{0.25}$$

$$H = 8.238$$

New F:

$$F = \frac{1}{(1 + 8.238^2)^{0.5}}$$

$$F = 0.121$$

New $\dot{Q}$Rf:

$$\dot{Q}_{Rf} = \frac{0.121 * (0.35 * 113.44)}{2}$$

$$\dot{Q}_{RF} = 2.392\ kW$$

New Heat Release Rate:

$$\dot{Q} = \frac{38.9}{1.43}(2.392 + 2.0)$$

$$\dot{Q} = 119.545\ kW$$

Fourth Iteration

New Flame Length:

$$L = 0.23 * (0.65 * 111.978)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = 1.057\ m$$

New H:

$$H = \frac{2 * 1.057}{0.25}$$

H= 8.455

New F:

$$F = \frac{1}{(1 + 8.455^2)^{0.5}}$$

$$F = 0.1175$$

New $\dot{Q}$Rf:

$$\dot{Q}_{Rf} = \frac{0.1175 * (0.35 * 119.545)}{2}$$

$$\dot{Q}_{Rf} = 2.457\ kW$$

New Heat Release Rate:

$$\dot{Q} = \frac{38.8}{1.43}(2.457 + 2.0)$$

$$\dot{Q} = 121.306\ kW$$

Fifth Iteration

New Flame Length:

$$L = 0.23 * (0.65 * 121.306)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = 1.065\ m$$

New H:

$$H = \frac{2 * 1.065}{0.25}$$

$$H = 8.517$$

New F:

$$F = \frac{1}{(1 + 8.517^2)^{0.5}}$$

$$F = 0.117$$

New $\dot{Q}$Rf:

$$\dot{Q}_{Rf} = \frac{0.117 * (0.35 * 121.306)}{2}$$

$$\dot{Q}_{Rf} = 2.476\ kW$$

New Heat Release Rate:

$$\dot{Q} = \frac{38.8}{1.43}(2.476 + 2.0)$$

$$\dot{Q} = 121.807\ kW$$

Sixth Iteration

New Flame Length:

$$L = 0.23 * (0.65 * 121.807)^{\frac{2}{5}} - 1.02 * 0.25$$

$$L = 1.067$$

New H:

$$H = \frac{2 * 1.067}{0.25}$$

$$H = 8.534$$

New F:

$$F = \frac{1}{(1 + 8.534^2)^{0.5}}$$

$$F = 0.116$$

New $\dot{Q}$Rf:

$$\dot{Q}_{Rf} = \frac{0.116 * (0.35 * 114\ )}{2}$$

$$\dot{Q}_{Rf} = 2.481\ kW$$

New Heat Release Rate:

$$\dot{Q} = \frac{38.8}{1.43}(2.481 + 2.0)$$

$$\dot{Q} = 121.95\ kW$$

After repeating enough times, the change in HRR starts to become negligible. In order to check if the newest one is accurate enough it is necessary to calculate how similar it is to the previous calculated HRR. In this particular case 121.99 kW and 121.807 kW. This can be done by calculating the percentage difference.

$$Percentage\ Difference = \frac{121.95 - 121.81}{121.95} * 100$$

The result is 0.11%. This means that the most recent calculation of HRR is less than 1% larger than the previous one, the increase from here on will be negligible.

Radiation Calculations

As calculated above for a 0.25 diameter pan fire on a 2.0 kW heat source, a HRR of 121.95 kW is estimated as a peak fire size.

The maximum radiative intensity allowed is 2.5kW/m2. To work out the radiative intensity for this case we can use the HRR of the fire and the distance to a specific point away from the pool fire. As well as the radiative fraction of heat transfer for the fire (which is still 0.35).

$$\dot{q}'' = \frac{X_r \dot{Q}}{4\pi R_0^2} \text{ (9)}$$

Where Xr is the radiative fraction, Q is the HRR of the fire and R0 is the distance to the point where radiation is to be measured. To achieve a received radiant heat flux of less than 2.5kW/m2, a separation distance of 1.17m from the centre of the cooking hob to the receiver is required. When accounting for a 500mm width of an occupant, this requires a separation distance of 1.67m from the centre of the hob to the nearest obstruction. This separation distance results in a received radiation of 2.48 kW/m2, which is below the 2.5 kW/m2 tenability criterion.

$$\dot{q}'' = \frac{0.35 * 121.99}{4\pi 1.17^2}$$

$$\dot{q}'' = 2.48 \frac{kW}{m^2}$$

It can be seen from the above analysis that the tenability criteria for escape passed a radiating source as detailed in PD 7974-6 (1) Table G.3 of 2.5kW/m2 for 30 seconds is not breached when considering the worse credible fire scenario for a cooker hob fire. As such, the above demonstrates that a separation distance of 1670mm from the centre of the hob to the nearest obstruction is acceptable with no additional fire safety features.

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