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Design Note No. DN01E

Project Chester Road, London **Date** 27th November 2020

Subject Fire Safety Overview

1.0 DOCUMENT CONTROL

Issue	Date	Description	Author	Reviewed
-	23/09/19	Initial issue	BW	BH
A	17/10/19	Including client feedback and open plan unit justification	BW	BH
B	05/12/19	Including design development and client team feedback	BW	BH
C	09/06/20	Including client discussions & feedback	BW	BH
D	10/11/20	Tender issue updates	BW	BH
E	27/11/20	Including door clarification	BW	BH

Note: All updates since the previous issue are highlighted with a vertical line in the right hand margin.

2.0 INTRODUCTION

BWC Fire Limited (BWC) has been appointed to produce the fire strategy for development of the site known as Chester Road in London.

This report, DN01, was originally produced during Stage 2 with this Issue A/B update including the development of those original principles to reflect the designs progression. Issue D of this report includes feedback from the Camden Service with a view to mitigating potential concerns on the defend in place evacuation philosophy experienced on other sites and also updates leading towards tender. The fire alarm systems have therefore been updated to allow flexibility should the philosophy be changed at a future date.

These fire strategy principles will be based on the guidance in Approved Document B (ADB) to the Building Regulations, August 2019 Edition (including the May 2020 amendments) as well as other relevant guidance, such as British Standard BS5839 Part 6.

Following the client briefing it was confirmed that the accommodation is intended for homeless families and therefore the occupants are generally a stable family unit with few support needs beyond accommodation. The families tend to have a higher frequency of single parents however it is not expected that the occupants would need secondary assistance to evacuate, would pose a higher / unusual fire risk in their own right (e.g. have a history of arson etc), or would expect to have unusual responses to a fire alarm event. Further to this the building management assess the needs of the families prior to providing accommodation and allocate according to their needs and risks. Occupants whom are known to have prior history of issues (e.g. hoarding etc) are also closely monitored with site management undertaking regular inspections to prevent issues escalating.

Further to the above families will generally be given accommodation on a period between six months up to two years with the accommodation being given via a planned process, therefore it is not short notice accommodation. Given this background it is proposed that the building is more appropriate to be considered as a general purpose apartment block which includes some onsite facilities management services rather than a hostel building. On this basis the building has been considered under Purpose Group 1(a) of Approved Document B. It should be noted that this designation is subject to discussion and agreement with Building Control during Building Regulations stages.

3.0 FIRE STRATEGY PRINCIPLES

The information summarised in the table below reflects the fire safety aspects of Building Regulations that are applicable to the building when treated as an apartment building to current standards.

Design Item	Recommendations
Evacuation Philosophy	• Based on the external walkway access, extent of the compartmentation proposed plus the building use the building has been treated as an apartment building. Given this a defend in place evacuation strategy has been adopted. • As noted in Section 2 the fire alarm systems will allow reprogramming to facilitate a simultaneous evacuation regime if desired at a later date.
Escape within the Apartments	• The units are configured as residential apartments with their access being via external access decks. Furthermore several units are based on open plan layouts with the units including automatic fire suppression systems. In our opinion given the uplifts to the fire protection present and the intended family unit nature of these arrangements it is considered reasonable to permit deviations from the typical internal escape arrangements within the individual units. This arrangement has been discussed with LBC's Fire Safety team whom have accepted this premise on the basis that these are single family flats of medium term occupancy and more akin to apartments than traditional hostels. It has however been accepted on the proviso that the accommodation is not for higher risk occupants (e.g. high dependency occupants, people with significant mobility or cognitive issues). • Following the above it is proposed that each unit will either be configured as a studio unit (i.e. a single open plan space with inner rooms limited to either kitchens or bathrooms). Travel distances in such cases will be limited to 9m from all parts of the unit and the cooking facilities will be remote from the escape route (at this stage ideally at least 1.8m away from the escape route however a radiation analysis will also be provided during the Building Regulations stages to support the cooking hob positions). • The units with inner sleeping rooms will adopt the principles for open plan apartments discussed in BS9991 and therefore will include residential sprinklers and L1 standard fire alarm and detection systems. The cooking hobs should be remote from the escape routes and are proposed as achieved where these are at least 1.8m away from the escape route. It should be noted that for any open plan unit that is greater than 8m by 4m in footprint (32sqm) with an open kitchen or layout which requires escape through the kitchen then these will require further justification by fire engineering. Fire engineering justification has been based on CFD modelling for these arrangements and is documented in Appendix A at the end of this report. • Following on from the above there are some units where the open plan design permits the lounge space to be separated off from the kitchen area which results in the bedroom becoming an inner inner room. This is a further deviation from the basic guidance in BS9991 however further CFD modelling has been undertaken for this configuration and is included in Appendix A. Notwithstanding this conceptually the premise of the open plan arrangements is that the suppression and early warning overcome the lack of sight of the exit route. In this case following this principle providing the conditions within the spaces are tenable for the escape period then it should not matter how remote the worst case room is. • In all units the client has recommended that the cooking hobs include thermal cutout facilities to assist with minimising the potential for cooking fires.
Escape within the Common Areas	• The building is composed of lower ground, upper ground plus up to three floors with the top floor being less than 18m high. At each floor the apartments are accessed from external access walkways that connect onto two common staircases. In this case the guidance in Section 7.3 of BS9991 is applicable as the current guidance for open balcony access routes, as detailed below: <u>Details applicable to all balconies</u> - The balconies will afford 30minutes fire resistance (both structurally and as compartment floors) - The walking surfaces will be imperforate - The sectional profile should not contain smoke under a balcony (i.e. generally the balcony underside should be flat with no obstructions at the balcony edges that prevent spillage to outside). - The balconies should not be more than 2m wide otherwise minimum 300mm downstands would be needed. - The balconies should be adjoined to the facades at all points.

Design Item	Recommendations
Escape within the Common Areas (Cont)	Additional details applicable to dead end balconies - The facades adjacent to the balconies will afford 30minutes fire resistance up to a height of 1100mm. - The apartment doors will be FD30 self closing doors. - All balcony wall and ceiling finishes should be Class O rated. - The external balustrades should be imperforate. On this point the third floor is the only dead end section of walkway. Currently the planning drawings show a railing balustrade plus a covering to the walkway. In order to address this either the balustrade should be made imperforate (potentially by the introduction of a non-fire rated glass screen behind the existing railing) or the canopy omitted such that rising gases cannot be contained on the top floor balcony. • The common staircase will include a 1sqm manual remotely openable vent at the head of the staircase. No smoke detection is required to the common circulation areas of this building on the basis that these are external spaces. This vent is achieved based on the permanently open external facing side of each staircase. • The non-residential accommodation located at ground floor level are accessed from outside and are not linked by internal corridors to the residential escape routes. On this basis these accommodations can be considered in isolation to the residential escape routes. • The common staircase can be the width necessary for daily access but should be no less than 750mm (all stair widths are measured between walls, providing the handrails do not protrude more than 100mm into the stair on each side). Notwithstanding this the two staircases both afford 1200mm clear widths which are capable of accommodating the entire occupancy of the building after one staircase is discounted (Note: the entire occupancy of the upper levels is less than 150 people with this being accommodated by a minimum 1000mm clear width staircase). • Stair doors onto the staircases at each level should be a minimum of 750mm clear based on no individual floor having more than 60 people. The staircase final exits and any discharge corridors should maintain the minimum clear widths of the staircases, i.e. 1000mm to ensure flexibility of the building. The direction of opening for all doors on the staircase final exit routes should open in the direction of escape. • The staircase discharge routes should be maintained unobstructed and free of fire load. • Once occupants reach the ground levels they can then either escape to the street via the site entrances or through the staircase final exits. • Any access control devices fitted to the common escape route doors should be fitted with a manual override mechanism from the escape side of the door to enable occupants to escape without the need for a key in an emergency.
Escape Within Non-Residential Areas (Staff areas and community room)	• The maximum travel distances should not exceed 45m to the nearest storey or final exit where escape is possible in two directions, and 18m where escape is possible in one direction. These distances should be easily met based on the exit distribution. • In general each area will not serve more than 60 people and therefore each room will have sufficient exit width based on a single exit of 750mm clear width. It should be noted that further exits may be needed to satisfy travel distances. • As the accommodation on upper ground are accessed from outside with respect to the apartment exit routes no further protection is needed beyond the 60minute fire resistance to party walls and floors. At lower ground floor the accommodations additionally will be accessed from the staircase via a 60minute fire rated lobby which also includes a 0.4sqm permanent natural vent to outside. • All dead end corridors longer than 2m should be protected and enclosed in construction of at least 30 minutes fire resistance and FD30S self closing fire doors. • The staff areas have some inner rooms however these are considered acceptable on the basis of this space including coverage by the automatic fire alarm and detection system. • Plant rooms and bin stores will be subject to a maximum dead end travel distance of 9m within the room itself with the total dead end travel distance to a place of relative safety being 18m. This is applicable to the lower ground floor accommodations and is met directly. • Roof top open air plant locations will have maximum travel distances to a storey exit of 60m in a dead end and 100m in multiple direction routes.

Design Item	Recommendations
Escape Within Non-Residential Areas (Cont.)	• All doors on escape routes, including those from individual rooms should ideally open in the direction of escape. However it is mandatory for any exit door that is likely to be used by more than 60 people to open in the direction of escape.
Disabled Evacuation	• The non-residential accommodations have level access and egress therefore these areas do not require dedicated escape facilities for disabled occupants • In general disabled refuge facilities are not needed in residential accommodation so should not be provided in the residential common areas. This has been supported by the service teams confirmation that staff at this building will not generally be assisting with evacuations and therefore emergency voice communications (EVC) facilities are not considered to be a benefit. Notwithstanding this disabled refuge provisions and EVC provisions will need discussion and agreement with Building Control. • The Client has confirmed that the lifts will do not require additional enhancements with the exception that their power supplies will be from a dedicate spur from the distribution boards.
Fire alarm and detection system	• The building should be provided with an open protocol automatic fire alarm and detection system designed, installed and commissioned in accordance with the BS 5839 Part 1 to a minimum L1 standard. The L1 standard is due to there being a series of open plan units present. • Appropriate fire detection should be provided to all areas of the building. Manual call points should also be located by storey and final exits. It should be noted that further discussions with Building Control should be held with regards to the defend in place philosophy and details such as manual call point provisions. • The main fire alarm panel should be located by the main entrance. • Fire sounders should be provided to ensure a sound level of 75dbA at the bed head and 65dbA or 5dbA above background noise levels with the non-sleeping areas. • At this stage it is proposed that the evacuation philosophy for the building will be a defend in place philosophy. On this basis the activation of the fire alarm system will solely sound the alarm and evacuate the compartment of activation only. This evacuation premise is consistent with the apartment philosophy. Notwithstanding this on activation a management alert will also be sent to the staff office and associated warden call system. In addition the fire alarm system will also be linked to a remote monitoring service (e.g. BT Redcare or similar). • The lifts within the building should all ground automatically on the activation of the fire alarm system. Additionally all access controls to escape doors should be isolated on the activation of the fire alarm system. • The sprinkler system proposed throughout the building should on activation also trigger the fire alarm system. • Based on the defend in place philosophy any associated HVAC plant will only automatically shutdown on the activation of detection local to the plant rooms concerned and not on the general activation of the wider fire alarm system. It should be noted that there is no gas services to the building. • During the recent client meetings it has been requested that the fire alarm systems have the potential if desired to enable a simultaneous evacuation philosophy at some point in the future. It is for this reason why the L1 standard BS5839 Part 1 based system has been proposed. Subject to more detailed discussions with Building Control it may be necessary to alter the system designation to an L5 standard (i.e. a bespoke system) to facilitate this future requirement along with maintaining the defend in place premise of the current use (with respect to details such as manual call point facilities for example).
Sprinklers	• Due to the layouts of the accommodation units and the coverage of all areas of the building it is proposed that the building should include a residential sprinkler system that is designed to BS9251 and be of a minimum category 3 standard. The sprinklers should also be designed to include Table 2, footnote C requirements with respect to minimum design discharge density. • The sprinklers are proposed to the staff areas, buggy stores, plants rooms and ancillary rooms throughout the building plus all apartments within the building.
Emergency Lighting	• This should be installed in accordance with Approved Document B and BS 5266 Part 1 recommendations.
Escape signage	• This should be installed in accordance with BS 5499: Part 1.

Design Item	Recommendations
Escape signage (Cont)	• Fire door keep shut or keep locked signage should also be provided to all fire doors as applicable and outlined in Approved Document B.
Elements of Structure	• The building is less than 18m high therefore all elements of structure should afford 60minutes fire resistance. • Any elements which only support themselves and or a roof can be non-fire rated.
Compartmentation	• All apartments should have 60 minute fire resistant compartment walls. Apartments within dead end sections of walkways and also in the covered walkway zones close to the staircases will be provided with FD30 self closing front doors. Apartments in areas of external walkway with two directions of escape do not need fire rated front doors. • No fire resistance is proposed internal within each apartment however each will include L1 standard fire alarms systems and residential sprinklers. • All floors should be compartment floors with a fire resistance of 60minutes. • In general the staircases are proposed as being separated from the accommodation with 60minutes fire resisting construction and FD30S self closing doors. However, the staircase facades that face onto the pubic highway elevations are not proposed as being fire rated and may be potentially open. This arrangement is considered acceptable on the basis of the accommodation elevations within 1.8m of these zones being fire rated to a 60minute standard (note: this includes the zones where staircases extend out beyond the ends of the walkways such that smoke cannot spill around the edges of the staircase enclosures). Similarly on the ground to third floors inclusive it is proposed that the staircase elevations that face onto the external walkways will have reduced separation of the enclosures based on the staircase construction being remote from potential fire risks and the adjacent accommodations being sprinklered. This latter proposal will be based on fire engineering justification based on the quantification of the likely gas temperatures to which the construction could be exposed. This fire engineering has not been undertaken and will be done later however it is envisaged that this construction may potentially be reduced to either 30minute fire integrity only glazing or possibly even laminated, non-fire rated glazing, or potentially similar solid non-combustible materials that can withstand temperatures at this stage of in excess of 300ºC. This rationale is subject to further justification development and also discussions with the approving authorities. • The building has an external balcony design where the apartments are accessed via balconies that are permanently open to outside and also the third floor access balcony is in a dead ends. The design of the balconies will be in accordance with the guidance discussed in section 7.3 of BS9991, as discussed in the means of escape section earlier. • The lift shafts should have a fire resistance of 60minutes with FD30 landing doors. • Service risers should be constructed as continuous vertical protected shafts with a fire resistance of 60minutes with FD30S doors. No self closers are needed however the riser doors should be kept locked shut and signed as such. Note: LBC's Fire Safety team have recommended that service risers be designed as protected vertical shafts for ease of ongoing maintenance however the design team propose compartment floors at each level in the shafts with the omission of formal fire doors where these risers face onto external walkways that offer escape in two directions. This item therefore needs further discussion and agreement between the design team and the client stakeholders. • In order to protect the staircase means of escape routes from a fire on the floor plates the wall construction within 1.8m of the staircase will be fire rated to 30 minutes • The staff areas, ancillary stores and community room will not require internal subdivision on the basis that each is less than 2000sqm. In this case each will have 60minutes fire separation from all adjoining accommodations. The residential sprinklers have also been extended to serve the staff areas and ancillary stores. • All corridors in non-residential areas which are more than 2m long should afford 30minutes fire resistance with FD30S self closing doors. • Any lobbies that separate non-residential accommodation from the common staircases should afford 60minutes fire resistance with FD30S self closing doors. This scenario solely occurs at Lower Ground Floor level. The staircase lobby will also include a 0.4sqm permanent natural vent that discharges directly to outside.
Special Fire Risk Areas	• Plant and refuse rooms should achieve 60minutes fire resistance with FD30S self closing doors.

<table>
<tr><th>Design Item</th><th>Recommendations</th></tr>
<tr><td>Special Fire Risk Areas (Cont)</td><td>

Any electrical sub-stations should be fully separated from the adjacent accommodation spaces by at least 30 minutes fire resisting construction, although these requirements are likely to be superseded by the electricity supplier’s requirements, which are typical based on 4hours fire separation.
Refuse rooms accessed internally should be approached via a protected lobby which is provided with 0.2m² of natural ventilation direct to outside.
Cleaner cupboards, stores and utility rooms should be enclosed in 60 minutes fire resistance with FD30S self closing doors.
Any special fire hazard rooms (plant rooms) accessed off the internal circulation routes should be accessed via a 60minute fire resistant lobby which is provided with 0.4sqm of natural ventilation direct to outside.

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<tr><td>Surface Linings</td><td>

All linings within the protected staircase and lobbies and escape corridors should be Class 0.
Any room with an area less than 4m² should have a Class 3 surface lining.
All linings in spaces with an area greater than 4m² should have a Class 1 lining.
All linings on escape routes (including circulation routes) should have a Class 0 rating.

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<tr><td>Fire Stopping</td><td>

Ductwork passing through compartment/fire resistant walls will be either contained within fire resisting construction or provided with fire dampers.
The ductwork will be provided with fire and smoke dampers activated automatically on the activation of the building fire alarm and detection system. Fire and smoke dampers will be provided to ductwork which are installed in any of the following areas (unless they are contained within fire resisting construction throughout their route to fresh air):
- Ductwork serving both escape routes and accommodation or;
- Ductwork passing through both stairs, stair lobbies and accommodation or;
- Ductwork passing through walls separating fire compartments.
Any openings for services (exceeding the dimensions discussed in Table 9.1 of ADB, as shown below) breaching compartment walls or floors will be fire stopped (unless protected throughout their entire length with fire resisting material) in accordance with Section 9 of ADB. This is to prevent the passage of fire and to assist in retarding the movement of smoke. Joints between elements of structure that serve as barriers to fire will be fire stopped to prevent the passage of fire and smoke.

<table>
<tr><th rowspan="2">Situation</th><th colspan="3">Pipe material and maximum nominal internal diameter (mm)</th></tr>
<tr><th>(a) Non-combustible material</th><th>(b) Lead, Aluminium, aluminium alloy, UPVC, fibre cement</th><th>(c) Any other material</th></tr>
<tr><td>Structure (but not a wall separating buildings) enclosing a protected shaft which is not a staircase or a lift shaft</td><td>160</td><td>110</td><td>40</td></tr>
<tr><td>Compartment wall or Compartment floor between flats</td><td>160</td><td>160 (stake pipe)
110 (branch pipe)</td><td>40</td></tr>
<tr><td>Any other situation</td><td>160</td><td>40</td><td>40</td></tr>
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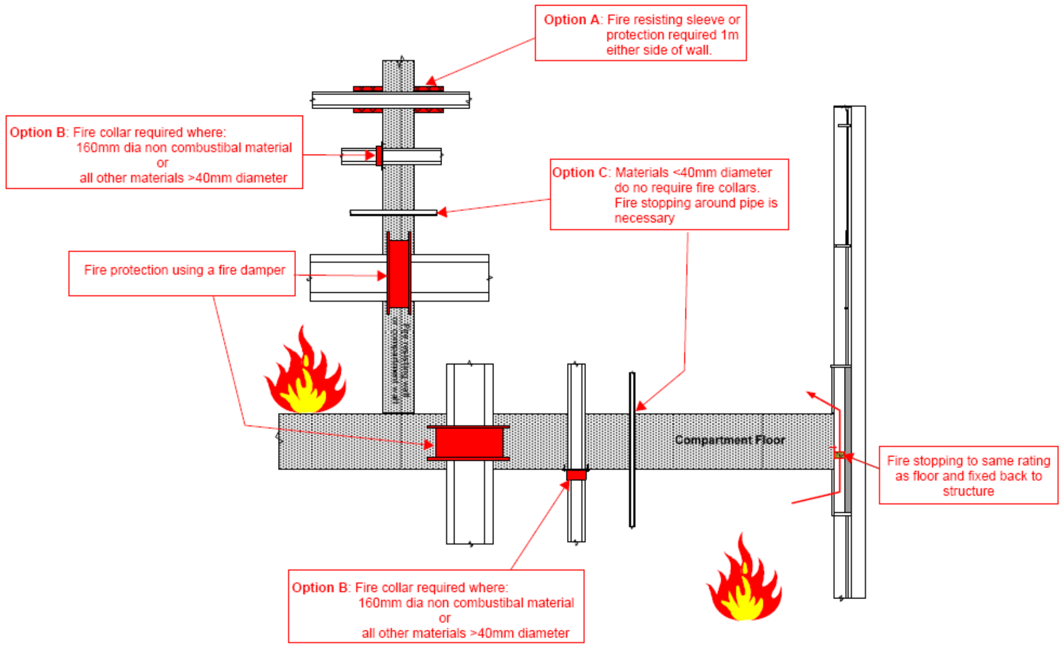
<tr><td></td><td>
</td></tr>
<tr><td>Cavity Barriers</td><td>

Cavity barriers will be included in any large cavity with the potential for extensive unseen fire spread. The key areas that require cavity barriers are as follows:
- At the junction between an external cavity wall and a compartment wall that separates buildings; and at the top of such an external cavity wall.
- At the junction between an external cavity wall and every compartment floor and compartment wall.
- At the junction between a cavity wall and every compartment floor, compartment wall, or other wall or door assembly that forms a fire-resisting barrier.
- In a protected escape route, above and below any fire-resisting construction that is not carried full storey height.
- Where the corridor will be sub-divided to prevent fire or smoke affecting two alternative escape routes simultaneously.
- Within the void behind the external face of rainscreen cladding at every floor level, and on the line of compartment walls abutting the external wall of buildings
- At the edges of cavities (including around openings).
In addition to the above locations cavity barrier are also required in cavities (including ceiling voids and under floor service voids) where the cavity exceeds 20m.
The cavity barriers will provide a 30-minute fire rating (i.e. 30 minutes integrity and 15 minutes insulation). Any penetrations through the cavity barriers will be either;
- Fitted with a proprietary sealing system.
- Pipes of limited diameters that are sealed with fire-stopping, or sealed with sleeving of non-combustible pipe material.
The specification of cavity barriers should not be confused with the specification of fire stopping between fire resisting elements, e.g. walls and floors, which should afford the same level of fire resistance as the fire resisting elements themselves. These principles and the general cavity barrier locations are indicated in the diagram below.

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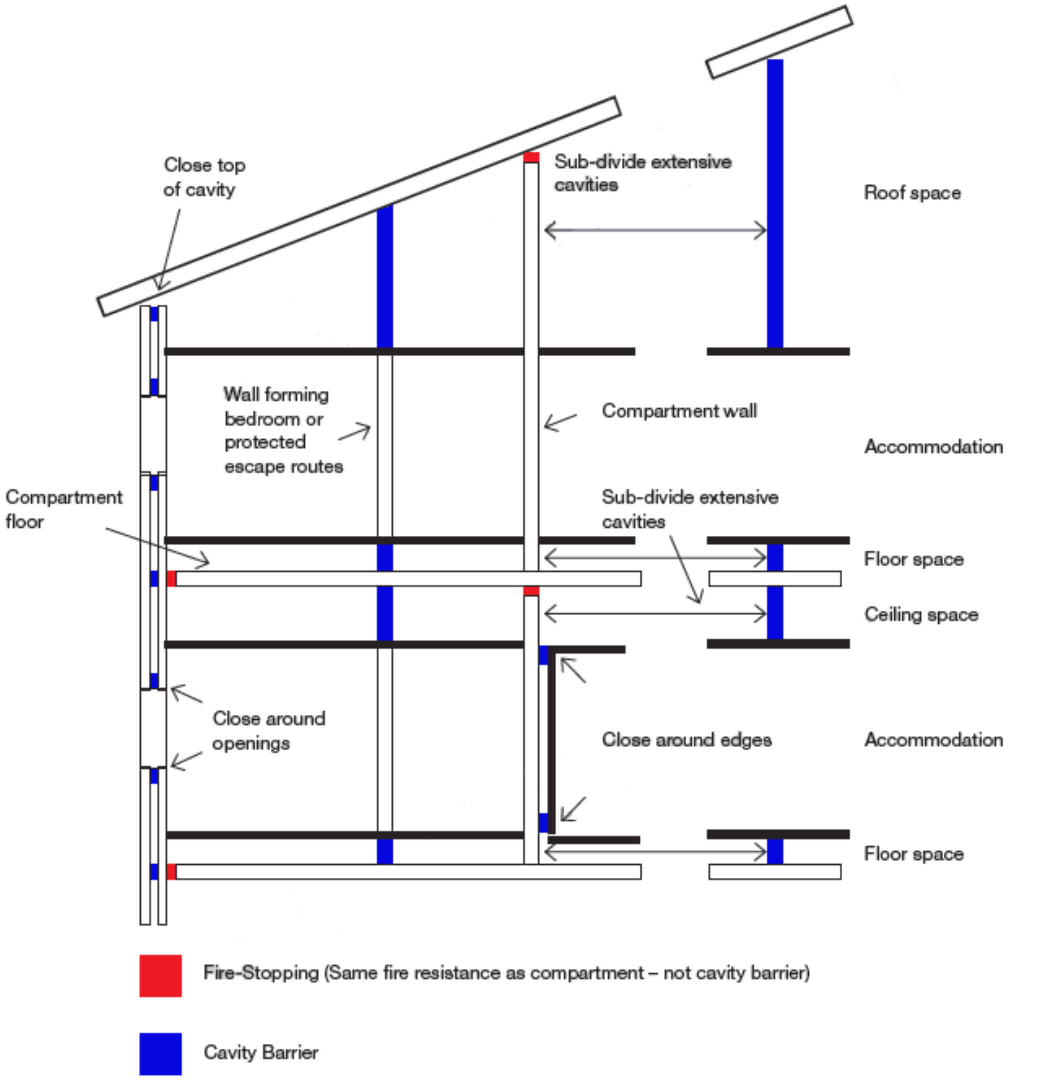
<tr><th>Design Item</th><th>Recommendations</th></tr>
<tr><td>Cavity Barriers (Cont)</td><td>
</td></tr>
<tr><td>Space Separation</td><td>The works will need the external walls assessing for the purposes of space separation and external fire spread to neighbouring sites. Given the fire suppression and fire compartmentation between units it is unlikely that significant areas of the facades would need to be formally fire rated to mitigate external fire spread to neighbouring land.
Due to the extent of the compartmentation across the site the largest compartment potentially occurs at lower ground floor with an enclosing rectangle of 21m by 3m high. Using BRE Guide 187 Table 1 recommends that a minimum separation distance of 4.5m would be required for this rectangle to be fully unprotected (which due to the sprinkler suppression can be reduced to 2.25m). None of the notional or land boundaries around the building are less than this separation distance and therefore no fire rated external wall construction is needed for space separation purposes.</td></tr>
<tr><td>External Walls</td><td>Strictly Approved Document B still prescriptively permits the inclusion of combustible materials in the external wall build ups however MHCLG subsequent guidance requires fire spread to be limited between units. Further to this the client has expressed the opinion that the external walls must not provide a route for fire spread. Given this it is proposed to adopt the same criteria as outlined in Approved Document B for buildings that are <u>more than 18m in height</u>. On this basis all materials used within the external walls should utilise Euroclass A1 or A2 rated materials.</td></tr>
<tr><td>Fire Service Access</td><td>As the building is under 18m in height fire fighting shafts are not proposed however a dry rising water main will be provided to the common staircase.
All parts of the apartments should be covered within 45m hose distances from the dry rising main outlets within both of the common staircases. The dry main inlets should be located within 18m of the fire appliance parking positions with the inlet visible from the</td></tr>
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Design Item	Recommendations
Fire Service Access (Cont)	fire appliance. The dry main inlet should be no more than a 18m horizontal distance from the vertical rise of the dry main pipe to comply with BS9990. • The dry main installation should comply with BS9990, this will include details such as dry main outlets being provided at all levels, including ground levels. It has been identified by Camden that some installations have used HDPE pipework for underground sections of dry mains. Camden do not wish to see such materials used on this site unless independent test evidence demonstrates that any alternative design materials can achieve the pressure, robustness and durability requirements of BS9990. • The ground and lower ground floor staff areas are each less than 2000sqm and therefore each will be fully covered within a 45m hose distance from a fire appliance parking position, although these are also similarly covered by the dry main outlets in the staircases as well. • Any access/security measures in and around the site (especially any bollards preventing vehicle access) should be bypass-able by the fire service. The details of the bypass arrangements should be developed and agreed with the fire service as applicable. • As no new compartment is being created that is larger than 280sqm there are no requirements to considered new fire hydrants within these works.
Smoke Clearance	• As an apartment building which has access via external walkways only requires limited smoke venting facilities which in this case would be a 1sqm natural remotely openable vent at the head of the common staircase. This vent should be operable via a manual switch located at ground floor level in the staircase. • The lower ground floor accommodation is less than 200sqm and not more than 3m below external ground level therefore no smoke venting facilities are provided. Notwithstanding this the staircase lobby at this level will include a 0.4sqm natural permanently open vent that discharges to outside.
Power supplies	• In general most life safety systems in the building can function based on mains power, supported by battery backups (e.g. fire alarm systems, emergency lighting etc). However the sprinklers should be provided with a secondary power supply. • For basic Building Regulations purposes when treated as an apartment building then as highlighted earlier evacuation lifts and disabled refuges are not needed. However in this case the client wishes to some further resilience to the lifts to mitigate potential risks. On this basis the lifts in the building will not be provided with a secondary power supply but they will be powered by their own dedicated supply from the electrical distribution boards to minimise issues should a fire affect other areas of the building.
General Responsibilities	• Given the use and likely occupancy of the building, management procedures will assist in the prevention and control of fires and the evacuation of occupants, should this be necessary. • Good housekeeping standards will be enforced to ensure that the effectiveness of the fire safety provisions is not affected. • Maintenance procedures will be developed to ensure that all equipment and services within the building are able to operate effectively. • Other fire legislation requires effective management of all the buildings fire provision. A risk assessment will have to be carried out together with staff training, systems maintenance etc. All information gathered during the risk assessment and on an ongoing basis should be documented and available for inspection as required. • A management strategy will need to be developed for the building by the management team, and staff trained to include how disabled occupants will be evacuated in the event of a fire and identify key roles in ensuring they are assisted in a fire situation. • Where possible residents whom cannot use the staircases unaided will be located on the ground floor.

4.0 BUILDING CONTROL CLARIFICATION POINTS & NOTES

During the discussion and development of this design there were a few items relating to the fire strategy which will require further discussion and agreement with the Building Control Body in due course. This section of the report has been added to highlight those areas:

- Building Designation – The building is a form of hostel by basic prescriptive definition however the use and nature of the occupancy (being long term occupancy) results in the design team's view that the actual building is more akin to a general purpose apartment building. On this basis the fire strategy has been developed to this latter designation however this rationale is subject to agreement with Building Control.

- Open Plan Apartments – Following the above building designation the concept of the open plan layouts and hob positions will be subject to discussion and agreement with Building Control in due course.

- Fire Alarm Systems – In order to reflect the potential clients desire to alter the evacuation philosophy at a later date the fire alarm system proposed to the site is an L1 standard tot BS5839 Part 1. However, this would typically include items such as manual call points which may potentially confuse the current defend in place philosophy. On this basis discussions and final system provisions will need agreeing with Building Control such that there is a consistent approach to the fire alarm systems which enables potential future flexibility to the fire alarm system whilst not compromising the current philosophy.

- Disabled Egress Facilities – Currently the design is based on an apartment building concept with no full disabled refuge or EVC facilities. This proposal is consistent with current staff procedures in an emergency for Camden's similar buildings. Notwithstanding this Building Control may have different views due to the basic hostel prescriptive designation therefore this item needs to be discussed and agreed with Building Control.

5.0 REPORT LIMITATIONS

This report is the copyright of BWC Fire Limited and applies only to the project known as Chester Road in London. It must not be used in support of any other project without the written agreement of BWC Fire Limited. This report may only be forwarded to a third party if reproduced in full and without amendment to the content or presentation.

In preparing this report it has been assumed that detailed aspects of the design and construction will, unless stated otherwise in this report, be in accordance with the recommendations of the relevant Approved Documents to the Building Regulations, applicable British Standards and other relevant codes of practice.

This report relates only to statutory requirements associated with Building Regulations and the Regulatory Reform (Fire Safety) Order 2005. Additional fire safety measures necessary during construction/remedial works or for insurance, loss prevention or environmental protection purposes are not considered.

The terminology "will" or "will be" as used in this report represents the recommendation/understanding of BWC Fire Limited regarding the proposed design, construction or management of the premises. The validity of this report is reliant upon these items being implemented as described.

This report relates to a project that is subject to third party ratification and it must be ensured that the contents of this report are agreed with all the relevant approval bodies prior to implementation.

APPENDIX A – OPEN PLAN UNIT ESCAPE ANALYSIS

A1.0 INTRODUCTION

The Chester Road development includes a series of residential units which are configured as forms of apartments which adopt an open plan living concept whereby the bedrooms are inner rooms from the open kitchen-living space.

This configuration has only limited exposure in prescriptively available guidance and therefore more detailed consideration is necessary where proposed layouts fall outside the generic principles.

In our opinion the application of apartment layouts is reasonable to this building type due to the occupants being a family unit and not any form of HMO. Similarly the accommodation is provided on a six month to two year basis with accommodation allocation being planned rather than this being emergency accommodation.

This appendix documents the assessment that has been undertaken for each of the apartment units on the site that deviate from the general guidance in BS9991 and presents a layout which is deemed to be justifiable in comparison to the level of performance achieved by compliant apartment layouts. This appendix documents the justification provided for the layouts and the associated mitigation for the escape arrangements.

Whilst the building accommodation is a hostel for the purposes of this appendix the units are referred to as apartments for the context of discussion in this assessment.

A2.0 LEGISLATIVE BACKGROUND

Approved Document B (ADB) provides basic design guidance for apartments and recommends for larger apartments that a protected internal hallway should be provided to achieve a minimum of 30 minutes fire resistance. The maximum travel distance within this internal hallway should be 9m from the door of any of the habitable rooms to the front door of the apartment. The doors within the protected hallway should be 20 minute fire doors without smoke seals or self-closers. The apartment front door should be an FD30S self closing fire door.

Beyond the above a typical apartment would include an LD3 standard fire alarm and detection system which is likely to consist of a smoke detector in the entrance hallway. With this level of detection a significant kitchen fire would need to have developed or smoke would have leaked from the habitable rooms into the entrance hall in order for the alarm to be raised.

It should be noted that ADB gives no guidance on the maximum size of any individual rooms within apartments with respect to escape therefore the only restrictions to room sizes are imposed indirectly via fire service access requirements. In extreme cases it would be possible to have an accommodation room within an apartment that is over 30m long. Under these circumstances some inner rooms and inner inner room scenarios are also accepted under ADB. Approved Document B does not however contain any guidance on open plan configurations where a bedroom occupant must escape through a living space.

More recently research conducted on behalf of the NHBC Foundation by the Building Research Establishment (BRE) considered the acceptability of open plan apartment layouts. This research study considered three different apartment configurations (notionally a small, medium and large apartment) and then assessed the quality of the escape routes with the current Approved Document B facilities, an open plan equivalent with just enhanced, LD1 standard fire alarm systems and finally with LD1 fire alarm systems and residential sprinklers. This study concluded that a similar or better level of safety was afforded to the occupants of an open plan apartment layout based on the LD1 fire alarm systems and residential sprinklers as would be the case in a typical Approved Document B compliant apartment.

The NHBC Foundation report findings were then subsequently included into the latest British Standard for residential buildings, BS9991. The recommendations that are included in BS9991 were taken directly from the NHBC Foundation report and can be summarised as follows:

- A maximum apartment footprint of 8m by 4m is applied to open plan apartments where the kitchens are not enclosed.
- For apartments with a footprint in excess of 8m by 4m up to a maximum of 16m by 12m the kitchens should be enclosed.
- The apartment should have a minimum ceiling height of 2.25m.
- The apartment should include a LD1 standard automatic fire alarm and detection system.
- The apartment should be fully covered by a residential sprinkler system.

It should be noted though that these limits were established by the BRE based on the limited range of scenarios that were considered in their research study and therefore these should not necessarily be considered as the maximum design limits for the open plan concept itself (providing that any deviation from this guidance is properly assessed and justified).

A3.0 METHODOLOGY

The NHBC Foundation report on open plan layouts utilised several forms of fire engineering as part of the study however the overall justification was based on statistical rather than deterministic fire engineering principles. In this case the study did not demonstrate that tenable conditions were maintained for a traditionally defined evacuation period (e.g. a global ASET / RSET comparison) but instead the study considered a broad spectrum of occupant profiles and behavioural responses to the various fire scenarios performed. These works demonstrated that all of the apartment fire scenarios did injure (and in some cases cause death of) the occupants however the overall numbers of occupants that were injured or killed were similar or less in the open plan layouts with enhanced fire alarm systems and residential sprinklers as in the traditional Approved Document B apartment layouts.

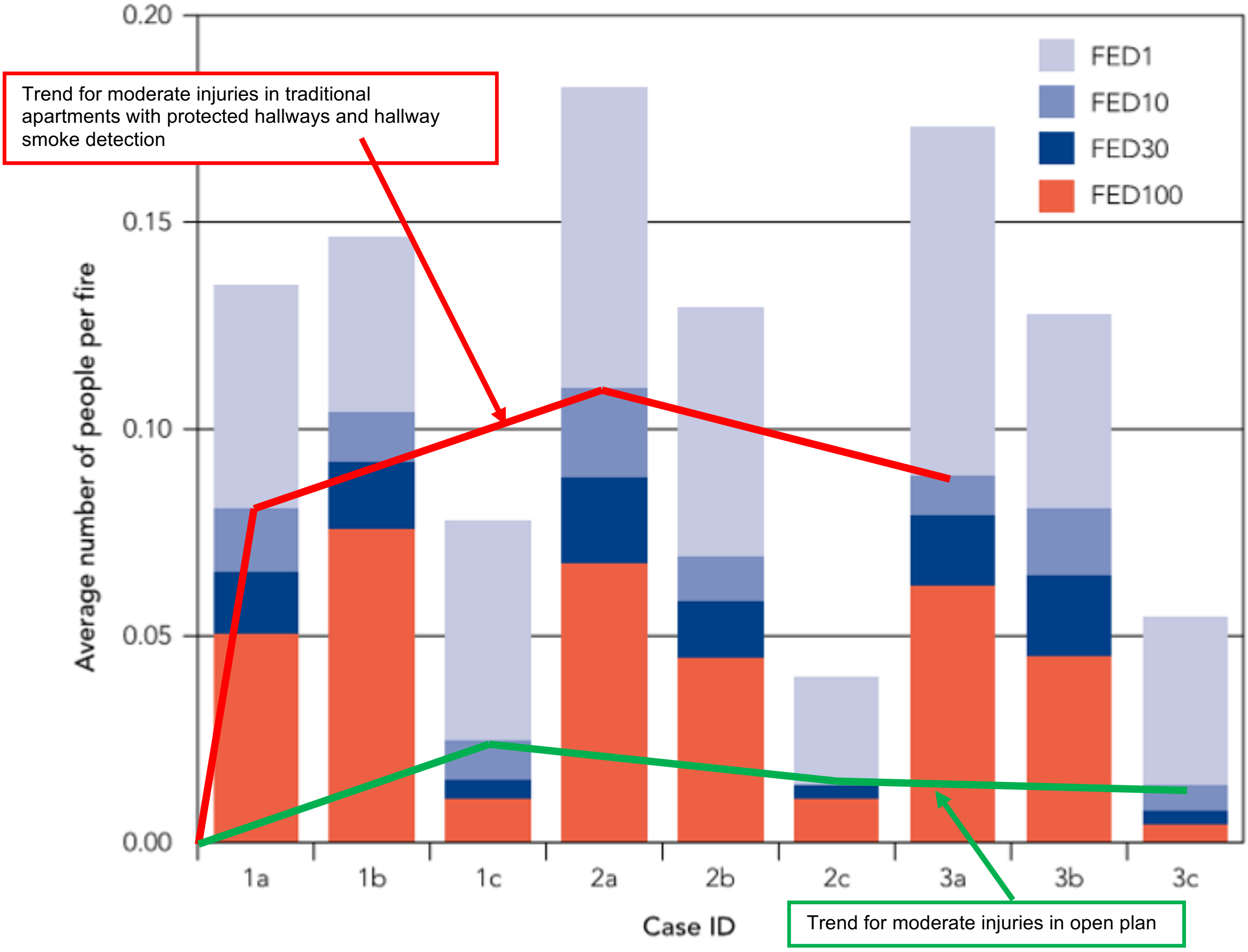


Figure 11 Main results. Risk of death or different levels of injury for each case.

Figure A3.1 – Reproduced from the NHBC Foundation report indicating the injury level results for the various apartment layout types ("1" prefix is for a 4x8m apartment, "2" prefix is for an 8x10m apartment, "3" prefix is for a 16x12m apartment) and fire safety provisions present ("a" suffix are a protected hallway and smoke detection in the hall only (ADB layout), "b" suffix are enhanced fire detection, "c" suffix are enhanced detection and sprinklers (BS9991 layout)).

Ideally the above range of scenarios and parameters from the original study would be reapplied to these apartment layouts and therefore the statistical results could be directly compared however the input data is not available in the public domain and this process would be difficult to recreate without access to BRE's in-house software.

Based on the above background it is therefore proposed that a reasonable alternative would be to focus on the apartment parameters that can be assessed (i.e. the fire dynamics within the apartments and the apartment geometric and escape provisions). It is proposed that whilst the occupant escape parameters cannot be assessed against the conditions within the apartments, it is clear that the conditions within a BS9991 compliant apartment layout are considered to be acceptable for a given fire scenario. It therefore follows that for the same fire scenario if the conditions within the actual apartment layouts are similar or better than those in the BS9991 compliant layouts then the layouts should therefore be acceptable.

Using this rationale a comparison has been performed for each apartment scenario between the actual apartment layout and the BRE research apartment scenario with open plan kitchens (i.e. apartments up to 8m x 4m). The larger BRE considered apartments have been ignored for the purposes of this study as the kitchens were enclosed and therefore a direct comparison is not considered valid.

Apartments to be compared

The overall shape and geometry of the apartments can influence the conditions predicted, particularly where CFD modelling is used. In this case the BRE research layouts were relatively complex and non-uniform layouts therefore it is potentially possible to artificially influence the comparison by applying these layouts. To address this a reasonable standardised BS9991 compliant apartment layout was used as a basis for the comparison which fully adopted the recommendations of BS9991.

In addition to the above as the focus of this study relates to the open plan space all fire scenarios and comparisons focused on the open plan living-kitchen areas therefore the entire apartments were not modelled at any point.

The only exception to this was for the units which include inner-inner bedrooms. In these situations multiple configurations were considered to reflect the different room separations (i.e. the situation of the two access rooms being open, then a fire scenario in each access room with the room doors closed). The same philosophy of justification has been adopted in each scenario.

Dimensional Analysis

Due to the comparative nature of the study pre-movement times are not considered on the basis that assuming the occupants are the same in both apartment scenarios then their reactions and responses to the scenario will also be the same.

This principle also follows for inner-inner room situations as the open plan concept assumes that occupants are not visually linked to access routes and so at that point whether escape is through one room or two is not fundamentally different. The proviso to this rationale is that the escape routes through the respective rooms still remain tenable within the wider parameters of this comparison when the access room spaces are in their various open and closed door conditions.

More critical to the comparison are the impact of the occupant exposure to the fire gases during the escape period. The key parameter driving this beyond the pre-movement times are the travel distances required through the access room and to a lesser degree the overall travel distance within the apartments.

Fire Dynamics Analysis

Both the standardised BRE apartment layout and the actual apartment layouts were assessed to fully understand the performance of each case. This assessment was performed using the CFD model, Fire Dynamics Simulator (FDS).

A reasonably conservative fire scenario was applied to each case, with the fire being only considered in the open plan living-kitchen space. The fire considered was a medium growth rate fire, allowed to grow throughout the modelled period (i.e. 300 seconds) and therefore achieving a maximum fire size of 1.1MW.

In each fire scenario the impact of sprinkler suppression was excluded therefore the only interaction between the sprinkler sprays and the fires were the cooling effect on the gas layer and the turbulence mixing between the two fluid phases.

Comparison of Results

The findings from both the dimensional and fire dynamics assessments were then assessed to establish firstly if the conditions in the actual apartment layouts maintained tenable conditions for a similar or longer period to the standardise compliant layouts. Secondly that where increased travel distances were present in the actual layouts that these were considered in conjunction with the tenability periods.

A4.0 PERFORMANCE CRITERIA

In order to demonstrate that the actual apartment layouts are acceptable the following comparative criteria must be met:

- The tenable conditions within the actual layouts must be maintained for the same time period or longer than the BS9991 compliant layouts.
- The tenable conditions must be suitable longer in the actual apartment layouts to allow for the extra time needed to traverse any extended travel distances (particularly in the open plan space).

In each modelling scenario tenability was considered in terms of visibility and gas temperatures with the associated tenable limits being taken as the following:

- Vision distances greater than 10m up to 2.0m above floor level
- Gas temperatures of less than 60ºC up to 2.0m above floor level

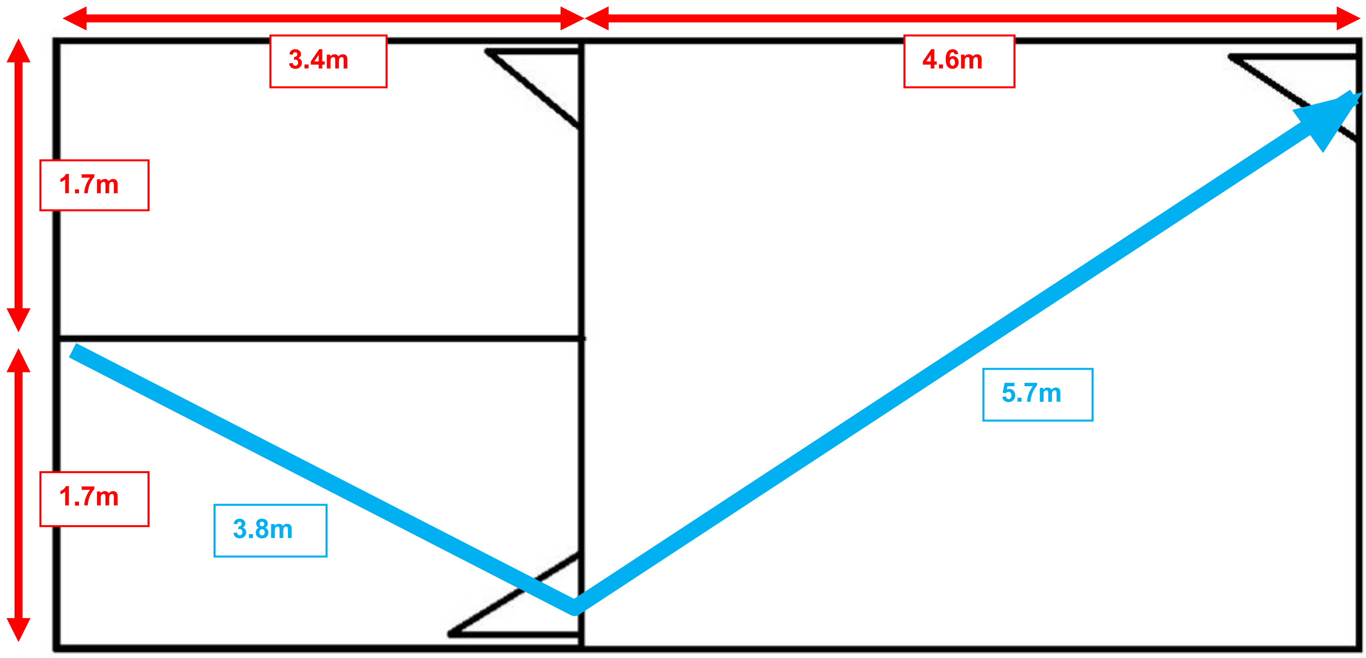
As this is a comparative study the actual values taken to be the tenable limits are relatively arbitrary providing that they are applied consistently to all scenarios. However, in this case the tenable limits have been taken from BS7974 Part 6. BS7974 Part 6 acknowledges that for vision distances of more than 5m toxicity limits are not usually exceeded and therefore this study has not considered the toxicity levels within any of the modelling scenarios.

A5.0 BS9991 STANDARDISED APARTMENTS

The guidance in BS9991 for the internal layouts of open plan apartments is very vague and leaves a very wide range of potential layouts as "compliant" albeit that these would also have a wide variance in their associated levels of safety.

In our opinion any form of comparison must maintain a degree of reasonability in the scenario to which a comparison is made against and therefore below is the layout that has been used as the BS 9991 compliant scenario. As indicated the BRE's smallest 8m by 4m apartment has been considered, as this is the largest apartment size permissible with the kitchen open to the living space under the BS 9991 guidance.

- Standardised BRE Scenario 1, 8m by 4m.



The ceiling height within the above scenario was taken as the minimum 2.25m.

A6.0 APARTMENT LAYOUT DISCUSSIONS

Dimensional Analysis

Based on the discussions in Section A5.0 and a review of the architectural layouts for the various open plan apartment types on the development, the following table summarises the relative travel distances, areas and volumes for each scenario.

Scenario	Overall Travel Distance	Travel in Access Room	Access Room Area	Access Room Volume	Ceiling Height
WCH Unit	8.8m	4.6m	$28m^2$	$70.1m^3$	2.5m
2B Unit	9.8m	5.1m	$22.9m^2$	$57.25m^3$	2.5m
1B Unit (open living-kitchen)	7.5m	3.9m	$17.24m^2$	$43.1m^3$	2.5m

Scenario	Overall Travel Distance	Travel in Access Room	Access Room Area	Access Room Volume	Ceiling Height
1B Unit (separate kitchen)	7.5m	3.1m	$7.04m^2$	$17.6m^3$	2.5m
1B Unit (separate lounge)	5m	1m	$9.86\ m^2$	$24.65m^3$	2.5m
BRE Scenario 1	9.5m	5.7m	$15.64m^2$	$35.19m^3$	2.25m

From these results the proposed apartment travel distances in the access rooms are broadly similar to those of the standardised BRE layout. For the scenarios considered in this appendix it is considered that a fire would be in the access room and not the bedrooms, and therefore travel within the bedrooms will be considerably quicker than travel within the fire room.

BS7974 Part 6 recommends travel speeds of between 0.3 – 1.2m/s depending on the occupant characteristics and the conditions on the travel route. Applying 0.3m/s to travel in the access room and 1.2m/s to the bedrooms to the scenarios above give the following results:

Scenario	Overall Travel Distance	Travel in Access Room	Overall Travel Time
WCH Unit	8.8m	4.6m	18.83s (-3.36s)
2B Unit	9.8m	5.1m	20.916s (-1.2s)
1B Unit (open living-kitchen)	7.5m	3.9m	16s (-6.2s)
1B Unit (separate kitchen)	7.5m	3.1m	13.93s (-8.27s)
1B Unit (separate lounge)	5m	1m	6.6s 15.6s (with kitchen travel included) (-6.6s)
BRE Scenario 1	9.5m	5.7m	22.2s

Based on the results of the dimensional assessment above the escape routes in actual units each has a much shorter travel time than the BRE standardised scenario and therefore for these layouts the fire dynamics assessment must show that tenable conditions within these actual layouts are maintained ideally at least as long as in BRE Scenario 1 but not less than the time difference between the actual layout and the BRE Scenario.

Fire Dynamics Analysis

Overview

As discussed in Section A3.0 this part of the analysis conducted a CFD models for each of the open plan apartments. For the purposes of these models only the access room itself was modelled.

A medium growth rate fire was modelled and allowed to grow throughout the modelled period for each of the layouts being assessed.

Each model included gypsum plaster based walls and ceilings and included a single permanently open $1.0m^2$ vent at floor level to represent air leakage that would be present within the apartments (i.e. kitchen and bathroom extracts, window trickle vents or HVAC venting and door leakage) and to prevent the fire becoming ventilation controlled prior to tenable limits being reached. The location and size of the leakage venting was consistent for each modelling scenario. In each case a 2m wide, 0.5m high vent was placed on the external wall of the apartment at floor level.

All models included a single smoke detector located at the centre of the open plan space, and in the case of the BRE scenario a sprinkler head laid out in accordance with the spacing guidelines found in BS 9251. The sprinkler representation was based on the response times, spray head distributions and water flow rates applicable to residential sprinkler heads.

Each simulation was run over a period of 300s (5 minutes).

Further details of the CFD modelling are included in Section A11 of this Appendix.

Comparison Results

Each simulation was limited to an assessment of visibility and gas temperatures in addition to events like the smoke detection time. This is considered reasonable on the basis that visibility parameters tend to be considered untenable prior to parameters such as toxicity.

The images below give a visual representation of the simulation model configurations for each of the assessed layouts. As visibility was the parameter that exceeds the tenability criteria first in all of the modelled scenarios, the visibility is the defining parameter for the available safe egress times for comparison purposes. In order to allow a thorough review of the modelling undertaken, the full model input and output files for each scenario will be made available to the approving authorities and design team alongside this report.

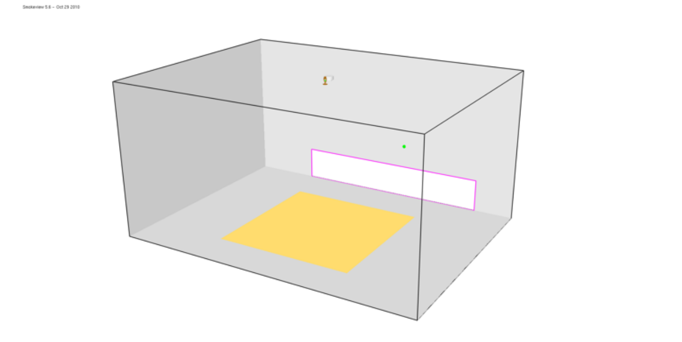
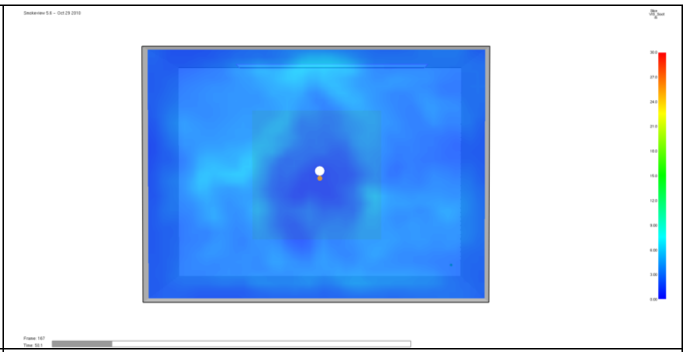
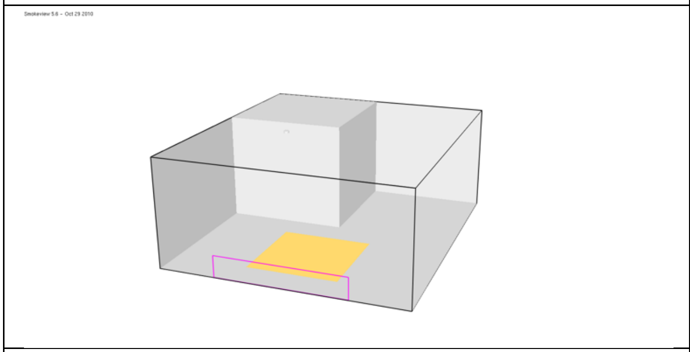
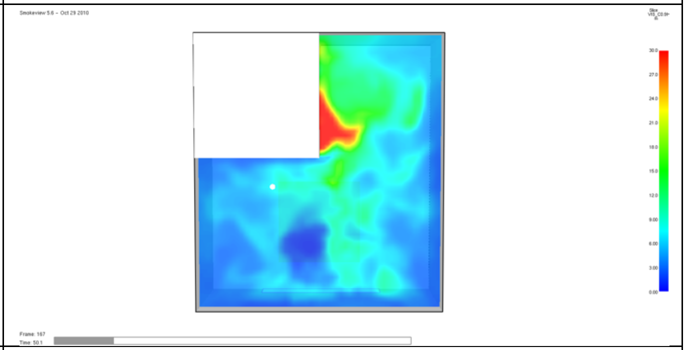
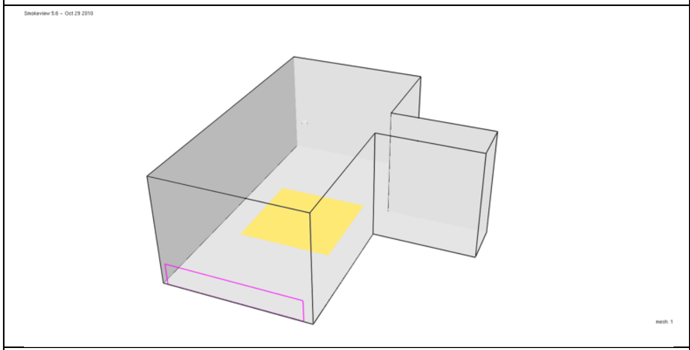
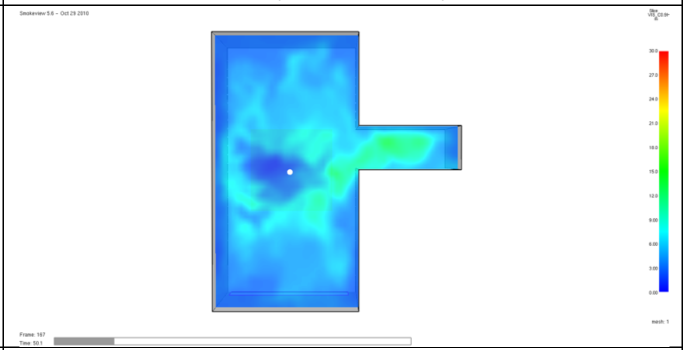
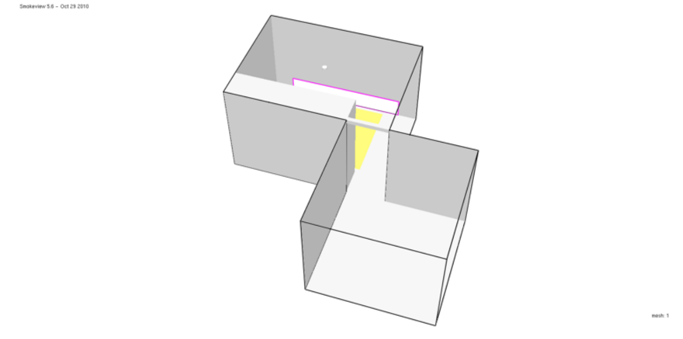
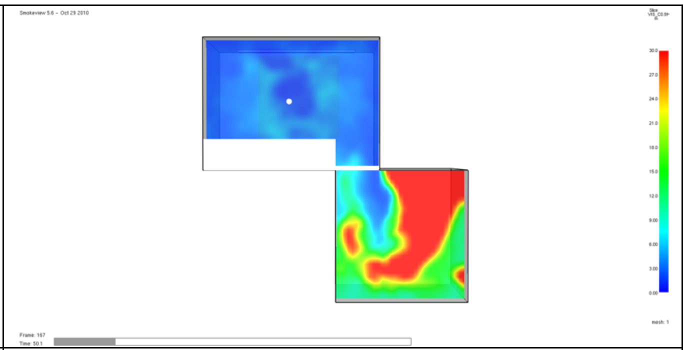
	
BRE Scenario 1	BRE Scenario 1 – Visibility after 50s
	
WCH Unit	WCH Unit Layout – Visibility after 50s
	
2B Unit	2B Unit Layout – Visibility after 50s

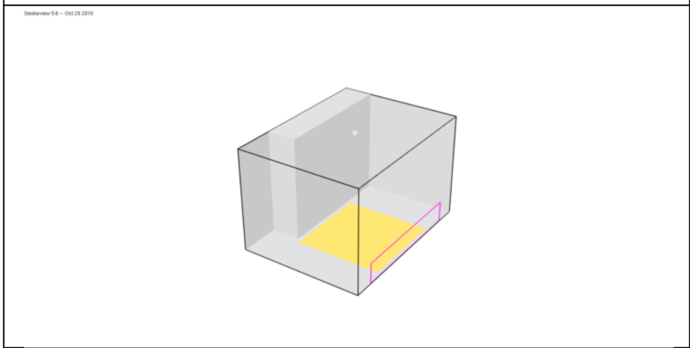
Figure A6.1 – Visual representations of CFD models



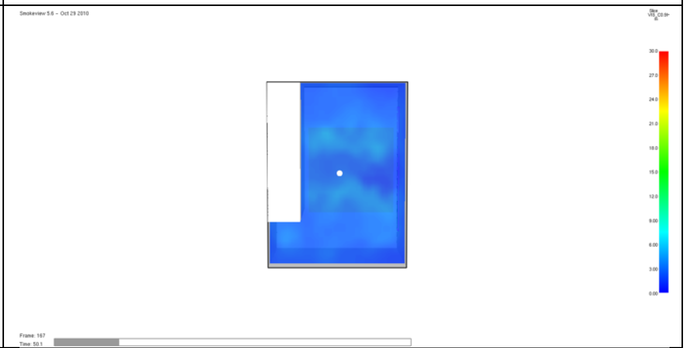
1B Unit (Open Living-kitchen)



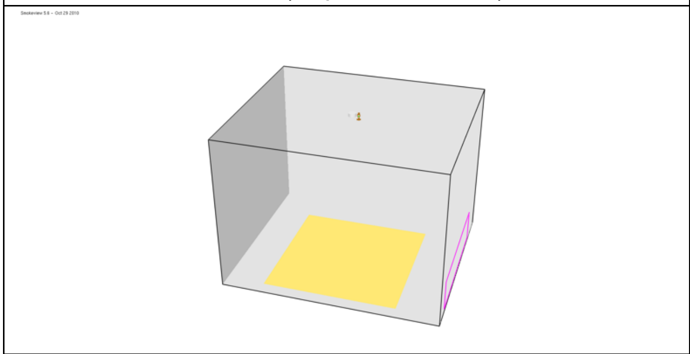
1B Unit (Open Living-kitchen) Layout – Visibility after 50s



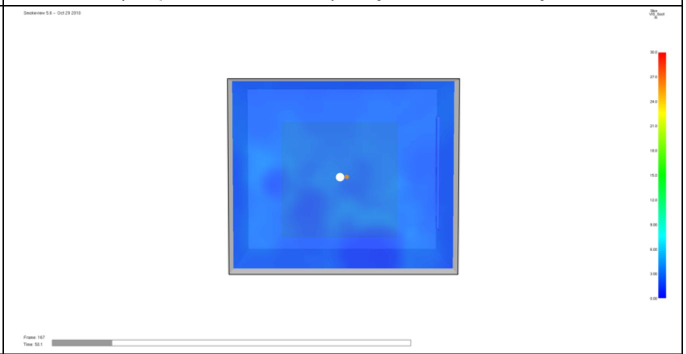
1B Unit (Separate Kitchen)



1B Unit (Separate Kitchen) Layout – Visibility after 50s



1B Unit (Separate Lounge)



1B Unit (Separate Lounge) Layout – Visibility after 50s

Figure A6.1 (Cont) – Visual representations of CFD models

The smoke detector activation times predicted in the various simulations are quoted below along with the times at which conditions at 2.0m above floor level become untenable.

Scenario	Detection Time	ASET (2.0m)	Time Difference
WCH Unit	25.5s	57.6s	32.1s (11.4s)
2B Unit	23.4s	53.1s	29.7s (9s)
1B Unit (open living-kitchen)	24.0s	63.6s (overall) 47.7s (kitchen)	39.6s (18.9s) 23.7s (3s)
1B Unit (separate kitchen)	24.0s	40.2s	16.2s (-4.5s)
1B Unit (separate lounge)	24.1s	45.3s	21.2s (0.5s)
BRE Scenario 1	23.7s	44.4s	20.7s

Based on the results discussed above across all of the results for the modelled scenarios, tenable conditions were maintained for in excess of the required extensions in all apartments when compared against the standardised BS9991 apartment with an open kitchen. It should be noted that in the one bedroom unit with the kitchen separated off the overall tenable period was 4.5s less than the BRE Scenario however as the travel time for this layout was 8.27s shorter than the BRE Scenario this counteracts the slightly lower tenability time. Similarly for a fire in the lounge of this unit with the lounge door closed the tenable period was 0.5s longer than the BRE scenairo with the travel time require being 6.6s less and therefore the inner inner room situation is better than the BRE scenario with both the access room doors open (i.e. a single open plan access space) or with the doors closed (inner inner rooms).

Comparison of Results

The dimensional analysis demonstrated that the travel times in the apartment types considered were similar or marginally extended when compared to the standardised BS9991 compliant layout. In each layouts the access room volume was also larger, due mainly to ceiling height differences between the proposed layouts and the BS9991 compliant layout.

Following this the CFD analysis demonstrated that tenable conditions were maintained for in excess of the required period of time than the equivalent BS9991 compliant layout in each of the proposed apartment types, including when the additional travel time for the extended routes was taken into account. Based on these observations it is considered that the layouts of the proposed apartments are acceptable with the kitchen open to the living space. Furthermore the inner-inner bedroom configurations are also justified based on these parameter.

A10.0 CONCLUSIONS & RECOMMENDATIONS

Based on the analysis that has been performed in the previous sections of this appendix it is proposed that the open plan units present are acceptable with the kitchens remaining open to the living space based purely on the proposed layouts when supported by LD1 standard fire alarm and detection systems and BS 9251 residential sprinklers.

This justification also supports the inner-inner room arrangements present in some of the layouts on this scheme.

A11.0 APPENDIX A – CFD MODELLING SUMMARY

The package used for this assessment was called Fire Dynamics Simulator (FDS) and was created and developed by the National Institute of Standards and Technology (NIST). The version used for this assessment was Version 6.

Fire Dynamics Simulator (FDS) is a computational fluid dynamics (CFD) model of fire-driven fluid flow. The software has been developed by NIST over a number of years and was originally intended to predict fire spread behaviour in warehouse racking systems. FDS's core program solves numerically a form of the Navier-Stokes equations appropriate for low-speed, thermally-driven flow with an emphasis on smoke and heat transport from fires. The formulation of the equations and the numerical algorithm are contained in the reference document, "Fire Dynamics Simulator (Version 6) – Technical Reference Guide". FDS is accompanied by a visualization package, Smokeview, which allows all the results from FDS to be viewed in a meaningful way. Both these pieces of software have been used in this report. Detailed descriptions of all FDS and Smokeview documentation and the programs themselves can be freely downloaded from the NIST Website (http://www.fire.nist.gov/fds/).

The model considered here incorporate a number of the in-built sub-models which form part of the FDS software. In this case the model included the inbuilt turbulence (Large Eddy Simulation, LES), radiation and combustion models. Each of these models is based on recognised scientific theory which have been developed and further validated by scientific research conducted by NIST.

The turbulence sub-model used for these simulations was the Large Eddy Simulation (LES) model which is the default turbulence approximation used as part of FDS's Hydrodynamic Model. FDS solves numerically a form of the Navier-Stokes equations appropriate for low speed, thermally-driven flow with an emphasis on smoke and heat transport from fires. The core algorithm is an explicit predictor-corrector scheme, second order accurate in space and time. Turbulence is treated by means of the Smagorinsky form of Large Eddy Simulation (LES).

Radiative heat transfer is included in the model via the solution of the radiation transport equation for a non-scattering gray gas. The radiation equation is solved using a technique similar to a finite volume method for convective transport, thus the name given to it is the Finite Volume Method (FVM). Using approximately 100 discrete angles, the finite volume solver requires about 15 % of the total CPU time of a calculation, a modest cost given the complexity of radiation heat transfer. Water droplets can absorb thermal radiation. The absorption coefficients are based on Mie theory.

The combustion sub-model used has been developed as an integral part of the FDS software. FDS uses a mixture fraction combustion model. The mixture fraction is a conserved scalar quantity that is defined as the fraction of gas at a given point in the flow field that originated as fuel. The model assumes that combustion is mixing-controlled, and that the reaction of fuel and oxygen is infinitely fast. The mass fractions of all of the major reactants and products can be derived from the mixture fraction by means of “state relations,” empirical expressions arrived at by a combination of simplified analysis and measurement. In this case the simulations were based on the reaction chemistry for “Wood” as the majority of the products stored are expected to be cellulose based. This chemistry was however modified to include a 10% soot yield to reflect current advise from London Fire Brigade’s Fire Engineering Group.

The model boundary conditions were assigned in the conventional FDS manner with all solid surfaces assigned thermal boundary conditions, plus information about the burning behaviour of the material. Usually, material properties are stored at the start of the FDS input file and then invoked by name. Heat and mass transfer to and from solid surfaces is usually handled with empirical correlations. Each material property is discussed below.

The modelling cases for the actual apartment living areas were based on the design dimensions provided by the Bell Philips Architects drawings. The representative BRE models maintained the same floor areas as indicated in Section A5 of this appendix.

The key areas of interest in these models were the fire dynamics occurring between the fire source and the room enclosure. In this case considering the size of the space a fine mesh was required to make a representative model of the fire plume and compartment. To achieve this each model included a fine mesh of dimensions (0.1m x 0.1m x 0.1m).

All blockages were included with material properties representative of those in the finished building i.e. gypsum plaster for all walls and ceilings. The material properties were taken from the internal FDS material database that specifies the friction coefficients and heat transfer properties representative for that material.

The finished apartments will not included any dedicated smoke vents and therefore no additional vents were included in any of the models. However a low level vent was introduced to ensure that the models had sufficient oxygen supply to support the combustion process throughout the simulation (effectively representing leakage routes that will be present to each apartment). In this case the opening had the dimensions of 2m wide by 0.5m high and was located at floor level in the access room. The opening was modelled using FDS’s default “OPEN” vent criteria. This condition assumes a windless environment with the flow into or out of the domain being determined by the pressure difference between the inside and the outside of the modelling domain. The opening was open throughout the simulation. This vent was considered acceptable as although the building will be constructed to a high standard the finished building will still include air leakage paths which will provide oxygen to support the combustion process, unlike the CFD model which assumes the enclosure is perfectly sealed with the exception of the vents. Beyond this the top edge of the vent is at only 0.5m above floor level which is also well below the critical gas layer height of concern here. Finally this vent is provided to each model so enables consistent comparisons to be made.

A Medium fire growth rate was used in each model, along with an ultimate heat release rates of 1.1MW and an overall heat release rate density of 250kW/m^2. Although sprinklers were included within the models there was no direct suppression of the fire source included therefore the sprinklers only interacted with the gas phase.

Each simulation only considered means of escape and therefore each scenario was run for 300s (5 minutes) on the basis that it is well in excess of the worst case evacuation time likely. The ambient conditions within the model were taken as a temperature of 20^{o}C and no wind.

FDS CFD Modelling Input Files

BRE Scenario

```
&MESH IJK=46,34,23, XB=0.0,4.6,0.0,3.4,0.0,2.3 / 100mm uniform mesh

&TIME T_END=300.0 / 300s simulation time

&MISC SURF_DEFAULT='WALL' /

&REAC ID        = 'WOOD'
     FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
     SOOT_YIELD = 0.1
     CO_YIELD   = 0.02
```

N = 0.0
C = 3.4
H = 6.2
O = 2.5 /

```
&MATL ID          = 'GYPSUM PLASTER'
     FYI          = 'Quintiere, Fire Behavior'
     CONDUCTIVITY  = 0.48
     SPECIFIC_HEAT = 0.84
     DENSITY       = 1440. /

&SURF ID           = 'WALL'
     RGB           = 200,200,200
     MATL_ID       = 'GYPSUM PLASTER'
     THICKNESS     = 0.0125 /

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE TEMPERATURE','PARTICLE AGE',
     DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 1.2, 3.3, 0.6, 2.7, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&VENT XB= 1.0, 4.0, 3.4, 3.4, 0.0, 0.5, SURF_ID='OPEN' / Apartment Leakage (1.5sqm Outside)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0, ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0, SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=2.35, 1.65, 2.25, PROP_ID='K-60' / Sprinkler 1

&DEVC ID='SD_A', PROP_ID='Acme Smoke DetectorA', XYZ=2.35,1.75,2.25 /
&PROP ID='Acme Smoke DetectorA', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8, ACTIVATION_OBSCURATION=3.24 /

&BNDF QUANTITY='NET HEAT FLUX' /

&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /

&SLCF PBX=2.3, QUANTITY='TEMPERATURE' /
&SLCF PBY=1.7, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=2.3, QUANTITY='VISIBILITY' /
&SLCF PBY=1.7, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /

&TAIL /
```

Actual Unit - WCH Scenario

```
&HEAD CHID='WCHUnit', TITLE='Chester Road, Wheel Chair Unit - Medium Growth Rate Fire'  /

&MESH IJK=56,63,25, XB=0.0,5.6,0.0,6.3,0.0,2.5, / 100mm uniform

&TIME T_END=300.0 / 300s simulation time
```

```
&MISC SURF_DEFAULT='WALL' /

&REAC ID        = 'WOOD'
     FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
     SOOT_YIELD = 0.1
     CO_YIELD   = 0.02
     N          = 0.0
     C          = 3.4
     H          = 6.2
     O          = 2.5  /

&MATL ID          = 'GYPSUM PLASTER'
     FYI          = 'Quintiere, Fire Behavior'
     CONDUCTIVITY  = 0.48
     SPECIFIC_HEAT = 0.84
     DENSITY       = 1440. /

&SURF ID           = 'WALL'
     RGB          = 200,200,200
     MATL_ID       = 'GYPSUM PLASTER'
     THICKNESS      = 0.0125 /

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE
TEMPERATURE','PARTICLE AGE',
     DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 1.7, 3.8, 0.7, 2.8, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&OBST XB=0.0, 2.8, 3.5, 6.3, 0.0, 2.5, SURF_ID='WALL' / Bathroom Obstruction

&VENT XB= 1.3, 4.3, 0.0, 0.0, 0.0, 0.5, SURF_ID='OPEN' / Leakage (Outside - 1.5sqm)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0,
ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0,
SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=1.75, 2.75, 2.45, PROP_ID='K-60' / Sprinkler 1

&PROP ID='Acme Smoke DetectorA', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8,
ACTIVATION_OBSCURATION=3.28 /
&DEVC ID='SD_A', PROP_ID='Acme Smoke DetectorA', XYZ=1.75,2.85,2.45 /

&BNDF QUANTITY='NET HEAT FLUX' /

&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /

&SLCF PBX=1.65, QUANTITY='TEMPERATURE' /
&SLCF PBY=2.85, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=1.65, QUANTITY='VISIBILITY' /
&SLCF PBY=2.85, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /
```

```
&TAIL /
```

Actual Unit – 2B Scenario

```
&HEAD CHID='2BUnit', TITLE='Chester Road, 2 Bed Unit - Medium Growth Rate Fire'  /

&MESH IJK=33,63,25, XB=0.0,3.3,0.0,6.3,0.0,2.5, / 100mm uniform
&MESH IJK=23,10,25, XB=3.3,5.6,3.2,4.2,0.0,2.5, / 100mm uniform

&TIME T_END=300.0 / 300s simulation time

&MISC SURF_DEFAULT='WALL' /

&REAC ID         = 'WOOD'
     FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
     SOOT_YIELD = 0.1
     CO_YIELD   = 0.02
     N          = 0.0
     C          = 3.4
     H          = 6.2
     O          = 2.5  /

&MATL ID           = 'GYPSUM PLASTER'
     FYI          = 'Quintiere, Fire Behavior'
     CONDUCTIVITY  = 0.48
     SPECIFIC_HEAT = 0.84
     DENSITY       = 1440. /

&SURF ID           = 'WALL'
     RGB          = 200,200,200
     MATL_ID       = 'GYPSUM PLASTER'
     THICKNESS      = 0.0125 /

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE TEMPERATURE','PARTICLE AGE',
     DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 0.6, 2.7, 2.1, 4.2, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&VENT XB= 0.1, 3.1, 0.0, 0.0, 0.0, 0.5, SURF_ID='OPEN' / Leakage (Outside - 1.5sqm)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0, ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0, SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=1.75, 3.05, 2.45, PROP_ID='K-60' / Sprinkler 1

&PROP ID='Acme Smoke DetectorA', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8, ACTIVATION_OBSCURATION=3.28 /
&DEVC ID='SD_A', PROP_ID='Acme Smoke DetectorA', XYZ=1.75,3.15,2.45 /

&BNDF QUANTITY='NET HEAT FLUX' /

&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /
```

```
&SLCF PBX=1.65, QUANTITY='TEMPERATURE' /
&SLCF PBY=3.15, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=1.65, QUANTITY='VISIBILITY' /
&SLCF PBY=3.15, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /

&TAIL /
```

Actual Unit – 1B (Open living-kitchen) Scenario

```
&HEAD CHID='1BBUnit', TITLE='Chester Road, 1 Bed Unit Kitchen and living Only - Medium Growth Rate Fire'  /

&MESH IJK=40,30,25, XB=0.0,4.0,3.0,6.0,0.0,2.5, / 100mm uniform
&MESH IJK=30,30,25, XB=3.0,6.0,0.0,3.0,0.0,2.5, / 100mm uniform

&TIME T_END=300.0 / 300s simulation time

&MISC SURF_DEFAULT='WALL' /

&REAC ID         = 'WOOD'
     FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
     SOOT_YIELD = 0.1
     CO_YIELD   = 0.02
     N          = 0.0
     C          = 3.4
     H          = 6.2
     O          = 2.5  /

&MATL ID           = 'GYPSUM PLASTER'
     FYI          = 'Quintiere, Fire Behavior'
     CONDUCTIVITY  = 0.48
     SPECIFIC_HEAT = 0.84
     DENSITY       = 1440. /

&SURF ID            = 'WALL'
     RGB          = 200,200,200
     MATL_ID       = 'GYPSUM PLASTER'
     THICKNESS      = 0.0125 /

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE TEMPERATURE','PARTICLE AGE',
     DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 1.0, 3.1, 3.8, 5.9, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&OBST XB=0.0, 3.0, 3.0, 3.7, 0.0, 2.5, SURF_ID='WALL' / Bathroom Obstruction
&OBST XB=0.0, 6.0, 3.0, 3.1, 2.4, 2.5, SURF_ID='WALL' / Soffit Obstruction

&VENT XB= 0.5, 3.5, 6.0, 6.0, 0.0, 0.5, SURF_ID='OPEN' / Leakage (Outside - 1.5sqm)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0, ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0, SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=1.95, 4.45, 2.45, PROP_ID='K-60' / Sprinkler 1
```

&PROP ID='Acme Smoke DetectorA', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8, ACTIVATION_OBSCURATION=3.28 /
&DEVC ID='SD_A', PROP_ID='Acme Smoke DetectorA', XYZ=1.95,4.55,2.45 /

&BNDF QUANTITY='NET HEAT FLUX' /

&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /

&SLCF PBX=1.95, QUANTITY='TEMPERATURE' /
&SLCF PBY=4.55, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=1.95, QUANTITY='VISIBILITY' /
&SLCF PBY=4.55, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /

&TAIL /

Actual Unit – 1B (Separate kitchen) Scenario

&HEAD CHID='1BAUnit', TITLE='Chester Road, 1 Bed Unit Kitchen Only - Medium Growth Rate Fire' /

&MESH IJK=40,30,25, XB=0.0,4.0,0.0,3.0,0.0,2.5, / 100mm uniform

&TIME T_END=300.0 / 300s simulation time

&MISC SURF_DEFAULT='WALL' /

```
&REAC ID        = 'WOOD'
     FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
     SOOT_YIELD = 0.1
     CO_YIELD   = 0.02
     N          = 0.0
     C          = 3.4
     H          = 6.2
     O          = 2.5  /

&MATL ID           = 'GYPSUM PLASTER'
     FYI          = 'Quintiere, Fire Behavior'
     CONDUCTIVITY  = 0.48
     SPECIFIC_HEAT = 0.84
     DENSITY       = 1440. /

&SURF ID           = 'WALL'
     RGB           = 200,200,200
     MATL_ID       = 'GYPSUM PLASTER'
     THICKNESS     = 0.0125 /
```

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE TEMPERATURE','PARTICLE AGE',
DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 1.0, 3.1, 0.8, 2.9, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&OBST XB=0.0, 3.0, 0.0, 0.7, 0.0, 2.5, SURF_ID='WALL' / Bathroom Obstruction

&VENT XB= 0.5, 3.5, 3.0, 3.0, 0.0, 0.5, SURF_ID='OPEN' / Leakage (Outside - 1.5sqm)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0, ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0, SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=1.95, 1.45, 2.45, PROP_ID='K-60' / Sprinkler 1

&PROP ID='Acme Smoke DetectorA', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8, ACTIVATION_OBSCURATION=3.28 /
&DEVC ID='SD_A', PROP_ID='Acme Smoke DetectorA', XYZ=1.95,1.55,2.45 /

&BNDF QUANTITY='NET HEAT FLUX' /

&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBZ=1.95, QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /

&SLCF PBX=1.95, QUANTITY='TEMPERATURE' /
&SLCF PBY=1.55, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=1.95, QUANTITY='VISIBILITY' /
&SLCF PBY=1.55, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /

&TAIL /

Actual Unit – 1B (Separate lounge) Scenario

&HEAD CHID='CR2', TITLE='Chester Road - Medium Growth Rate Fire, Living Room Fire Door Closed' /

&MESH IJK=34,29,25, XB=0.0,3.4,0.0,2.9,0.0,2.5, / 100mm uniform mesh 1

&TIME T_END=300.0 / 300s simulation time

&MISC SURF_DEFAULT='WALL' /

```
&REAC ID        = 'WOOD'
    FYI='Ritchie, et al., 5th IAFSS, C_3.4 H_6.2 O_2.5'
    SOOT_YIELD = 0.1
    N         = 0.0
    C         = 3.4
    H         = 6.2
    O         = 2.5  /

&MATL ID           = 'GYPSUM PLASTER'
    FYI          = 'Quintiere, Fire Behavior'
    CONDUCTIVITY  = 0.48
    SPECIFIC_HEAT = 0.84
    DENSITY       = 1440. /
```

&SPEC ID='WATER VAPOR'/

&PART ID='water drops', SPEC_ID='WATER VAPOR', QUANTITIES(1:3)='PARTICLE DIAMETER','PARTICLE TEMPERATURE','PARTICLE AGE',
DIAMETER=750., SAMPLING_FACTOR=1 /

&SURF ID = 'WALL'

```
RGB          = 200,200,200
MATL_ID      = 'GYPSUM PLASTER'
THICKNESS    = 0.0125 /

&SURF ID='BURNER', HRRPUA=250., TAU_Q=-300.0 /
&VENT XB= 0.6, 2.7, 0.2, 2.3, 0.0, 0.0, SURF_ID='BURNER' / Fire, Medium growth, 1102kW Maximum

&VENT XB= 3.4, 3.4, 0.4, 2.4, 0.0, 0.5, SURF_ID='OPEN' / Leakage (Outside - 1sqm)

&PROP ID='K-60', QUANTITY='SPRINKLER LINK TEMPERATURE', RTI=50.0, C_FACTOR=0.0, ACTIVATION_TEMPERATURE=68.0,
OFFSET=0.05, PART_ID='water drops', FLOW_RATE=60.0, PARTICLE_VELOCITY=10.0, SPRAY_ANGLE=30.0,80.0 /

&DEVC ID='Spr-1', XYZ=1.75, 1.45, 2.45, PROP_ID='K-60' / Sprinkler 1

&DEVC ID='SD_A', PROP_ID='Acme Smoke Detector', XYZ=1.65,1.45,2.45 /
&PROP ID='Acme Smoke Detector', QUANTITY='CHAMBER OBSCURATION', LENGTH=1.8, ACTIVATION_OBSCURATION=3.24 /

&BNDF QUANTITY='RADIATIVE HEAT FLUX' /

&SLCF PBX=1.75, QUANTITY='TEMPERATURE' /
&SLCF PBY=1.45, QUANTITY='TEMPERATURE' /
&SLCF PBZ=1.95, QUANTITY='TEMPERATURE' /

&SLCF PBX=1.75, QUANTITY='VISIBILITY' /
&SLCF PBY=1.45, QUANTITY='VISIBILITY' /
&SLCF PBZ=1.95, QUANTITY='VISIBILITY' /

&TAIL /
```