# Report

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| **Project** | Belmont Street, Camden |
| **Report Title** | Outline Fire Strategy |
| **Our Ref** | CL5956/R1 Issue 1 |

# Report

Project Belmont Street, Camden

Report Title Outline Fire Strategy

Report No. CL5956/R1
Issue No . Issue 1
Issue Date. 30/04/2020

| | Issue 1 | Issue 2 | Issue 3 | Issue 4 | Issue 5 | Issue 6 |
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| Date | 30/04/20 | | | | | |
| By | JS | | | | | |
| Checked | AM | | | | | |
| Approved | PM | | | | | |

## Contents

# 1.0 INTRODUCTION

## 1.1 Description of building

The project is a new residential development comprising of three single stair apartment blocks (blocks A, B and C).

Block A has seven storeys with a top floor height of 19.3m. Block B has ten storeys with a top floor height of 28.8m. Block C has five storeys with a top floor height of 13m. The buildings are accessed from Belmont street and Crogsland Road. The apartments at ground level are accessed direct from outside, independent of the rest of the building.

The Blocks A and C apartments are accessed by external decking at each of the upper levels. The Block B apartments are all access via an internal common corridor.

Access to the central courtyard is possible from all blocks. External gates located in the southeastern and southwestern corners of the site will provide access to the central courtyard space and will be secured with fob access.

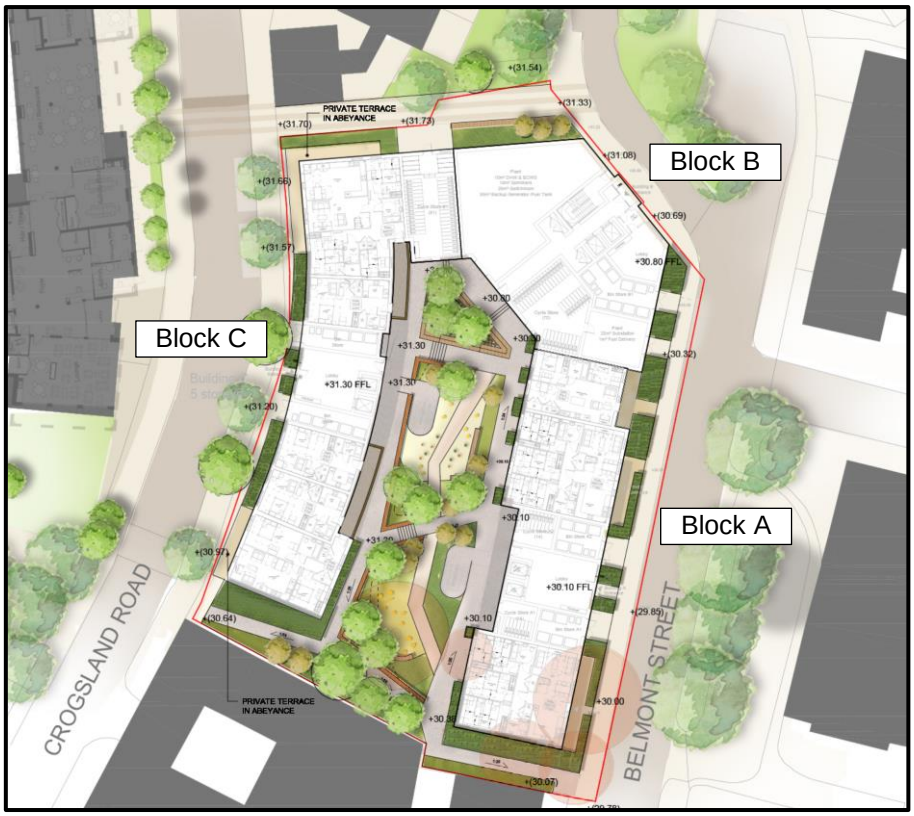



*Figure 1: Site Plan*

## 1.2 Guidance

The report draws from guidance in the Approved Document B and BS 9991: 2015 *Fire safety in the design, management and use of residential buildings*.

## 1.3 Aim of report

This report describes the Fire Strategy for the building and is intended to support the planning application and for discussion with the approving authorities.

There are some aspects of the design which don't comply with the recommendations of Building Regulations guidance. Alternative fire engineered solutions have been developed and are discussed in this report to support a more efficient design of the common areas and apartments.

# 2.0 ACTIVE FIRE SAFETY SYSTEMS

## 2.1 Sprinklers

The top floor of each block is more than 11m above ground level and all apartments will be sprinklered in line with the recent Government intent to decrease the sprinkler height requirement threshold from 30m to 11m.

The provision of sprinklers in apartments will also allow for open plan design.

## 2.2 Automatic Fire Detection and Alarm

All apartments will be provided with an automatic fire detection and alarm system to an LD1 standard to support open plan flat layouts.

An LD3 fire detection and alarm system will be provided in apartments with a protected entrance hallway no longer than 9m and achieving 30 minutes fire resistance

Smoke detection will be provided in common corridors achieving an L5 standard. These detectors are to activate the corridor/stair smoke vents. There are no fire alarm sounders in the communal corridors or stairs as is consistent with the defend in place evacuation strategy.

***Draft note – On other similar projects consideration is being given to providing a facility that would enable the fire brigade to raise the alarm in all apartments at their discretion. The project may wish to consider a similar feature in these buildings, particularly the tallest building.***

# 3.0 MEANS OF ESCAPE FROM FLAT

## 3.1 Evacuation Strategy

The building will operate a defend in place evacuation strategy where the alarm will be raised in the fire flat only. The alarm in the other apartment will not be raised.

## 3.2 Apartment Layouts

### 3.2.1 Studios

The proposals include apartments with escape distances up to 12m from the balcony. This is in excess of the 9m recommended limit. This is proposed based on the provision of sprinklers and a LD1 fire detection and alarm system.

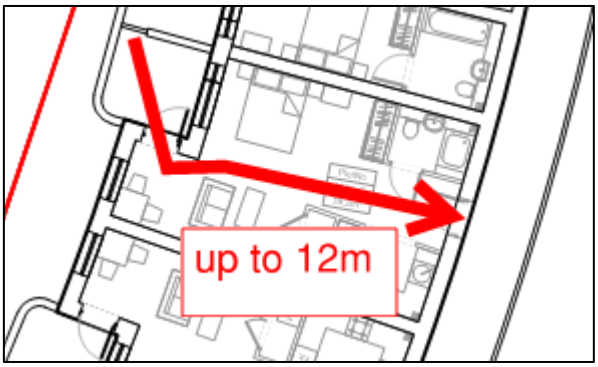



*Figure 2: Studios Means of Escape*

### 3.2.2 Apartment with Entrance Hallway

The proposals include a number of apartments provided with an entrance hallway. The entrance hallway will achieve 30 minutes fire resistance and the apartment provided with a LD3 fire detection and alarm system.


*Figure 3: Entrance Hallway*

### 3.2.3 Open Plan Apartments

The proposal includes open plan apartments. The apartment will be sprinklered and provided with a LD1 fire detection and alarm system.

BS 9991 recommends that kitchens in open-plan apartments should be enclosed if the dimensions of the apartments are more than 8m x 4m. There are many apartments that exceed these dimensions with unenclosed kitchens.

The recommendation in BS9991 comes from research carried out by the Building Research Establishment on behalf of the NHBC Foundation. The research involved a number of studies of apartments of varying size, using computational fire modelling to compare code compliant layouts in unsprinklered apartments with open-plan layouts in sprinklered apartments. The code compliant apartments were designed following the guidance of the Approved Document B (ADB) and had rooms accessed from a protected hallway.

The studies only covered apartments up to 16m x 12m, and kitchens were open to the living area in smaller apartments up to 8m x 4m, but enclosed in larger apartments. The conclusion of the studies was that sprinklers provided better conditions for apartment occupants than an ADB-compliant layout, but that further work was required to study the effect of larger apartment dimensions and the design of kitchens. The research did not conclude that open kitchens in larger apartments would present an additional danger to occupants, because that was not covered by the research carried out.

As this issue was not specifically addressed additional research has been referenced in the development of the fire strategy, this is described in Appendix A.

### 3.2.4 Hob Location in Studios and Open Plan Apartments

In the studio and open plan apartments the kitchen hob will be located at least 1.8m from the escape route to the apartment entrance. This should be sufficient to allow occupants escape past the hob fire and ensure that radiant heat does not exceed 2.5kW/m$^2$. Additional research has been referenced in Appendix B.

# 4.0 MEANS OF ESCAPE FROM COMMON AREAS

## 4.1 Block B Common Corridor

Apartments in Block B share a common corridor that provides access to the stair and lifts.

Guidance recommends travel distances within common corridors do not exceed 15m in a single direction where the flats are sprinklered and the corridor smoke vented. Travel distances are within recommended limits.

The corridor will be provided with a 1.5m$^2$ natural vent on all floors. Alternatively, the corridor smoke venting can be provided by either a 1.5m$^2$ natural smoke shaft, or mechanical smoke shaft, serving all floors.

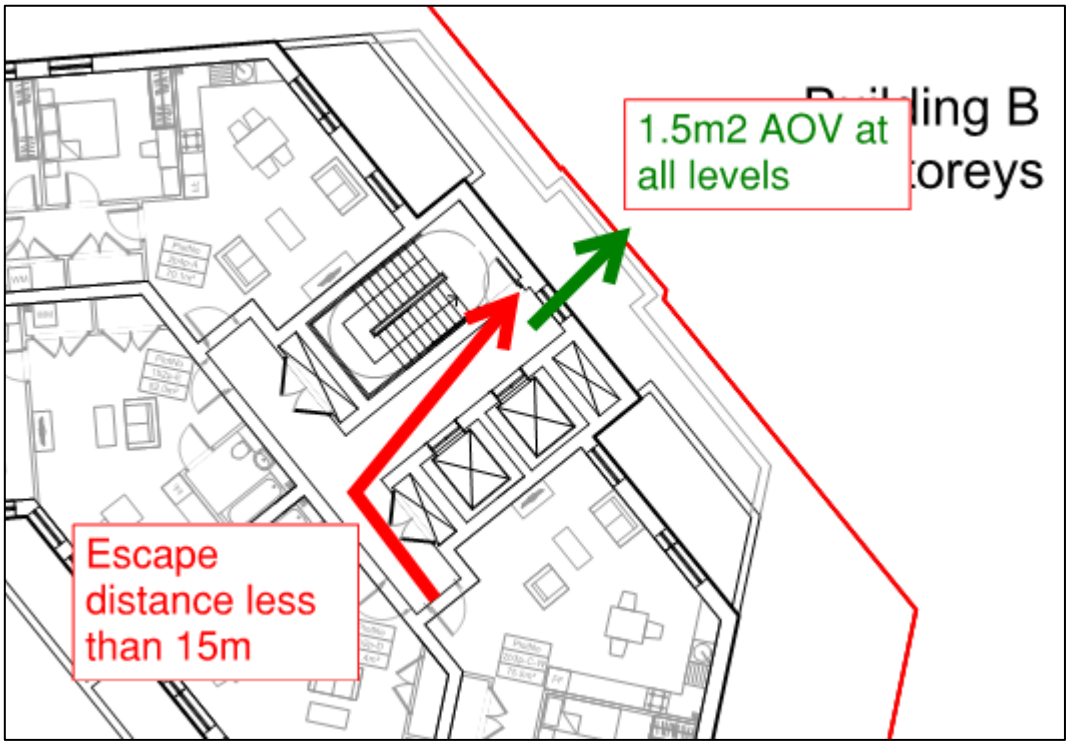



*Figure 4: Block B Corridor Smoke Venting*

## 4.2 Balcony Deck Approach – Block A and Block C

Apartments in Block A and C are accessed via a common external balcony as shown in Figure 5. There are no travel restrictions from the apartment entrances to the stair provided the hose coverage limits from a fire main to the furthest point of an apartment are not exceeded for firefighting purposes. Limits are not exceeded in either case.

As there is only a single direction of escape, the following provisions are proposed to protect people who might have to escape past an apartment on fire,

- At least 50% of the vertical section of the deck will be open to allow smoke to disperse.
- The face of the building will provide at least 30 minutes fire resistance, at least up to a height of 1.1m above deck level. See section 5.1 for additional Block A protection.
- Doors opening onto the deck will be FD30S self-closing doors.
- Windows or similar non fire rated openings will not be located below a height of 1.1 m above the deck level.

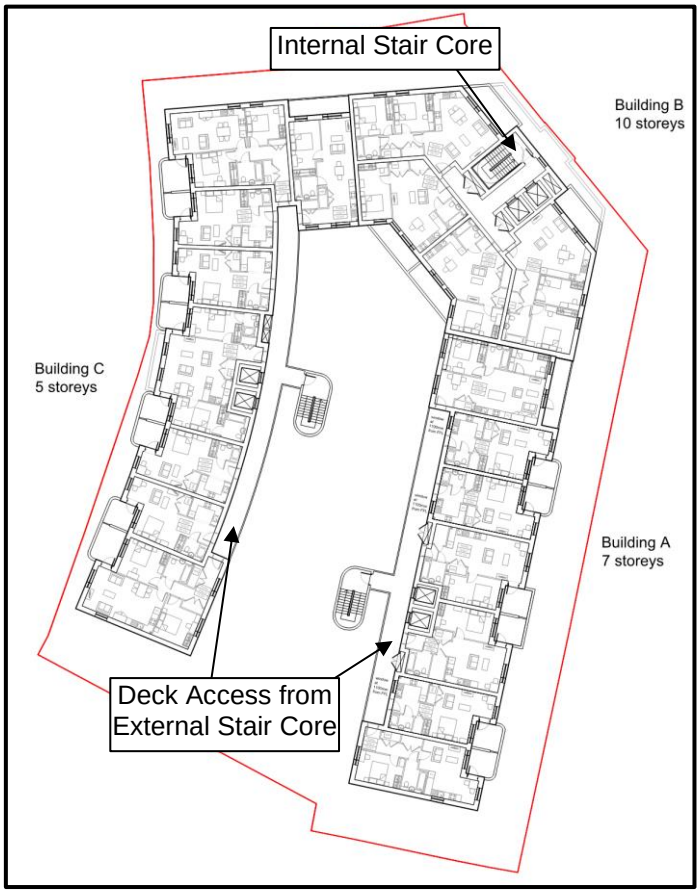



*Figure 5: General Floor Plan*

## 4.3 Stairs

### 4.3.1 General

The stair for each block will be at least 1.1m wide to allow for firefighting access and will be provided with a 1m² AOV at the head of the stair.

The final escape from the stair should be treated as if it is a part of the stair. The stair should therefore discharge directly to outside or by way of protected corridor.

### 4.3.2 Blocks A and C

Stairs serving Blocks A and C open directly to outside on the ground floor. Residents can then escape from the central courtyard via the external gates or through a fire-sterile lobby to the street.

The lobby of both blocks contain post-boxes. These will be enclosed in 30-minute fire resistant construction.

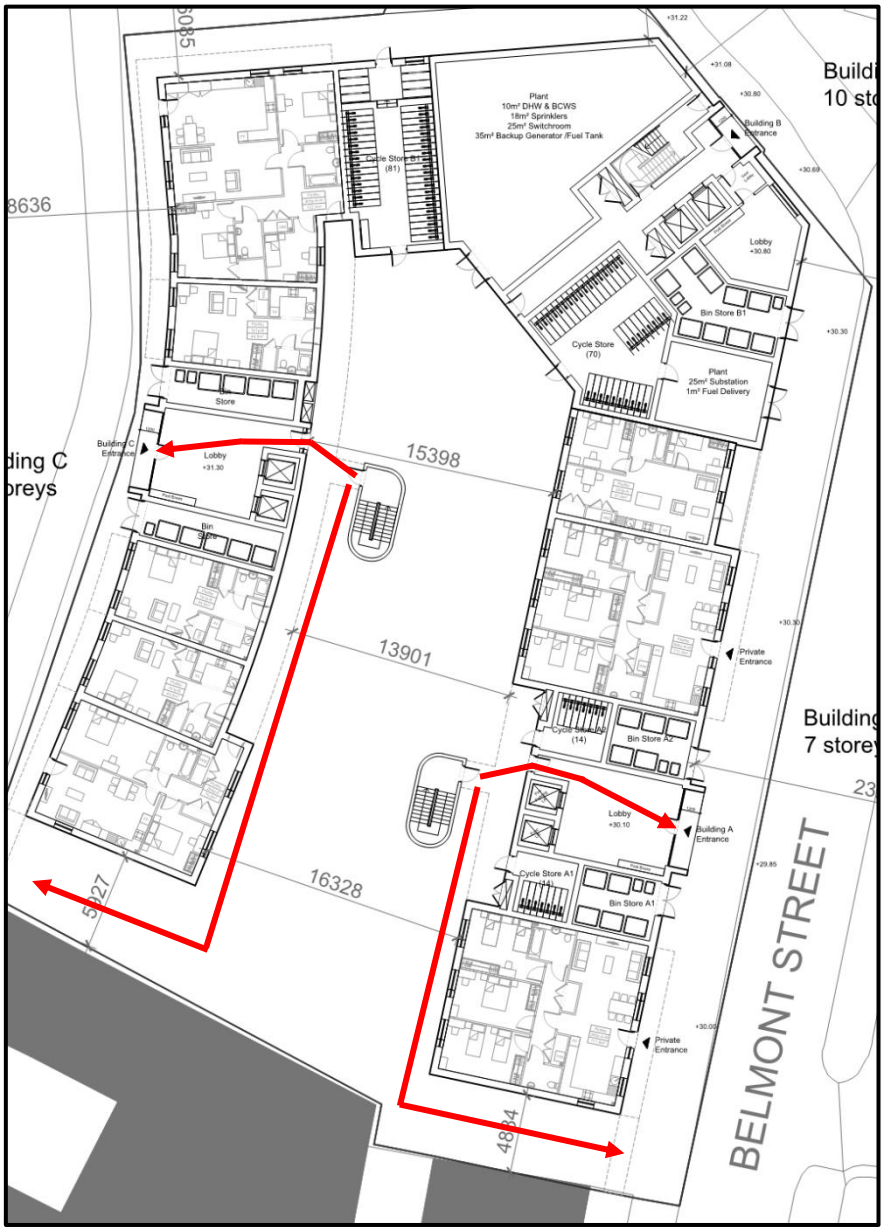



*Figure 6: Escape from Blocks A and C*

### 4.3.3 Block B

Escape from Block B is via a fire-sterile corridor and out to Belmont Street. An alternative route through the central courtyard is also exists.

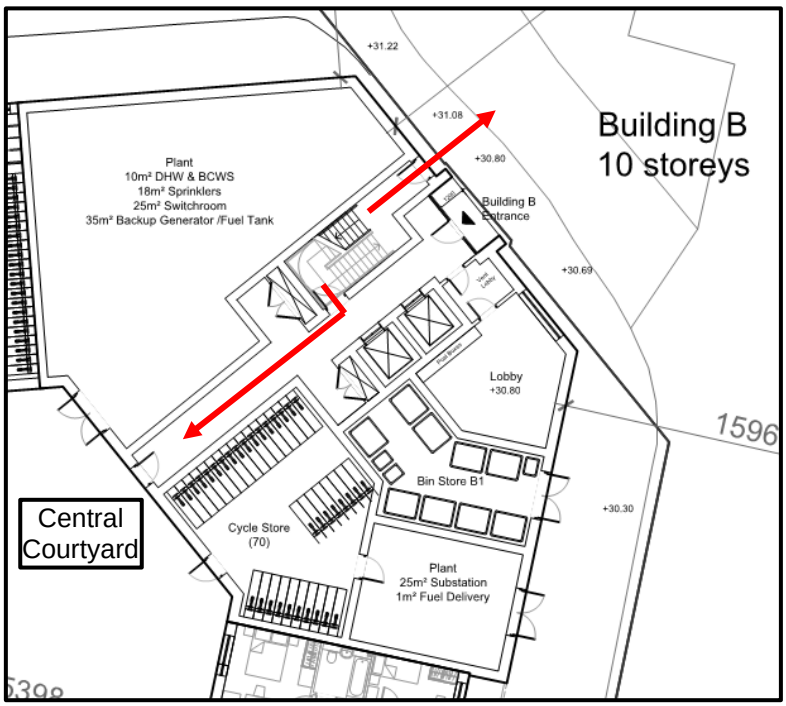



*Figure 7: Escape from Block B*

## 4.4 Mobility Impaired Occupants

The provisions provided in an apartment building are designed to minimise the risk of fire spread beyond the flat on fire and allows the residents of non-fire flats to stay in their own homes ("defend in place" strategy). This strategy applies to all occupants both able bodied and mobility impaired.

For that reason, Building Regulations guidance does not make any specific recommendation for the need for any additional features to assist mobility impaired occupants who use the building.

The "intend to publish" London Plan, however, states that buildings should be designed to facilitate a dignified escape for occupants of restricted mobility. Blocks A and B are tall enough to need fire fighting lifts. These could be used by mobility impaired occupants to escape. However, to avoid any potential conflicts between escaping occupants and fire fighters who may both need to use the lift at various points, it is proposed that one of the other lifts in each core is also designed as a fire fighting lift or evacuation lift.

Block C isn't tall enough to need a fire fighting lift. However, one of the lifts in that core will be designed as either a fire fighting lift or evacuation lift.

# 5.0 FIREFIGHTING

## 5.1 Firefighting Shaft

Blocks A and B have a top floor height above 18m from firefighting access level. Therefore, a firefighting shaft with a firefighting lift will be provided.

Both the external stair of Block A and the internal stair of Block B will be at least 1.1m wide with a 1m$^2$ AOV at the head of the stair. Dry fire main outlets will be provided within the stair enclosure at each level to ensure adequate hose coverage to apartments, see Section 5.2. The firefighting lift will be within 7.5m of the door to the firefighting stair.

In Block B, the lift, stair and access route for the fire brigade at ground floor will be enclosed in 2 hours fire resisting construction.

In Block A, the stair is external and is more than 5m away from any non-fire rated windows. All parts of the flat elevations will be full height fire rated and provided with fire rated doors. All flats will be sprinklered. It is proposed that the stair will be enclosed in non-fire rated construction. The fire fighting lift will be enclosed in 2 hours fire rated construction.

Block C has a height below 18m and does not need a firefighting shaft. However, a dry riser main will be provided in the stair. Fire fighting provision are summarised in the following figure: -

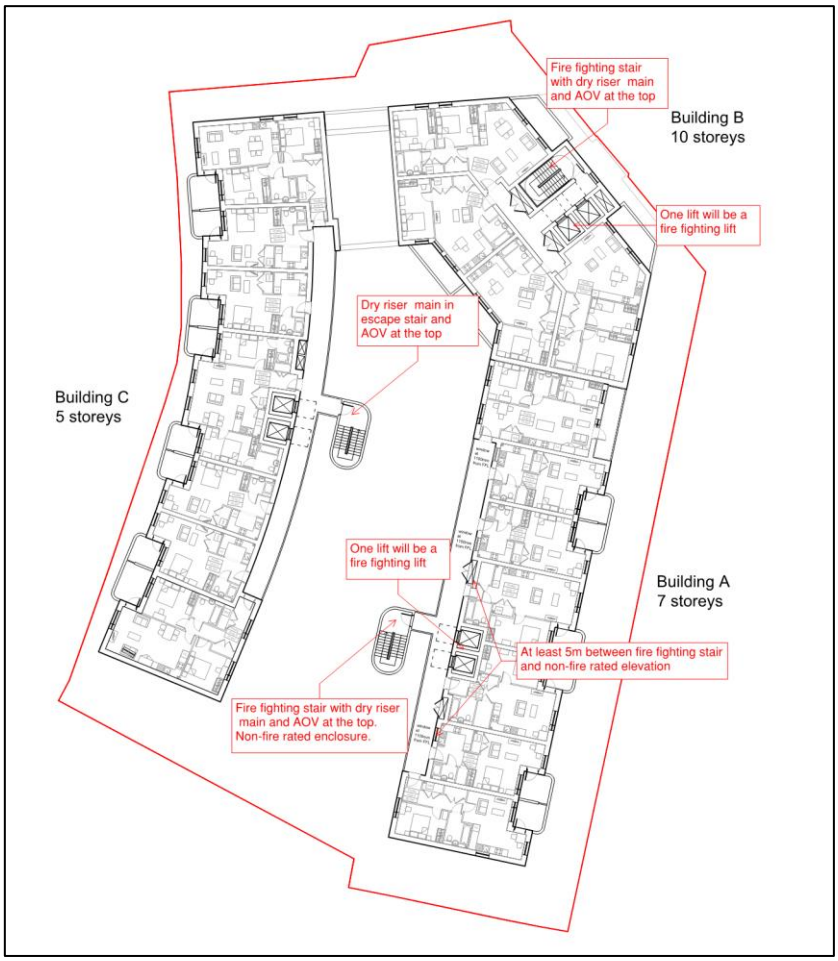



*Figure 8: Fire Fighting Facilities*

## 5.2 Hose Coverage

Hose cover for ground floor apartments, accessed from the street without fire mains can be up to 90m. This is achieved.

Hose cover is within 60m of a fire main outlet as shown in the following Figure 9.

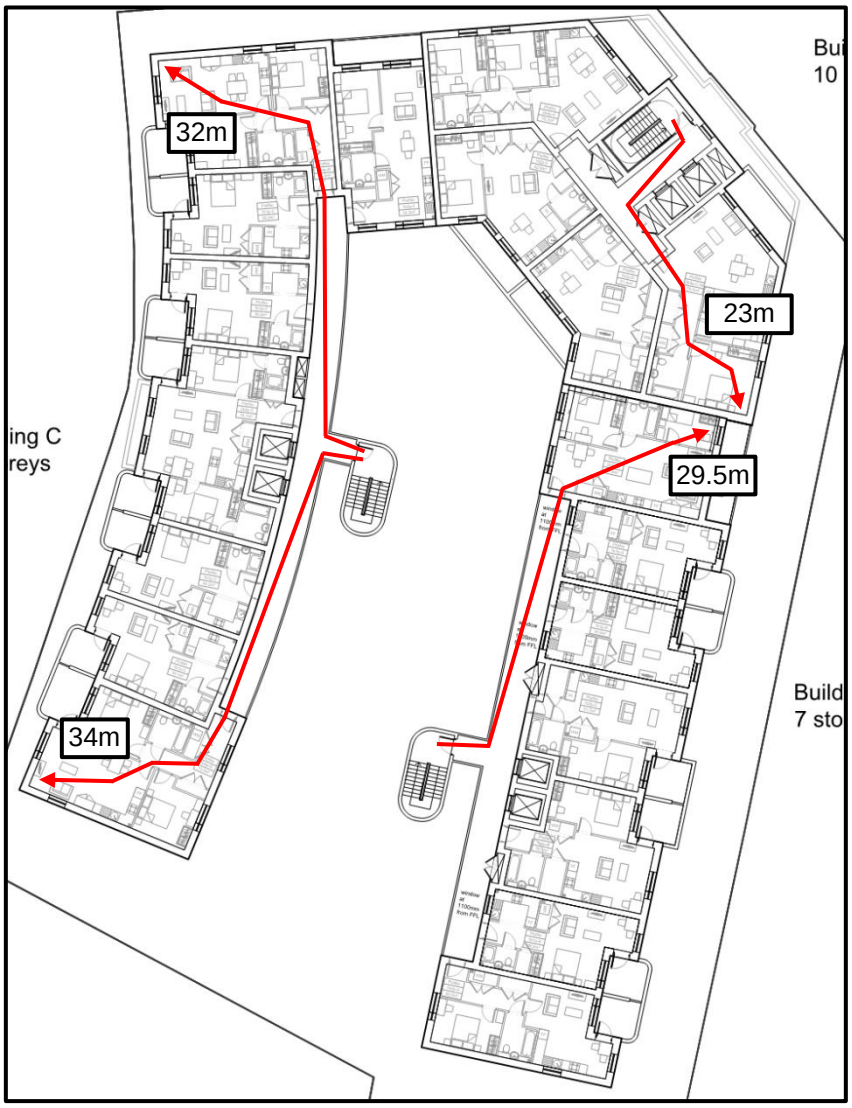



*Figure 9: Hose Coverage*

## 5.3 Fire Vehicle Access

Vehicle access is via Crogsland Road and Belmont Street. Belmont Street leads to a dead-end however adjoining roads will provide turning positions.

The inlet points for the dry fire mains will be located on the external elevation of each block, near the main entrance. Inlets will be positioned to allow for a fire vehicle to park within 18m and in sight of the inlet. Outlets will be located within the stair enclosures at each level to ensure adequate hose coverage to apartments.

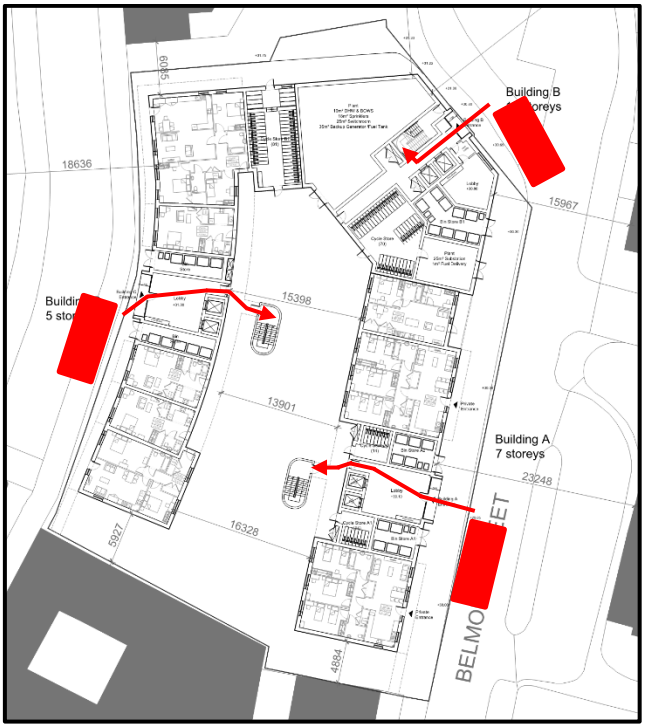



*Figure 10: Firefighting Access*

# 6.0 STRUCTURE AND COMPARTMENTATION

## 6.1 Structure

The structure of Block A and Block B will achieve 90 minutes fire resistance.

The structure of Block C will achieve 60 minutes fire resistance.

## 6.2 Compartmentation

The following will be constructed as compartment walls achieving at least 120 minutes fire resistance:

- Walls enclosing the Fire Fighting Stair with FD60S fire doors in Block B.
- Walls enclosing the Fire Fighting Lift with FD60 fire doors.
- Walls enclosing the Firefighter access route at ground floor.

The following will be constructed as compartment walls or floors which achieving at least 90 minutes fire resistance in Block A and Block B: -

- All floors.
- Walls enclosing risers with FD60 fire doors.

The following will be constructed as compartment walls or floors which achieving at least 60 minutes fire resistance in Block C: -

- All floors.
- Walls enclosing risers with FD60 fire doors;.

The following will be constructed as compartment walls achieving at least 60 minutes fire resistance in all Blocks: -

- Walls between flats;
- Walls between flats and common areas with FD30S fire doors;
- Passenger lifts;
- Walls enclosing ancillary spaces with FD30 fire doors.

Balconies will be fire rated from the underside and will achieve the same fire resistance as the building they are located. The vertical partition between any two adjoining balcony will achieve 60 minutes fire resistance.

Party walls separating the blocks will achieve 90 minutes fire resistance.

## 6.3 Cavity Barriers and Fire Stopping Materials

Cavity barriers and fire stopping materials will be provided in line with the recommendations of the Approved Document B and BS 9991.

## 6.4 Wall and Ceiling Linings

Wall and ceiling linings will be provided in line with the recommendations of the Approved Document B and BS 9991.

## 6.5 Roof Coverings

Roof covering will be provided in line with the recommendations of the Approved Document B and BS 9991.

# 7.0 ELEVATIONS

## 7.1 Site Boundary Description

The site is bounded by Crogsland Road to the west; Belmont Street to the east; and the Denton Estate to the north. To the south, the site is bounded by a two-storey commercial building in light industrial use, as well as three-storey residential properties fronting Belmont Street. The site is relatively flat and level with Belmont Street. However, there are significant level changes between the site and Crogsland Road, along the western site boundary, and pedestrian footpath along the northern site boundary.

## 7.2 Non Fire Rated Construction

There are no limits on the extent of glazing to the apartments facing the streets. The elevations of the apartments opening onto the common balcony will be fire rated and achieve at least 30 minutes fire resistance. In block B, this will increase to at least 1 hour to part of the elevation within the 5m of the fire fighting stair.

## 7.3 External Walls Construction

Blocks A and B have a top floor more than 18m above ground floor. The materials used in the external wall construction will be designed to meet the requirements of Regulation 7.

Products which form part of the external wall construction (including balconies) will achieve European Class A2-s1, d0 or Class A1, with the exception of sealants, gaskets, doors and windows (including frames); (see regulation 7(3) for the full list of exemptions).

Membranes within the external wall should achieve a minimum Class B-s3, d0.

# 8.0 FIRE SAFETY MANAGEMENT

## 8.1 General

Once the building is occupied, it is the responsibility of the management to ensure that all fire safety systems are tested and maintained to ensure their continuous effectiveness. The management should: -

- Be aware of all the fire safety features provided and their purpose
- Liaise with and seek the advice of the fire authority

## 8.2 Staff

Staff should be trained by competent persons. The training should be at regular intervals and should ensure that all staff know what to do if a fire is discovered; the correct response on hearing a fire alarm, and the correct escape procedures from every part of the building.

A management structure should be provided to ensure that in the case of fire staff are aware of their responsibilities, which should be clearly defined. A chain of command should be provided with clear lines of responsibility, authority and accountability.

## 8.3 Fire Safety Manual

Before a building is occupied, a fire safety manual should be completed. The purpose of the manual is to clearly define the nature of the fire safety systems provided for the building. It should include: -

- An explanation of the overall fire safety strategy
- Evacuation procedures
- Design documentation to describe the use of each fire safety system
- Staff roles in the event of a fire: their responsibility, authority and accountability
- A detailed maintenance routine

The Fire Safety Manual should be reviewed periodically and when any alterations are made to the building. Details of the suggested contents of the fire safety manual are provided in Section 19 of the Approved Document B and Annex H of BS 9999 Code of practice for fire safety in the design management and use of buildings.

## 8.4 Maintenance and Housekeeping

It is the role of management to ensure that maintenance is carried out in accordance with the relevant British Standards, so that all fire safety systems are operational in the event of a fire. It is also important that good housekeeping practices are followed. The building management should be aware of any hazardous substances or practices within the building, which increase the risk of fire.

## 8.5 The Regulatory Reform (Fire Safety) Order 2005

This Order places a duty on the 'responsible person' to ensure, 'as far as is reasonably practical' the safety of his employees and to take such general fire precautions as may be reasonably required to ensure that the premises are safe [i.e. for non-employees].

Under the Order, there is a requirement to carry out and continually update an assessment of the risk of fire to people in and around the premises/building, and to assess and maintain the measures to reduce those risks to an acceptable level. Where there are five or more employees, the risk assessment must be recorded.

A Fire Risk Assessment should be carried out:-

1. On completion of the building fit out, and strictly before first occupation of the building.
2. Regularly, particularly where any changes occur such as changes in the use of the building, the number or nature of occupants, or building works.
3. We would recommend that a fire risk assessment is carried out at least annually.

Other legal duties include: -

1. Keeping a record of the Fire Safety Arrangements. These are the preventative and protective measures for the building.
2. A person must be nominated for any special role identified in an emergency plan.
3. Employees must be consulted about nominations to perform special roles, and about any proposals for improving the fire precautions.
4. Other employers in the building must be informed about any significant risks, which might affect the safety of their employees, and there must be co-operation with them in measures to reduce the risk.
5. Those having control over the workplace have a responsibility to ensure compliance with the regulations in those parts of the building over which they have control.
6. A suitable and readily available method of calling the emergency services must be established.
7. Employees are required to co-operate in ensuring that the workplace is safe from fire.

The order also adopts 'Principles of Prevention'. These include:-

- Avoiding risks;
- Evaluating the risks which cannot be avoided;
- Combating the risks at source;
- Adapting to technical progress;
- Replacing the dangerous by the non-dangerous or less dangerous [particularly with respect to hazardous substances];
- Developing a coherent overall prevention policy which covers technology, organisation of work and the influence of factors relating to the working environment, and;
- Giving appropriate instructions to employees.

# 9.0 INFORMATION, LIMITATIONS AND ASSUMPTIONS

The information limitations and assumptions used in the preparation of this report are noted below: -

## Drawings

This report is based on drawings issued to us. Dimensions have been taken from these drawings. The following drawings were used: -

200406-CHA-HTA-A-0100-Floor Plan Level 00
200406-CHA-HTA-A-0101-Floor Plan Level 01-03
200406-CHA-HTA-A-0104-Floor Plan Level 04
200406-CHA-HTA-A-0105-Floor Plan Level 05-06
200406-CHA-HTA-A-0107-Floor Plan Level 07-09
200406-CHA-HTA-A-0110-Floor Plan Level 10
200406-CHA-HTA-A-0211-Proposed Elevations - Outer Facing-1-1-100
200406-CHA-HTA-A-0212-Proposed Elevations - Outer Facing-2-1-100
200406-CHA-HTA-A-0213-Proposed Elevations - Outer Facing-3-1-100
200406-CHA-HTA-A-0214-Proposed Elevations - Outer Facing-4-1-100
200406-CHA-HTA-A-0215-Proposed Elevations - Outer Facing-5-1-100
200406-CHA-HTA-A-0220-Proposed Elevations - Courtyard-8-1-100
200406-CHA-HTA-A-0221-Proposed Elevations - Courtyard-9-1-100
200406-CHA-HTA-A-0222-Proposed Elevations - Courtyard-10-1-100
200406-CHA-HTA-A-0223-Proposed Elevations - Courtyard-11-1-100
200406-CHA-HTA-A-0251-Section AA
200406-CHA-HTA-A-0252-Section BB
200406-CHA-HTA-L-0905_Ground Floor Illustrative Plan

## Building Regulations

This report considers building regulations, which deal with life safety. Property protection and insurance issues are not addressed in this report. Guidance on property protection and insurance requirements can be found in the document *Approved Document B: Fire Safety (Volume 2) – Buildings other than dwellinghouses Incorporating Insurers' Requirements for Property Protection,* RIBA Publishing 2015.

## Other Limitations

Complying with the recommendations of this report will not guarantee that a fire will not occur.

Unless otherwise described in this report, the fire strategy assumes that the building design, the mechanical and electrical systems, construction methods and materials specifications will comply with current Building Regulations guidance, and relevant British Standards and Codes of Practice. The design of mechanical and electrical systems such as fire alarm and sprinklers is a specialist area. Fire Strategy recommendations are given in this report, however, the design and specifications need to be developed at the appropriate stage in consultation with the specialist designers of these systems.

This report has been prepared for the sole benefit, use and information of Vistry Partnerships Limited and the liability of Jeremy Gardner Associates Limited, its directors and employees in respect of the information contained in the report will not extend to any third party.

# APPENDIX A RESIDENTIAL SPRINKLER RESEARCH

## Tenable Conditions

The table below summaries the recommended tenability criteria given in BS 7974-6:

| Combustion Product | Period of Exposure | Extent of exposure |
|---|---|---|
| Temperature | >30 minutes | <60ºC (100% saturated) |
| Temperature | 8 minutes | 100ºC (<10% $H_2O$) |
| Temperature | 6 minutes | 110ºC (<10% $H_2O$) |
| Temperature | 4 minutes | 120ºC (<10% $H_2O$) |
| Temperature | 3 minutes | 130ºC (<10% $H_2O$) |
| Temperature | 2 minutes | 150ºC (<10% $H_2O$) |
| Temperature | 1 minute | 180ºC (<10% $H_2O$) |
| Carbon Monoxide | 5 minutes | 800ppm |
| Carbon Monoxide | 30 minutes | 125ppm |

*Table 2: Tenability Criteria (Temperature and CO)*

BS7974 recommends a limit of 5m visibility for small compartments and 10m for large compartments. These figures do not take into account familiarity and are therefore conservative in a residential building.

## BRE Project Report 204505

In 2004 the Building Research Establishment carried out a study into residential sprinkler systems and published the report '*Effectiveness of Sprinklers in Residential Premises: BRE Project Report 204505'.*

The pilot study carried out by the BRE as part of this project concluded that the combination of sprinklers and linked smoke alarms in the rooms and circulation spaces would reduce deaths by 83% and injuries by up to 85%.

The report describes experiments carried out by the BRE on eight sprinklered and unsprinklered lounge fires in a two-storey dwelling house with a loft conversion. The duration of each house fire test was 30 minutes.

The experiments demonstrated the following:

**Unsprinklered lounge fire**

- Without sprinklers, conditions in the lounge became unsurvivable within 15 to 20 minutes.
- Visibility in the room of origin was reduced to less than 2m within 5 to 7 minutes.
- With an open plan lounge, or a standard lounge with the doors open, fires without sprinklers would eventually cause untenable conditions in all open spaces throughout the house.

**Sprinklered lounge fire**

- The sprinklers controlled all fires.
- The sprinklers extinguished some of the fires.
- For sprinklered fires, the fire-damaged area was less than when unsprinklered.

With sprinklers, the fire gases were cooled sufficiently so that the occupants of the room of origin would not have experienced extreme pain due to convected heat.

- Sprinklers significantly reduced the Fractional Effective Dose (FED) in the room of origin. In all but one test sprinklers maintained tenable conditions in the room of fire origin in terms of toxic effects. In the other test unconsciousness due to asphyxiants was estimated to have occurred approximately 25 minutes after ignition.
- Visibility in the room of origin was reduced to less than 2m within 5 minutes.
- Tenable conditions (apart from visibility) were achieved throughout the house in the sprinklered tests.

These tests demonstrate that sprinklers are effective in providing more time for occupants to escape. Not only would tenable conditions be maintained within the remainder of the house but also occupants of the room of fire origin would not have died.

As part of the same research project the BRE carried out 29 further fire tests considering a series of three adjacent compartments. Fires in beds, sofas, televisions and tables were modelled. The conclusions from these fires are broadly similar to those from the house fire tests:-

- Conditions became unsurvivable in all unsprinklered tests.
- Sprinklers significantly reduced temperature in the room of fire origin.
- Sprinklers maintained tenable conditions in terms of toxic effects for television and bed fires.

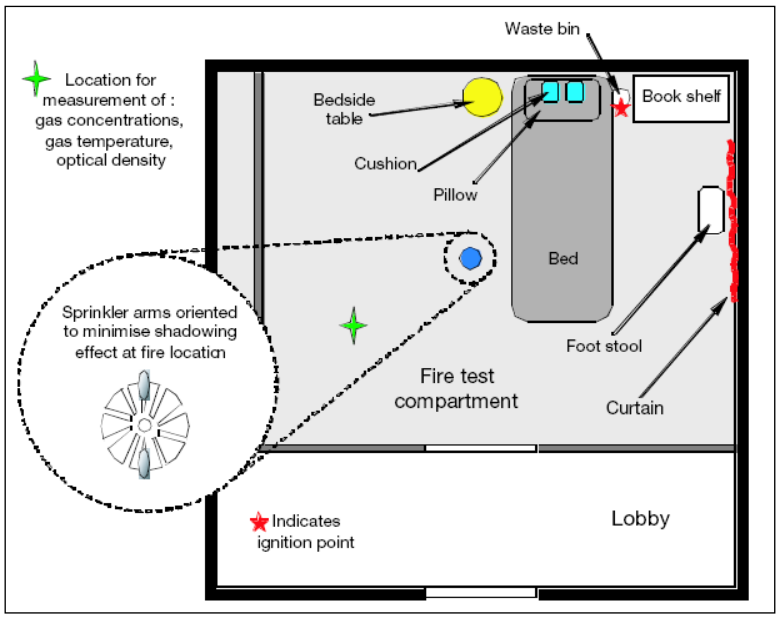
Untenable conditions in terms of toxic effects did occur in the sprinklered table fires. The time to unconsciousness varied between 5 and 10 minutes. Sprinklers reduced temperatures such that these were tolerable for a significant period of time (>30 minutes). In contrast, in the unsprinklered tests occupants would have experienced extreme pain after 2.5 to 3 minutes

## DCLG Fire Research Technical Report 2/2007

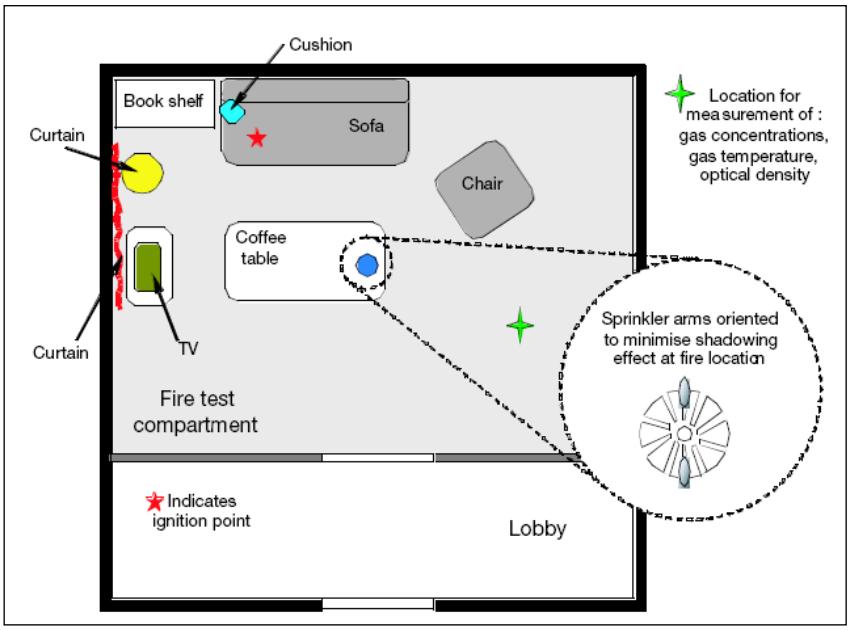
THE FPA were commissioned to carry out research into providing a low cost residential fire suppression system for the UK housing sector. As part of this project a series of practical fire trials were carried out to demonstrate and assess the effectiveness of sprinkler systems under realistic conditions.

## Bedroom & Lounge Fires

The bedroom tests were based on a fire occurring in a wastepaper bin adjacent to the bed and bookcase, which contained books and other combustibles. The arrangement of the fuel in relation to the fire was intended to encourage rapid fire spread to challenge the sprinkler system.




In the lounge the fire started on a sofa immediately adjacent to a bookcase. The sofa padding was constructed from non modified foam.

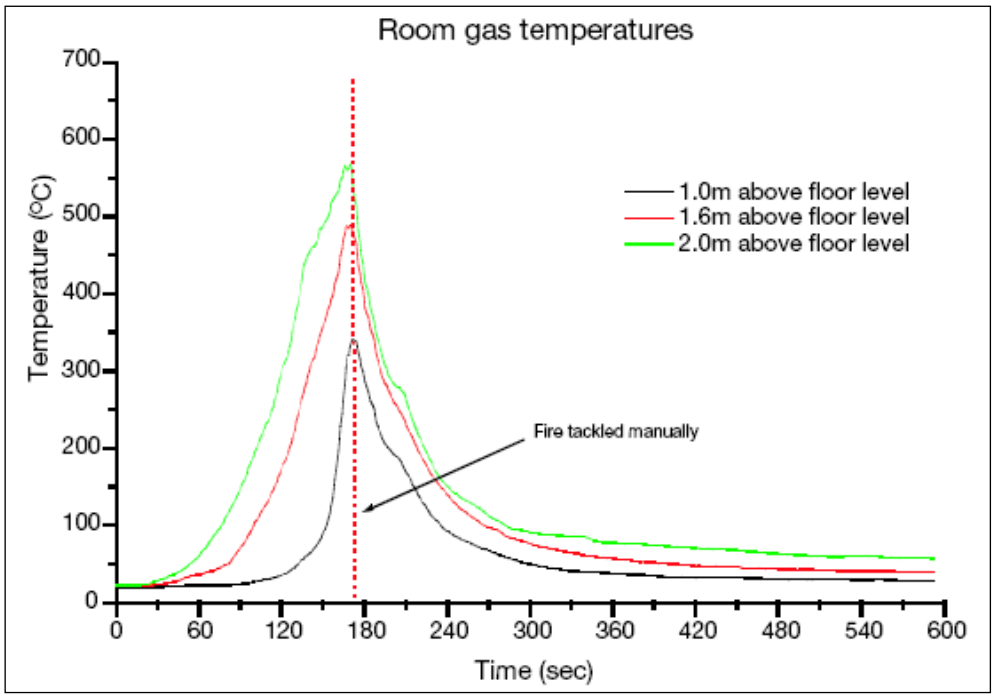



A concealed sprinkler was used in the tests. The results are summarised below:-

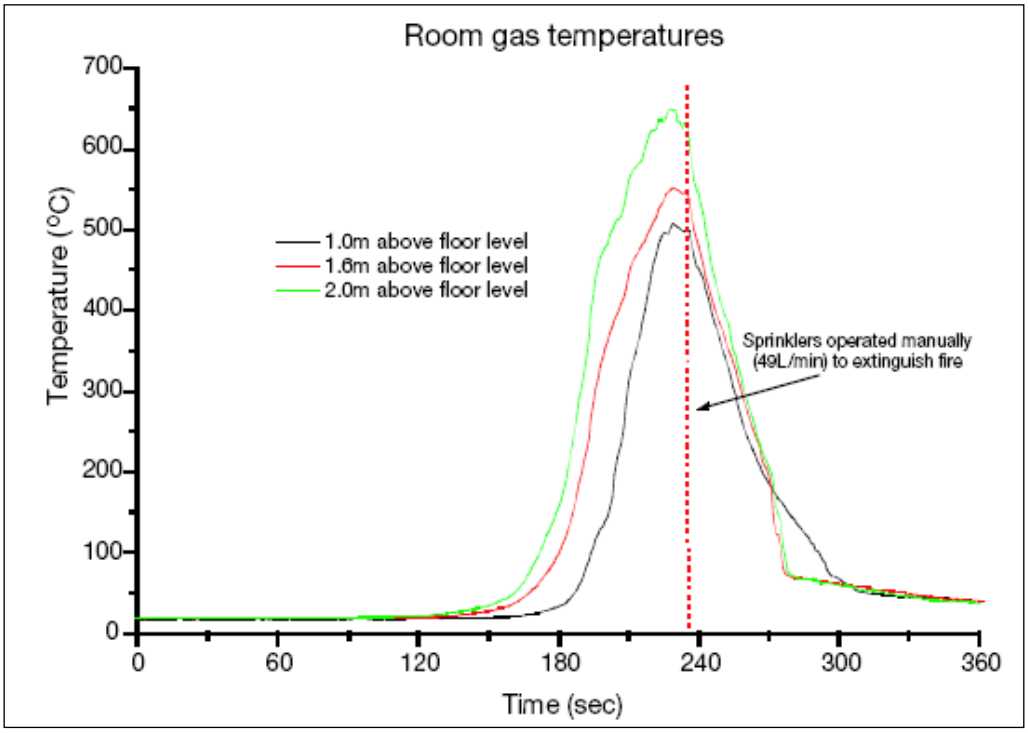
### Unsprinklered Rooms

- Rapid fire development occurred in the unsprinklered bedroom and lounge.

- Flashover occurred after 2 mins 30 secs in the bedroom and 3 mins and 15 secs in the lounge.



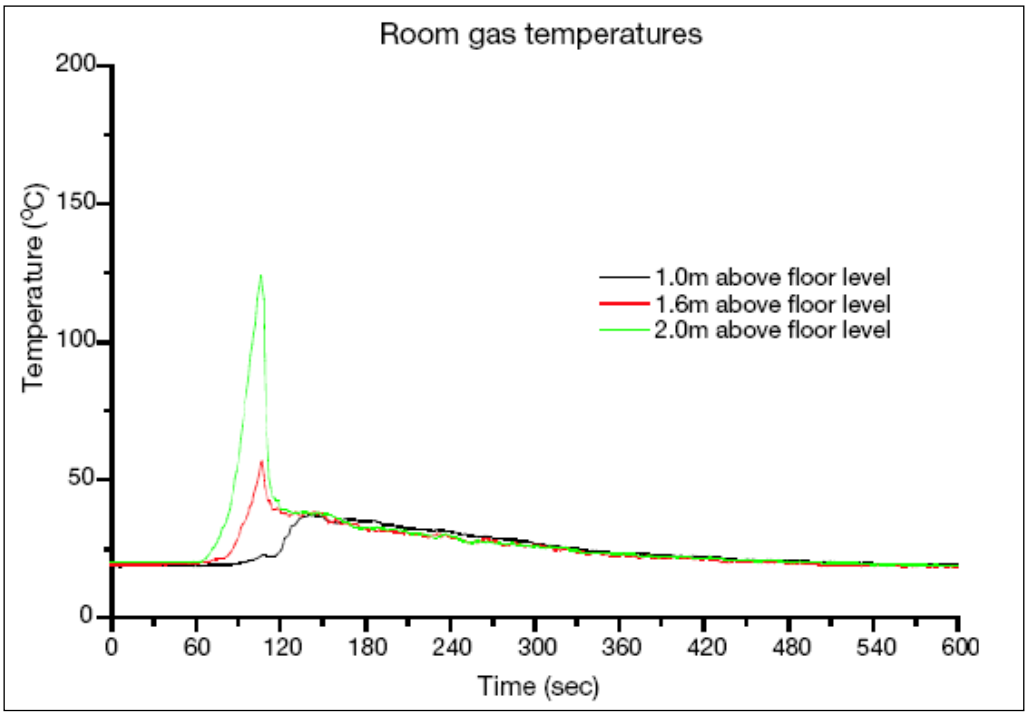

*Unsprinklered bedroom fire*




*Unsprinklered lounge fire*

### Sprinklered Bedrooms

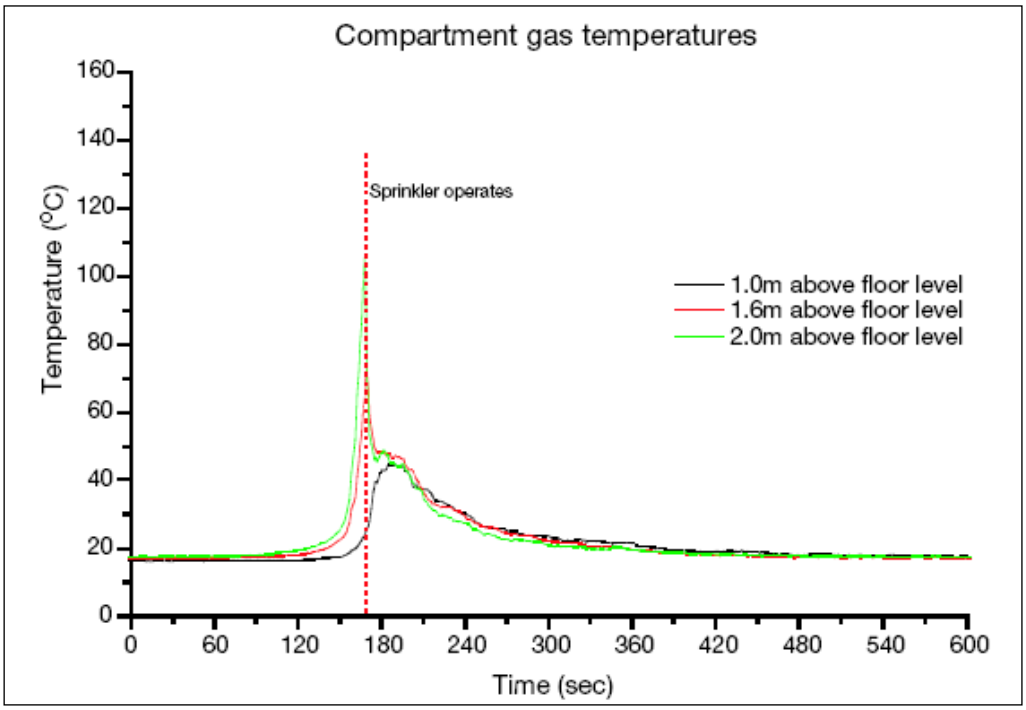
- In both sprinklered bedroom tests the sprinklers activated after approximately 2 minutes.
- Fire was controlled and mostly suppressed although there is still some limited burning on the shelves.
- Room gas temperatures peaked at 125 deg C at 2m above floor level. At head height temperatures in the room were a maximum of approximately 60 deg C.




*Sprinklered bedroom fire*

### Sprinklered Lounge

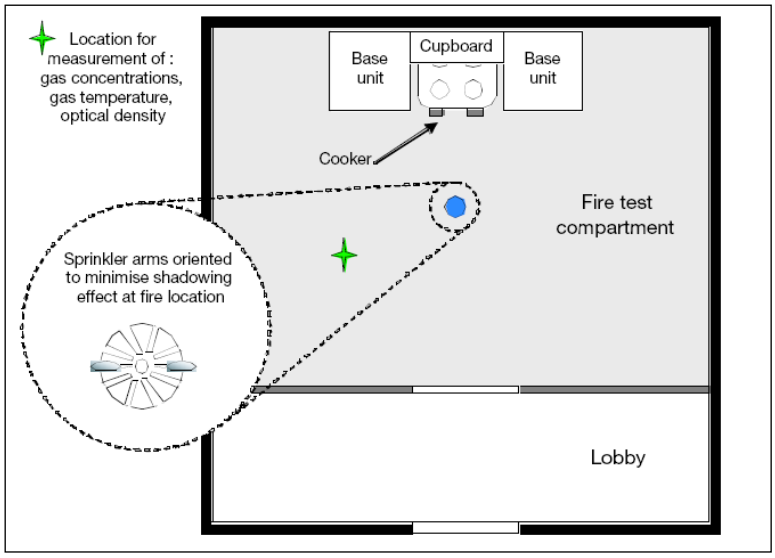
- In both sprinklered tests the sprinklers operated after approximately 3 minutes.
- The fires were controlled and mostly suppressed although there was some residual burning on the sofa cushions.
- Temperatures in the room peaked at approximately 120 deg C (2m above floor level) prior to sprinkler activation. At head height temperatures of up to 90 deg C occur. These were quickly reduced once sprinklers activated.




*Sprinklered lounge fire*

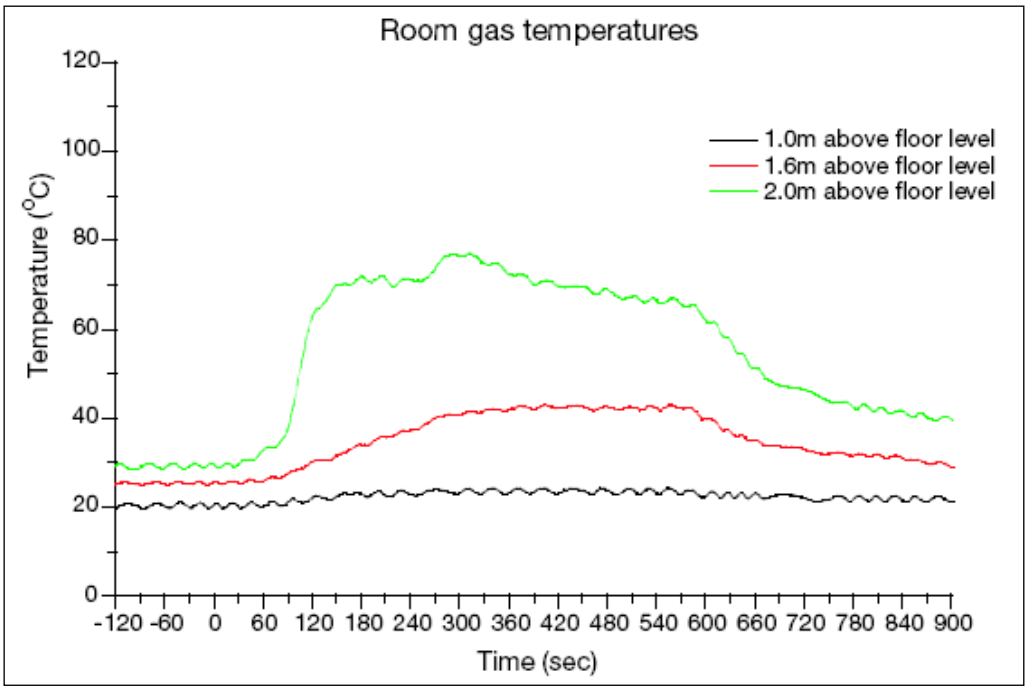
## Kitchen Fire Scenario

The kitchen fire tests were based on a chip pan fire. A two litre pan was used filled with one litre of pure vegetable oil. Several tea towels were draped over the top of the cooker grill pan to provide an opportunity for flame spread from the chip pan (layout shown below). The pan was left on a lit stove to reach its auto ignition temperature. This occurred after approximately 50 minutes.



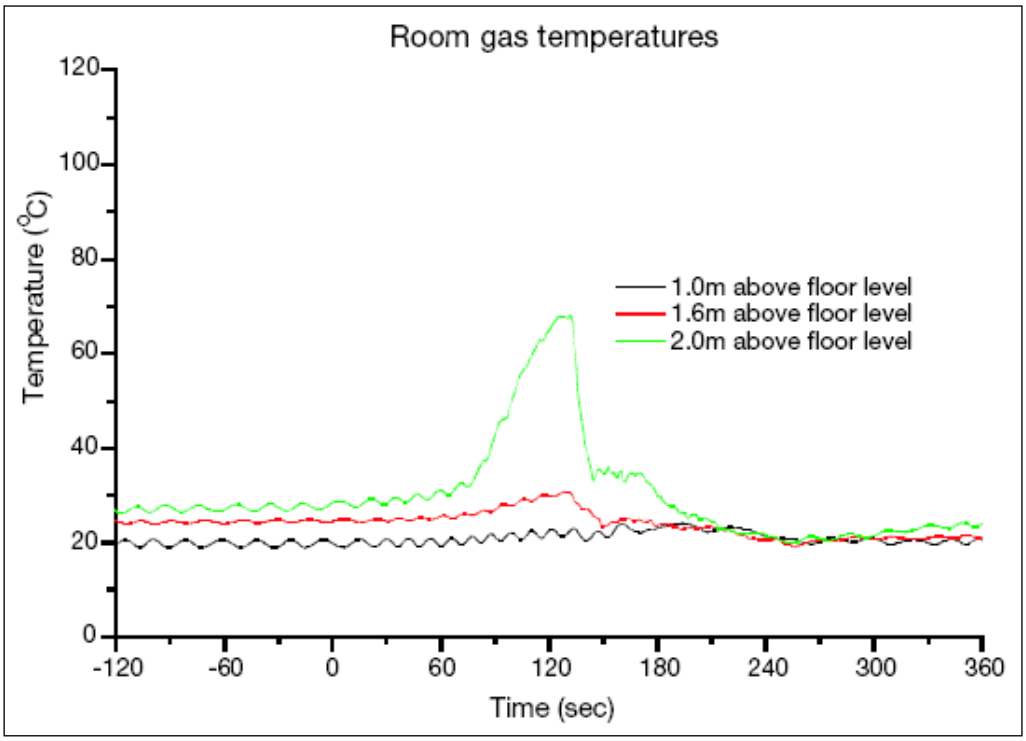
Test observations and results for the unsprinklered test are shown below: -

| Table 44 Test details and observations for 1st kitchen test | | |
|---|---|---|
| **Test No** | | K1 |
| **Scenario** | | Kitchen |
| **Sprinklered?** | | No |
| **Test details** | | Chip pan heated on gas cooker until 1 minute after auto-ignition of oil occurs. Tea-towels paced on cooker hood, above chip pan to propagate flames. |
| **Time** | | **Event** |
| Minutes | Seconds | |
| -24 | 0 | Lobby smoke alarm activated |
| 0 | 0 | Ignition (@ oil temperature of 361°C) |
| 1 | 12 | Towels ignite |
| 1 | 33 | Front towels fully burning |
| 3 | 09 | Burning of front of towels decreases |
| 3 | 43 | Side towels start burning |
| 5 | 09 | Burning of front of towels ceases |
| 6 | 48 | Sporadic flaming of towels ceases |
| **Post test damage assessment** | | |
| Cooker | | Grill pan cover scorched |
| Tea towels | | All towels fully burned |
| Cupboards | | Smoke damage and some charring of underside of cupboards |
| Work surfaces | | No damage |



Test observations and results for the sprinklered test are shown below: -

| Table 45 Test details and observations for 2nd kitchen test | | |
|---|---|---|
| **Test No** | | K2 |
| **Scenario** | | Kitchen |
| **Sprinklered?** | | Yes @ 60Lpm |
| **Test details** | | Chip pan heated on gas cooker until 1 minute after auto-ignition of oil occurs. Tea-towels paced on cooker hood, above chip pan to propagate flames. |
| **Time** | | **Event** |
| Minutes | Seconds | |
| 0 | 0 | Ignition (@ oil temperature of 355°C) |
| 1 | 08 | Tea-towels ignite |
| 1 | 17 | Tea-towels fully burning |
| 2 | 12 | Sprinkler operation |
| 2 | 58 | Flames extinguished |
| **Post test damage assessment** | | |
| Cooker | | Grill pan cover scorched<br>Main cooker surface covered with water and blackened cooking oil. |
| Tea towels | | Front facing towels partially burnt, side towels slightly charred |
| Cupboards | | Smoke damage to wall cupboards. |
| Work surface | | Spattered with water and blackened oil |



## Other Research in the USA

BFRL, with support from the US Fire Administration, conducted experiments to quantify the effectiveness of residential sprinkler systems designed in accordance with NFPA 13D.

An example of these experiments is the following comparison of a “living room” fire, with and without residential sprinklers. Two rooms, each 3.7m X 2.4m high, were built in the Large Fire Research Facility at NIST (National Institute of Standards and Technology in the US). Both of the “living rooms” were furnished with a sofa, love seat, end table, lamp and carpeting. Room A had a smoke detector installed and Room B had both a smoke detector and a residential sprinkler system. A match was used to ignite the sofa.

Within 40 seconds after ignition, the smoke detectors in each room activated. The fires in both rooms continued to grow. At 85 seconds the residential sprinkler activated in Room B. As a result of the water spray from the sprinkler in Room B, the fire was suppressed and safe conditions were maintained. The fire in Room A continues to grow. Flashover occurs in Room A, 195 seconds after ignition, with temperatures exceeding 600 °C.

## Statistics

The installation of residential sprinklers in Europe is relatively new, but there are studies in North America which highlight their effectiveness. Many jurisdictions in the USA and Canada now require sprinklers to be provided in new residential buildings. These are:-

1. San Clemente, California, 1978
2. Cobb County, Georgia USA
3. NAPA, California
4. Prince George’s County, Maryland, 1992
5. Scottsdale, Arizona, 1986
6. Port Angeles, Washington, 1986
7. City of Vancouver, Canada, 1990

There has not been a single fire fatality in either Napa, California or Cobb County since the inception of those programs.

There has not been a single fire fatality in Prince Georges County in a residential building fitted with a sprinkler system.

In Scottsdale, more than 50% of homes have sprinklers. During a fifteen year period (between 1986 and 2001) there were 49 fires in sprinklered homes. There were no fatalities in sprinklered homes. During the same period there were 549 fires in unsprinklered homes with 13 fatalities.

In Vancouver, annual fire deaths in the City have fallen from 7 fatalities per 100,000 population in the early 1970’s to 1 fatality per 100,000 in the 1990’s.

In 1984, a report by NIST estimated that the effect of adding sprinklers when smoke detectors are already present could reduce the number of fire deaths by 63%.

A NFPA analysis of national US data, collected from 1983 to 1992, indicates the number of fire deaths per 1,000 fires was reduced by 57% in homes with sprinklers.

# APPENDIX B KITCHEN LAYOUT

The analysis is for a sprinkler controlled fire that limits the fire to the cooking pan, which is in line with results of BRE sprinklered test. The time for occupants to escape past the hobs is solely that for movement past the hob, in order to demonstrate that occupants would not be harmed in passing the hob.

BS 7974 “Applications of Fire Safety Engineering Principles to the Design of Buildings” states that at a point where the radiant heat flux is 10 kW/m² tenable conditions are maintained for 4 seconds and where the radiant heat flux is 2.5 kW/m² they are maintained for 30s. This is a reasonable time to escape from a flat. The radiant heat flux is a function of the heat release rate of a fire and the distance from the fire (see Figure 1).

A research study carried out by Iit Gandhinagar and Underwriters Laboratory Inc. (“Report of research on detection of kitchen fire”, 8 July 2010) shows that the peak heat release rate of a cooktop fire is 86.9 KW. Another research study carried out by Hyeong-Jin Kim and David G. Lilley and published by the American Institute of Aeronautics and Astronautics (“Heat release rates of burning items in fires”, January 2000) gives a heat release rate for a 12 inch pan fire of 116KW. Both of these fire sizes were not controlled by sprinklers and represent the worst case scenario as the fire was fed by constantly burning oil.

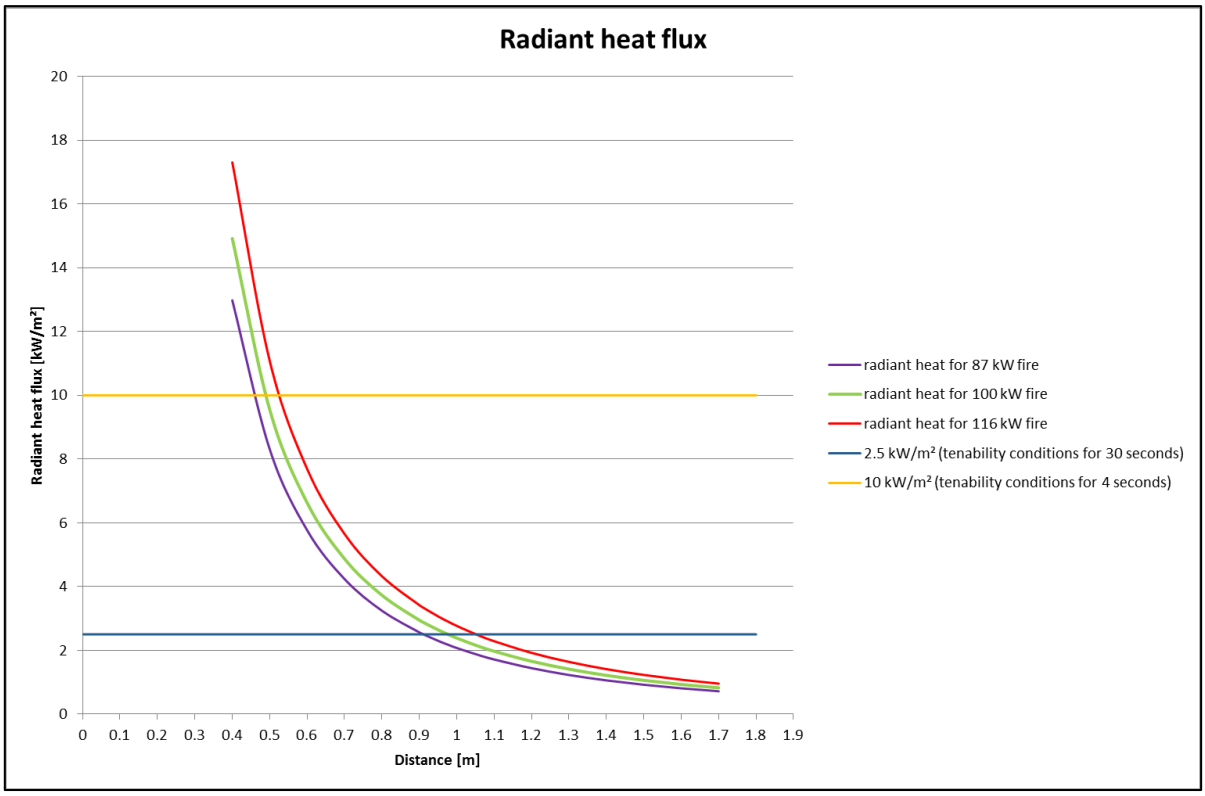



**Figure 1: Radiant Heat Flux**

The hob fire sizes within a range between 87kW and 116kW are modelled, as shown in the figure above. To keep tenable conditions for 30 seconds the distance from the hob fire should not be less than 1.1m. To keep tenable conditions for 4 seconds the distance from the hob fire should not be less than 0.53m.

The shortest distance between the hob and the opposite wall in the open-plan flats is approximately 1.6m. Assuming occupants have shoulder width of 0.5m they would be at least 1.1m from the hob fire. Therefore, the radiant heat flux in the proposed open-plan flats does not exceed 2.5 kW/m² and tenable conditions remain to allow occupants to escape past the hob fire.

The analysis takes no account of the effect of sprinklers in controlling the hob fire, or of the radiation absorption and cooling of the occupants’ skin by the water spray. Therefore, in the event of a hob fire occupants should be able to escape safely from the flat.

A method of calculating the separation between a fire and a combustible material is described in NFPA92b and the SFPE Handbook, which assumes a point source, and measures the separation distance from this point.

The method relates the radiant heat flux (RHF), q, at a distance r from the centre of a fire to the total of heat release rate (HRR) of the fire, $Q_t$.

The equation is:

$$q = \frac{0.3Q_t}{4\pi r^2}$$

Where 0.3 is the fraction of heat emitted as radiation.

The distance, r, from the centre of fire can be calculated from the following equation:

$$r = \sqrt{\frac{0.3Q_t}{4\pi q}}$$

Therefore, the distance for 2.5kw/m$^2$ RHF at 116kW HRR would be:

$$r = \sqrt{\frac{0.3 \times 116}{4\pi \times 2.5}}$$
$$r = 1.1m$$

The distance for 10kw/m$^2$ RHF at 116kW HRR would be:

$$r = \sqrt{\frac{0.3 \times 116}{4\pi \times 10}}$$
$$r = 0.53m$$

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