HOARE LEA (H.)

Design Note.

To:	Planning Gateway One Team (Health and Safety Executive)
Cc:	Project design team
From:	Eric Swainson, Associate
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Qualitative Design Review – Common corridor travel distances.

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	04/08/2022	Draft for comment	ES	AS	MH
01	17/08/2022	Updated in line with design team comments	ES	AS	MH
02	02/11/2023	Updated in line with redesign of blocks over 18m in height	ES	BR	MH

1. Introduction

Hoare Lea has been appointed to provide fire safety advice for the Stag Brewery scheme in London. The scheme consists of twenty one blocks the majority of which are proposed to be mixed use residential buildings. All blocks are proposed to be under 30m in height and the development is located in the London Borough of Richmond upon Thames. Some of the buildings are proposed to be over 18m in height and thus qualify as Higher Risk Buildings under the Building Safety Act. The buildings under 18m in height are proposed to be designed with a single stair serving the residential levels (Buildings 1, 3, 6, 9, 10, 13, 14, 16, 18 and 19). The buildings over 18m will be provided with two stairs (2, 4, 7, 8, 11, 12 15 and 17). Building 5 is under 18m but designed as a hotel and is provided with two stairs, building 20 and 21 are made up of individual dwellings. Currently extended travel distances are provided in the dead ends of the following buildings:

- Building 1 (single stair building) travel distances up to 20m;
- Building 3 (single stair building) travel distances up to 18m;
- Building 8 (two stair building) travel distances up to 20m;
- Building 13 (single stair building) travel distances up to 19m;
- Building 18 (single stair building) travel distances up to 19m..

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Details of the planning application are provided in Section 2 below.

The applications were submitted in March 22. In May 2022 comments from the HSE were received with the following main comments and concerns:

- Communication between the basement carparks and the above ground levels through the single residential stair shafts.
- Communication between the basement carparks and the above ground levels through the lift shafts
- Refuse stores accessed internally

Following on from receipt of these comments, a comprehensive review of the design was undertaken to ensure that the HSE concerns were addressed. The main changes to the design involved:

- Full internal separation between the basement stairs and above ground stairs with independent egress routes directly to external.
- Separate lift shafts serving the basement and above ground levels.
- Refuge stores relocated to ground floor level such that they are accessed from external only.

A full list of the comments from the HSE and a summary of how the fire engineering design has addressed these comments is provided within the document MEM-1920618-02-ES-20220727-HSE Responses-Rev03 which was issued as part of the application that was submitted in August 2022.

On 24 July 2023 the Secretary of State made a statement confirming the Government's intention to mandate second staircases in new residential buildings above 18 metres. As such the fire strategy has been amended, resulting in two stairs to all residential buildings over 18m in height and re-introducing connections to the basement car park for the two stair buildings. The basement car park fire strategy has also been updated to provide fire safety enhancements to account for the introduction of EV charging in the basement car park

During the initial PGO process (after the application submission on 11th march) the proposed design was reviewed by the Health and Safety Executive (HSE) in addition to the above concerns the HSE requested that a QDR was carried out for the development prior to the resubmission of the planning application. The QDR is a qualitative process that draws upon the experience and knowledge of the fire safety engineer and a team of others involved in the design, construction and operation of the building. The QDR should be used to identify the inputs to the quantitative analysis and acceptance criteria.

The guidance of BS 9991:2015 (*Fire safety in the design, management and use of residential buildings – Code of practice*) [3] will be used for the design of this scheme. Recommendations in BS 9991 state that the single direction travel distance within a residential common corridor should be limited to 15m (where sprinklers are provided). The Stag Brewery development is proposed to have extended travel distances up to approximately 20m (note this distance may change slightly as the design develops) in Building 1, 2, 3, 8, 13 and 18. It is proposed to justify this extended travel distance by providing an enhanced smoke ventilation system which will be justified using a fire engineered assessment supported by Computational Fluid Dynamics (CFD) modelling.

It is noted that extended travel distances within residential single stair buildings based on provision of an enhanced smoke ventilation system is a well understood and long standing fire engineered design. The proposed enhanced smoke ventilation mitigation measures have been subject to independent research carried out by the system manufacturers and extensive fire and smoke modelling carried out by fire engineers. As such the hazards of the proposed design and the benefits and limitations of the proposed mitigation methods are well understood.

However, it is recognised that guidance in BS 7974:2019 (Application of fire safety engineering principles to the design of buildings - Code of Practice) [4] recommends that before attempting to carry out a detailed quantified analysis, the fire hazards should be identified, the problem simplified and the required extent of quantification established. As the justification for extended travel distances is well understood and to avoid the need to reassess if the design changes in the early stages this process is usually carried out as the design develops. This process will include production of a Computational Fluid Dynamics (CFD) analysis of the proposed design. Before this model is created a scoping document will be produced. This document defines the fire hazards associated with the proposed design, establishes the performance criteria of the system and provides the proposed design solutions to mitigate the extended travel distance. The CFD analysis will consider the internal layouts of apartments and will consider the worst case fire scenarios both in terms of smoke spread into the stair and longest travel distance to the stair. This process traditionally acts as the QDR for the extended travel distance design.

Notwithstanding the above, it is acknowledged that the HSE consider this review should be carried out at the early stages of the design and as such this document details a preliminary QDR focusing on the extended travel distances. It is recognised that these travel distances may change as the design develops and as such this document should be treated as a live document and updated and reassessed accordingly.

2. Planning Application

2.1 Proposals

The Applications seek planning permission for:

Application A:

"Hybrid application to include the demolition of existing buildings to allow for comprehensive phased redevelopment of the site:

Planning permission is sought in detail for works to the east side of Ship Lane which comprise:

- Demolition of existing buildings (except the Maltings and the façade of the Bottling Plant and former Hotel), walls, associated structures, site clearance and groundworks
- Alterations and extensions to existing buildings and erection of buildings varying in height from 3 to 9 storeys plus a basement of one to two storeys below ground
- Residential apartments
- Flexible use floorspace for:
  - Retail, financial and professional services, café/restaurant and drinking establishment uses
  - Offices
  - Non-residential institutions and community use
  - Boathouse
- Hotel / public house with accommodation
- Cinema
- Offices
- New pedestrian, vehicle and cycle accesses and internal routes, and associated highway works
- Provision of on-site cycle, vehicle and servicing parking at surface and basement level
- Provision of public open space, amenity and play space and landscaping
- Flood defence and towpath works
- Installation of plant and energy equipment

Planning permission is also sought in outline with all matters reserved for works to the west of Ship Lane which comprise:

- The erection of a single storey basement and buildings varying in height from 3 to 8 storeys
- Residential development
- Provision of on-site cycle, vehicle and servicing parking
- Provision of public open space, amenity and play space and landscaping

– New pedestrian, vehicle and cycle accesses and internal routes, and associated highways works"

Application B:

"Detailed planning permission for the erection of a three-storey building to provide a new secondary school with sixth form; sports pitch with floodlighting, external MUGA and play space; and associated external works including landscaping, car and cycle parking, new access routes and other associated works"

Together, Applications A and B described above comprise the 'Proposed Development'.

2.2 Background to Submission

Two applications for planning permission were submitted to the London Borough of Richmond upon Thames ('LBRuT') on 11 March 2022 for the masterplan redevelopment of the Site and are currently pending determination. Consultation with statutory and public consultees has been ongoing throughout this period.

On 19 July 2023 both applications were heard at LBRuT's Planning Committee. The LBRuT's Planning Committee resolved to approve both applications, subject to the provisions set out in the Officer's Report.

On 24 July 2023 the Secretary of State made a statement confirming the Government's intention to mandate second staircases in new residential buildings above 18 metres. This followed consultation on this matter where expert bodies advocated support for this threshold.

2.3 Matters for Substitution

Although no formal transition arrangements or legislation has been announced at this stage, the Applicant has taken the decision to make amendments to the scheme which will allow it to adhere to the forthcoming changes announced on the 24 July 2023 by the Secretary of State in relation to the Government's intention to mandate second staircases in new residential buildings above 18 metres.

In summary the proposed changes to the scheme relate to Application A only and comprise changes to

Building 1 (Cinema): Three levels of office changed to residential use (creating 17 new residential units) and decrease in building height by 2.6m. The cinema floor plans remain relatively similar with changes made to accommodate the residential core, refuse and cycle stores, risers and extending the cinema café. The third floor has changed from glazed to bronze cladding to suit the change of use, a cycle store has been added to ground floor and recessed balconies added to accommodate the introduced residential use in this building;

Building 2: Internal layout changes only (including removal of top floor of duplex) – increase in 1 residential unit;

Building 4 (The Maltings): Removal of residential floorspace on floor levels 6 and 7 and internal re-configuration to include only one core with two stairs and two lifts – overall decrease in 1 residential unit. Minor elevation changes to the Maltings to re-position the double height windows and change in the layout of the ground floor flexible use areas;

Building 7: Internal layout changes only (including removal of top floor of duplex) – no change in residential unit numbers;

Building 8: Re-arrangement of internal layout to accommodate core changes (no change in residential unit mix). Mansard roof stepped out around the southern staircase to accommodate dual staircases to the 8th floor;

Building 10: Floor to ceiling heights changed very slightly to bring building under 18m;

Building 11: Internal layout changes only (third lift and second stair added affecting number of habitable rooms) – no change in residential unit numbers;

Building 12: Internal layout changes only (third lift and second stair added affecting number of habitable rooms) – no change in residential unit numbers;

Buildings 15 and 17: These buildings are in Development Area 2 and are only in outline. Changes will be internal only;

Overall increase in residential floorspace by +1,722 sqm GIA and increase in 7 private residential units (increase in 17 residential units in Development Area 1 and decrease in 10 residential units in Development Area 2). No change in affordable residential unit numbers;

Decrease in office floorspace by -2,571 sqm GIA, increase in cinema floorspace (+149 sqm GIA), and increase in flexible use (+125 sqm GIA);

Internal re-configuration of the basements to accommodate second stairwells, changes to waste stores, partitions and enlarged sprinkler tanks to satisfy updated electric vehicle fire regulations resulting in a reduction of 15 car parking spaces across the Development;

Fire strategy amended, resulting in two stairs to all residential buildings over 18m in height and re-introducing connections to the basement car park for the two stair buildings. The basement car park fire strategy has also been updated to provide fire safety enhancements to account for the introduction of EV charging in the basement car park;

Waste strategy amended, to return the refuse and recycling stores for Buildings 2, 7, 8, 11 and 12 to the basement level. For these buildings, holding stores at ground level have been provided in Buildings 3, 8 and 12 to support the collection process. Buildings 1, 3, 4, 5, 6, 9, 10 and all buildings in Development Area 2 maintain refuse and recycling stores at ground level; and

Landscaping updates associated with changes to ground floor entrances for Blocks 8, 11 and 12, with amendments to the length of private gardens, additional planting and steps moved

3. The QDR Process

The recommended structure for a QDR in accordance with BS 7974 is as follows:

1. Review of architectural design and selection of materials
2. Establish functional objectives for fire safety
3. Identify hazards and possible consequences
4. Establish trial fire safety engineered designs
5. Set acceptance criteria
6. Identify method of analysis
7. Establish fire scenarios for analysis

BS 7974 recommends that for large and complex projects the QDR should be carried out by a study team involving the fire safety engineer, members of the design team and the building operational management. It is further recommended that additional members may also include the relevant building control body, relevant fire authority and insurers. A building control body has not yet been engaged on the design.

In this instance the first draft of this QDR will be undertaken by Hoare Lea Fire Engineering Group (acting as the project fire engineers) this draft report will then be issued to the wider design team for comment on the steps highlighted above; all comments will be incorporated to a final document issued. The revision 01 issue of this document incorporated all comments from the design team. This revision 02 has been updated to reflect the change in the design to incorporate two stairs into all blocks in excess of 18m in height (measured from the lowest adjacent ground level to the top occupied storey).

4. Architectural design

The full development consists of a total of twenty-three standalone blocks, these are divided into nine mixed use residential blocks with flexible space on the ground level, eleven standalone residential blocks, an office/cinema, a school and a hotel/office. The top occupied storey of each of the blocks is highlighted below in Table 1, the height of the top occupied storey has been provided by Squire & Partner Architects.

Table 1: Building heights

Block No.	Use	No. of storeys (including ground)	Height of top occupied storey (m) Note 1
1	Cinema/office	4	13.3
2	Residential with flexible space at ground	8	24.1
3	Residential	6	17.5
4	Residential with flexible space at ground	6	19.2
5	Hotel and office	3	8.6
6	Residential with flexible space at ground, including energy plant	5	15.1
7		8	24.1
8		9	27.4
9		5	15.7
10		6	17.95
11		8	24.1
12		8	24.1
13	Residential	6	17.95
14		6	17.95
15		8	27.0
16		6	17.95
17		7	23.6
18		6	17.95
19		4	13.0
20		3	9.4

Block No.	Use	No. of storeys (including ground)	Height of top occupied storey (m) [Note 1]
21		3	9.4
n/a	School	3	<18

Note 1: For blocks 13-21 are currently designed as outline only and do not yet have set floor levels. As such the height of the top occupied storey has been assumed based on 3m below the parapet height provided by Squire & Partner Architects. Buildings 13, 14, 16 and 18 are currently proposed to be designed to be under 18m in height (to the top occupied storey), although as it is noted that they are close to the 18m. As such if the final top sotrey height exceeds this threshold they will be provided with firefighting shafts and a minimum of two stairs serving all residential levels.

Figure 1 gives an overview of the block numbers corresponding to those within Table 1 above.

Figure 1: Proposed Stag Brewery Site Numbering Plan.

The buildings will be constructed with concrete cores and the fire resisting partitions between apartments and common corridors will be provided via fire resisting plasterboard panels.

To limit the spread of fire within the buildings, all wall and ceiling linings will satisfy the appropriate classification stated within BS 9991:2015, BS 9999:2017 and ADB Volume 2:2019 for internal linings in the residential, commercial and hotel areas respectively.

The RIBA Stage 2 fire safety strategy will include a space separation analysis to establish the necessary boundary distance around each building and whether any fire protection to the external façade is required. At this stage, no significant risk of spread of fire between buildings has currently been identified; however, detailed analysis will be provided during the RIBA Stage 2 design stage and the appropriate fire resisting construction will be provided.

In accordance with Regulation 7(2) of the Building Regulations, each residential block which has a storey height in excess of 18m above the lowest adjacent external ground level (Blocks 2, 4, 7, 8, 11, 12, 15 and 17), the external wall construction, and specified attachments including balconies, solar shading or solar panels, will achieve European Classification A2-s1, d0 or Class A1. Where multiple blocks are connected by a shared basement carpark or podium and one of those blocks has a storey height in excess of 18m all connected blocks should be designed to meet the requirements of Regulation 7(2). There are two carparks proposed for the scheme and as such in addition to those blocks described above Blocks 3, 6, 10, 13 and 16 as they connect to blocks over 18m via the carpark, it should be noted that as these blocks are designed with single stairs they will not have internal connections to the carpark but rather escape routes from the carpark (or the ramp for building 10) pass through the envelope of the building.

For building 1, 9, 14, 18 and 19 the uppermost storey of the building is in excess of 11m but not more than 18m in height and, therefore, either the external walls should meet the performance criteria described in BRE report BR 135 or satisfy the following:

- any insulation product, filler material (such as the core materials of metal composite panels, sandwich panels and window spandrel panels but not including gaskets, sealants and similar) etc. used in the construction of an external wall should be class A2-s1, d0 or better,
  Note: This restriction does not apply to certain masonry cavity wall construction as described in Approved Document B.
- the external wall surface should achieve class A2-s1, d0 or better for surface spread of flame classification, and
- cavity barriers in any external wall cavity are required in accordance with the Approved Document.
- Where balconies are provided, these should only contain materials achieving class A1 or A2-s1, d0, unless with the exception of except for any of the following.
  - Cavity trays when used between two leaves of masonry.
  - Intumescent and fire-stopping materials where the inclusion of the materials is necessary to meet the requirements of Part B of Schedule 1 to the Building Regulations 2010.
  - Membranes.
  - Seals, gaskets, fixings, sealants and backer rods.
  - Thermal break materials where the inclusion of the materials is necessary to meet the thermal bridging requirements of Part L of Schedule 1 to the Building Regulations 2010.
  - Any material achieving class A1f or A2f-s1 when it forms the top horizontal floor layer of a balcony and is provided with an imperforate substrate under it which extends to the full size of the class A1f or A2f-s1 material.
  - Electrical installations.
  - Fibre optic cables.

The hotel/office buildings do not have a storey that exceeds 18m in height and, therefore, either the external walls should satisfy the performance criteria described in BRE report BR 135 or the external wall surface should be in accordance with Table 12.1 of Approved Document B Volume 2 for surface spread of flame classification, and cavity barriers in any external wall cavity are required in accordance with Section 9 of the Approved Document.

Note: In practice, it may be necessary for external surfaces to achieve a Class B-s3, d2 or better (European Classification) surface spread of flame classification to avoid the walls contributing to the space separation (unprotected areas) calculations.

Full reference should made be to the guidance provided in Approved Document B regarding recommendations for external walls.

The school building does not have a storey that exceeds 18m in height and, therefore, either the external walls should satisfy the performance criteria described in BRE report BR 135 or the external wall surface should be in accordance with Table 13 of BB 100 for surface spread of flame classification, and cavity barriers in any external wall cavity are required in accordance with Section 7.2.4.1 of BB 100.

Note: In practice, it may be necessary for external surfaces to achieve a Class B-s3, d2 or better (European Classification) surface spread of flame classification to avoid the walls contributing to the space separation (unprotected areas) calculations.

Note: With regards to surface spread of flame, care should be taken when providing advice to the client, noting that the requirements of Table 13 of BB 100 apply based on the wall height and not the storey height.

In addition, for property protection purposes, combustible cladding should be avoided at ground floor level.

Full reference should be made to the guidance provided in BB 100 regarding recommendations for external walls.

5. Functional objectives for fire safety

The functional objectives for the design of the Stag Brewery development are outlined in Table 2.

Table 2: Functional objectives for QDR assessment.

Functional objective.	Criteria to achieve
Life Safety	– Provide safety provisions in excess of the minimum recommendations outlined in code as the travel distances exceed the maximum limits in code guidance. This objective will be met by fulfilling the functional requirements of the Building Regulations.
Management of building once operational	– This objective will be met by fulfilling the requirements of the Fire Safety Order [3] and undertaking a Fire Risk Assessment (FRA) and management strategy previous to occupation.
PGO recommendations	– Comments received from the HSE as part of the Planning Gateway One process requested that a QDR be carried out on the proposed fire engineered justification for extended travel distances proposed within the building.
Property protection	– Not specifically addressed but indirectly benefits from life safety provisions.
Business continuity	– Not specifically addressed but indirectly benefits from life safety provisions.

6. Hazards and Possible consequences

Potential fire hazards and possible consequences have been assessed for the Stag Brewery development specifically in relation to the extended corridor travel distances in a single stair building, as outlined in Table 3.

Table 3: Hazards associated with the Stag Brewery development and possible consequences.

Item	Hazard	Possible consequences
1.	Apartment layout	– Apartment layouts will affect an occupant’s ability to evacuate the building successfully. Open plan layouts may lead to more

Item	Hazard	Possible consequences
		smoke spread into the common corridor when occupants evacuate the apartment. The internal apartment layouts are currently proposed to be open plan but are not fixed at this stage of the design and are subject to change.
2.	Extended common corridor travel distance	– The occupants will have longer to travel until they can reach the relative safety of the protected stair core. This could mean occupants have a longer time exposed to the heat and smoke from a fire.
3.	Residential building with a single stair	– The stair will provide the main means of escape route from the upper levels of the building in building 1, 3 and 13. A single escape stair does not provide any redundancy should the stair become blocked by fire or smoke.
4.	Car park	– Cars will be parked in the car park, in which large amounts of combustible material (i.e. composed of large amounts of plastic, fuel and electronics), leading to a potential fire within the car park. If connected to the stair that serves the residential levels a fire in the carpark could block the residential occupants escape.
5.	Electrical charging for electric cars	– Electric cars require charging points where electrical batteries are provided with electrical current. Electric current presents an ignition risk to associated fuel load which could lead to fire. Electrical vehicles have been found to represent unique hazards
6.	Refuse stores	– Bin stores contain a high degree of fire load and potential flammable gases and as such if an ignition source is present a large fire may occur in a bin store. If connected to the stair that serves the residential levels a fire in the refuse stores could block the residential occupants escape.

7. Trial design

In accordance with BS 7974, a trial design is defined as "group of fire safety measures which, in the context of the building parameters, might meet the specified functional objectives".

In accordance with BS 7974, it is considered necessary to amend the architectural design or provide additional fire safety measures to achieve the functional objectives as defined as part of the QDR process. Multiple trial designs can be identified to provide acceptable solutions to the building design. As this QDR is focusing on the extended travel distances in the common corridor where only a single direction of escape is available a single trial design has been undertaken. In developing trial designs, the focus has not been solely on additional fire protection systems but a review of the potential for reducing or eliminating some of the identified hazards by amending the construction or layout of the building has been considered.

The trial design presented analyses different iterations of the extended corridor design with diverse degrees of fire safety measures incorporated to assess which design is the most appropriate for the development based on the hazards identified in Section 6 which will be incorporated into the building design. The trial design starts at the minimum level of fire safety design and increases fire safety provisions as part of the design.

Table 4: Trial design – Extended Common corridor design.

Iterations of trial design	Fire safety provisions	Qualitative assessment
1	No fire safety provisions. The common corridor is a route from the apartment to the stair no fire resistance is provided between apartments and common corridor. Corridor is up to 25m.	It is considered that an unprotected common corridor will provide a route from the apartment to the stair for a person to evacuate during a fire. In addition, any other occupant of the building should either evacuate safely or be able to remain in place without being affected by the effect of a fire. If the corridor is unprotected it is assumed that the fire could spread into the common corridor in the event of a fire. This trial design iteration is not considered suitable as it does not comply with the recommendations of statutory guidance. This design is not considered to provide an adequate level of safety as a common corridor could be very quickly overcome, rendering means of escape provisions unusable in the event of a fire.
2	Each apartment and the common corridor is constructed out of 60-minute fire resistance.	It is considered that designing the common corridor out of fire resisting construction (60 minutes) will provide an adequate level of separation between the common corridors and adjacent apartments. As outlined in BS 9991, walls separating a dwelling and accommodation that does not form part of the dwelling by construction offering not less than 60-minute fire resistance. It is considered that the enclosure around each apartment would prevent a fire spreading into the common corridor (or other apartments) from an apartment on fire, based on a typical fire duration within a residential apartment burning for less than 60 minutes based on the typical fire load. This trial design iteration is not considered reasonable as, although the protection of the common corridor is considered to prevent fire spread into the common corridor from adjacent accommodation, the common corridor would likely become compromised by smoke. This is due to the heat and smoke which would enter the corridor while occupants are evacuating the apartment on fire into the corridor through the open apartment door. Furthermore, as smoke is likely to enter the corridor, the stair could be rendered smoke logged which would compromise evacuation from other apartments if necessary.
3	Each apartment will be provided with sprinkler protection	It is considered that sprinkler protecting the apartments will provide a significant uplift to the fire safety of occupants. Sprinkles significantly reduce the heat and

Iterations of trial design	Fire safety provisions	Qualitative assessment
	designed and installed in accordance with BS 9251:2021.	smoke produced within a fire scenario and would work with the fire resistance to reduce the likelihood of fire spread into the residential common corridor. As above this trial design iteration is not considered reasonable as, although the sprinklers will significantly reduce the fire and smoke, the common corridor may still become compromised by smoke. This is due to the heat and smoke which would enter the corridor while occupants are evacuating the apartment on fire into the corridor through the open apartment door.
3	Mechanical smoke extract system within the common corridor. Simple system without fire resisting equipment, fire resisting shafts or backup power supplies	It is considered that a mechanical smoke extract system may provide the common corridor with smoke clearance could be used to protect the single means of escape stair from the ingress of heat and smoke. Based on the guidance outlined in BS 9991 for single stair building, common corridor design. Ingress of heat and smoke into the common corridor is considered to be unavoidable and through providing a mechanical extract system it is considered that heat and smoke may be removed from the common corridor. However, due to the extended travel distance in the common corridor an enhanced ventilation system may be required to fully clear the corridor. This system will work in conjunction of an AOV at the head of stair which will provide suitable make-up air for the extract system to operate. This trial design iteration is not considered reasonable as the smoke extract may move hot smoke up the building and cause the fans to fail or lead to fire spread throughout the building.
4	Mechanical smoke extract system within the common corridor. Provided with fire resisting ductwork and fire resisting fan sets, backup power supplies are not provided.	As above it is considered that a mechanical smoke extract system may provide the common corridor with smoke clearance. The fire resisting fans and ductwork will ensure the system remains operational as it extracts the hot smoke. However, due to the extended travel distance in the common corridor an enhanced ventilation system may be required to fully clear the corridor. This trial design iteration is not considered reasonable as the smoke extract system would fail to operate if the mains power supply to the building fails.

Iterations of trial design	Fire safety provisions	Qualitative assessment
5	Mechanical smoke extract system within the common corridor. Provided with fire resisting ductwork and fire resisting fan sets and backup power supplies.	As above it is considered that a mechanical smoke extract system may provide the common corridor with smoke clearance. The backup power supplies will ensure the system remains operational should the mains power supply fail. This trial design iteration is not considered reasonable as due to the extended travel distance in the common corridor an enhanced ventilation system may be required to fully clear the corridor.
6	Double-Reversible-Mechanical-Extract (DRME) system within the common corridor. Provided with fire resisting ductwork and fire resisting fan sets and backup power supplies.	It is considered that a DRME system within the common corridor would provide suitable means of ventilating the common corridor and protecting the stair from ingress of smoke. In an extended corridor a DRME system is considered to provide significant benefit over a single mechanical extract system. The mechanical extract system is considered reasonable as a concept which will be demonstrated by Computational Fluid Dynamics (CFD) modelling carried out as the design develops this modelling will feed into the specialist design on the required extract rate for the sustem This trial design iteration is not considered reasonable as the smoke extract system would not be able to operate as intended without automatic detection within the common corridor.
7	Category L5 detection system in the common corridor in accordance with BS 5839.	It is considered that the provision of automatic detection within the common corridor will activate the mechanical smoke extract system in a timely manner i.e. when smoke enters the common corridor when an occupant is evacuating from the apartment on fire. As such, the smoke extract will activate at the required time to remove fire and smoke within the common corridor and protect the stair from the ingress of smoke. This trial design iteration is not considered to be reasonable as it protects the stair from smoke ingress from the common corridor but not from ancillary accommodation such as the carpark and refuse stores located on the lower levels.
8a	Where a single stair is provided to the building the stairs serving the basement carpark rearranged	In single stair buildings it is considered that this design iteration will remove the risk of a fire within the carpark or within the refuse stores from impacting on the single

Iterations of trial design	Fire safety provisions	Qualitative assessment
	such that they are fully independent from the stairs serving the residential levels. Such that there are no internal connections between the basement carpark stairs and the residential stairs. Where a single stair is provided to the building All refuse stores rearranged such that they are accessed from external only	stair serving the residential levels as there are no internal connections between these areas. For multiple stair buildings the potential fire size in the carpark is limited and the additional lobby protection, smoke ventilation and stair separation is expected to significantly reduce the likelihood that a fire would render all stairs within the building untenable on the upper levels. This trial design iteration is considered to be reasonable as it provides a number of enhancements to mitigate the risks from the extended travel distance . The single means of escape is considered to be suitably protected via the common corridor and mechanical extract system; subject to confirmation of the CFD analysis.
8b	Where more than one stair is provided to the building (building 8) all stairs serving the basement carpark will be fire separated at ground floor level by fire resisting walls and doors. In addition all stairs will be separated at basement level from the carpark by fire resisting lobby protection with the lobbies provided with direct smoke ventilation. To address the additional risk of EV charging within the basement a suite of additional fire safety measures will be provided to the basement carpark, including enhanced mechanical ventilation (14 ACH), Structural fire resistance of the car park will be at least 120 minutes (REI), Sprinkler system designed as a category HHP3 system in accordance with BS EN 12845:2015, Car bays where EV charging is provided and between EV charging bays and regular bays should be separated by a distance of at least 1200mm, or fire resisting walls are provided to group EV charging bays into groups of a maximum of three, EV charging points will be linked to the fire detection system, for	

Iterations of trial design	Fire safety provisions	Qualitative assessment
	automatic shut-off of the power supply in the event of a fire. Manual shut-off switches will be provided at the Fire Brigade access points.	

Trial design – Proposed fire safety features for extended travel distance common corridor design

- Construct each apartment and the common corridor out of 60-minute fire resisting construction with FD30S doors opening into the common corridor;
- Residential sprinkler protection designed in accordance with BS 9251:2021;
- Double-Reversible-Mechanical-Extract (DRME) system within the common corridor. Provided with fire resisting ductwork and fire resisting fan sets and backup power supplies.; and
- Category L5 detection in the common corridor in accordance with BS 9251.
- In single stair buildings the Stairs serving the basement carpark rearranged such that they are fully independent from the stairs serving the residential levels. Such that there are no internal connections between the basement carpark stairs and the residential stairs.
- In multiple stair buildings the all stairs serving the basement carpark will be fire separated at ground floor level by fire resisting walls and doors. In addition all stairs will be separated at basement level from the carpark by fire resisting lobby protection with the lobbies provided with direct smoke ventilation.
- To address the additional risk of EV charging within the basement a suite of additional fire safety measures will be provided to the basement carpark including:
    - enhanced mechanical ventilation (14 ACH);
    - Structural fire resistance of the car park will be at least 120 minutes (REI);
    - Sprinkler system designed as a category HHP3 system in accordance with BS EN 12845:2015; Car bays where EV charging is provided and between EV charging bays and regular bays should be separated by a distance of at least 1200mm, or fire resisting walls are provided to group EV charging bays into groups of a maximum of three;
    - EV charging points will be linked to the fire detection system, for automatic shut-off of the power supply in the event of a fire. Manual shut-off switches will be provided at the Fire Brigade access points.
- All refuse stores rearranged such that they are accessed from external only.

8. Acceptance criteria

8.1 Life safety

The acceptance criteria have been defined as to provide a level of fire safety design that exceeds the minimum recommendations of guidance i.e. better than code. This is considered to be satisfied by satisfying the functional requirements of Part B of Schedule 1 of Building Regulations [4].

8.1.1 CFD analysis

Where CFD analysis is required as a method of analysis, the tenability criteria outlined within this section have been utilised to determine the suitability of the systems proposed. A full CFD assessment into the extended travel distance within the residential common corridor will be carried out as the design develops.

Where the performance of a fire engineered system is being assessed deterministically, it is necessary to establish acceptance criteria, in this case the measurement for acceptance is defined by the tenability criteria. The tenability for a means of escape assessment and fire-fighting access assessment differ and are outlined below.

It is proposed to undertake the analysis of the common corridor smoke ventilation systems in accordance with the recommendations outlined in "Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)" produced by Smoke Control Association (SCA) Revision 3, herein referred to as the SCA guide [3].

8.1.1.1 Means of escape tenability criteria

To demonstrate that conditions are acceptable for occupants evacuating, the tenability criteria examined are related to the limits at which the average human being is affected by the products of combustion. These criteria are visibility, smoke temperature, thermal radiation (radiative heat flux), and Fractional Effective Dose (FED) within the smoke ventilated common corridor.

Visibility

During the period where the apartment door is open (i.e. 60 – 80s in the model),
BRE Report 213179:2015 [13] found that it was difficult under most smoke control scenarios to keep the corridor clear of smoke. As such, visibility in the corridor is not assessed during this period.

It is noted that; CIBSE Guide E [14] recommends that for small enclosures, visibility distance should not decrease below 5m, and for large enclosures, 10m. However, PD 7974-6 infers that people move as if in total darkness at a visibility distance of 5m in irritant smoke conditions. Therefore, to enable some form of comparison to be undertaken, a conservative 10m visibility distance will be adopted to represent "smoke," based on the guidance given in CIBSE Guide E for large enclosures.

It is commonly accepted, although there is no scientific verification of these values, that a smoke control system should return visibility to 10m after approximately two minutes (120 seconds) of the apartment door closing. While it is subject to the engineer's judgement, as recommended in the SCA Guide, a ventilation system which achieves this clearance time is considered to meet the guidance of the Building Regulations.

The visibility factor applied within FDS will be the default value of 3.

Smoke temperature

It is considered within CIBSE Guide E that smoke and gaseous products at a temperature of 120°C can lead to burning of the lungs and the throat for exposure times of less than five minutes, whilst a smoke temperature of 190°C would be fatal in less than one minute. These temperatures are based on 'dry smoke' temperatures. However, where smoke is laden with moisture, such as where activation of sprinklers has occurred causing quantities of water to be added to the fire, the tenable temperature reduces to 60°C for any exposure duration up to 30 minutes before lung damage will occur.

However, the wet tenability limit is based on the assumption that the air/smoke is fully saturated and is 100% moisture laden. It is considered that the air/smoke will not be fully saturated instantaneously upon sprinkler activation and in reality, it will take some time for the air/smoke to become fully saturated. However, for conservatism the tenability criteria will be based on 60°C at a height of 2m above floor level.

Fractional effective dose (FED)

Purser's FED concept has been used to assess the toxicity levels within the corridor. FED is calculated by assessing the concentration of narcotic gasses, namely Carbon Monoxide (CO), Carbon Dioxide (CO_2), and Oxygen (O_2). These are combined in the following formula:

$$FED_{total} = \left(FED_{CO} + FED_{CN} + FED_{NO_2} + FLD_{irr}\right) \times HV_{CO_2} + FED_{O_2}$$

FED is considered to be untenable when it reaches a value of unity (1) as detailed in the SFPE Handbook. However, it is proposed to adopt a tenability criterion of 0.3 as these levels of toxicity can cause a loss of consciousness, after which occupants would not be able to escape independently.

Radiative heat flux (thermal radiation)
Smoke temperature itself is not the sole thermal effect of fire that can lead to conditions in the corridor becoming untenable. Thermal radiation (radiative heat flux (RHF)) of 2.5kW/m^2 can cause severe skin pain and burns. On this basis, and in accordance with guidance given in CIBSE Guide E, a tenability limit of 2.5kW/m^2 for RHF at 2m above floor level has been set.

Pressure
While not a factor that will affect the tenability conditions within the corridor, the effects of excess pressure differentials can result in difficulty in opening doors which would make it difficult to escape.

BS EN 12101 Part 6 recommends that the force required to open a door should not exceed 100N and, as such, the pressure difference between enclosures should not exceed +/-60Pa as per Appendix A.6.1 of BS EN 12101.

8.1.1.2 Firefighting phase tenability criteria
When assessing firefighting conditions there are three tenability conditions that should be reviewed; smoke temperature, RHF, and pressure. Due to the provision of breathing apparatus for responding Fire Service personnel and that the Fire Service are able to operate in zero visibility, there is no requirement to assess the impact of toxic smoke and visibility on Fire Service performance. However, it is important that during firefighting operations the stair should be provided with relatively smoke free conditions.

It is stated in the SCA Guide that due to the stair door remaining open throughout the assessment, it is almost impossible to totally mitigate against smoke entering the stair. On this basis, some very minor localised smoke spreading into the stair may occur. However it is considered that all occupants of the apartment of fire origin will have evacuated the building by the time the fire and rescue service have entered the building to carry out the firefighting phase The stair is used to allow the Fire Service to escape in the event of critical conditions being reached and to allow them to evacuate other residents and, as such, a fail will be recorded if the stair becomes smoke logged so that escape is not possible.

In addition, it is also proposed to review the conditions in the corridor against known Fire Service tenability limits, to ensure the highest levels of firefighter safety.

Smoke temperature and RHF
The assessment for the conditions for the FSA will be based on the criteria set out in Table 5 for hazardous and extreme conditions at a height of 1.5m above floor level, as per the guidance set out in Section 5.3.3 of the SCA Guide.

Table 5: Fire Service Access Acceptance Criteria

Exposure Condition	Maximum exposure time (minutes)	Maximum air temperature (°C)	Maximum radiated heat flux (kWm^{-2})	Remarks	Recommended distance from flat door
Routine	25	100	1	General fire-fighting.	15-30m
Hazardous	10	120	3	Short exposure with thermal radiation.	4-15m

Exposure Condition	Maximum exposure time (minutes)	Maximum air temperature (°C)	Maximum radiated heat flux (kWm^{-2})	Remarks	Recommended distance from flat door
Extreme	1	160	4-4.5	For example, snatch rescue scenario.	2-4m
Critical	<1	>235	>10	Considered life threatening.	0-2m

Note 1: This table has been reproduced from the SCA guide for smoke control to common escape routes in Apartment buildings (rev3) as stated in this document the remarks and distance columns are not part of the original research document and are the opinion of the SCA.

Pressure

The Fire Service may be required to enter rooms to assist in the evacuation of trapped occupants, fight fires etc. As no guidance is available on the door opening forces suitable for the Fire Service, the guidance outlined in Section 8.1.1.1 for means of escape will be used i.e. the pressure difference between enclosures should not exceed +/-60Pa.

8.2 Property protection

Property protection has not been specifically addressed but indirectly benefits from life safety provisions.

8.3 Business continuity

Business continuity has not been specifically addressed but indirectly benefits from life safety provisions.

9. Methods of analysis

As described above in order to demonstrate the effectiveness of the smoke ventilation systems, the proposal is subject to validation by CFD modelling. The CFD software package to be used in this assessment is Fire Dynamics Simulator (Version 6.8.0 or later) [6], produced by the National Institute of Science and Technology (NIST).

The simulator has been extensively validated against both real and laboratory fires and is an industry standard. The assumptions and limitations of the simulator are not reviewed here, and full reference should be made to NIST Special Publication 1018 'Fire Dynamics Simulator Technical Reference Guide' [7]. All models are to be undertaken and checked by experienced users in line with the recommendations of NIST.

It is proposed to undertake the analysis of the common corridor smoke ventilation systems in accordance with the recommendations outlined in "Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)" produced by Smoke Control Association (SCA) Revision 3, herein referred to as the SCA guide [3].

Following the SCA guide Section 5.1, the travel distances are outside the recommendations of standard guidance (i.e. BS 9991:2015), therefore the proposed smoke control system should demonstrate that the conditions in the common corridor should provide an acceptable level of safety when compared to an established tenability criteria. On this basis, a deterministic study is proposed.

10. Establish fire scenarios for analysis

It is proposed to model up to two Fire Scenarios (FS) for each block with extended travel distances to determine whether the smoke ventilation system is suitable: one for the means of escape phase (FS1) and one for the firefighting phase (FS2) of operation of the DRME system.

For each phase of operation, a single worst-case scenario will be modelled, the results of which are considered to be applicable to all other extended travel distance common corridors in that block. The worst case scenarios will be selected based on the following:

- Layout of the corridor, particularly considering arrangements which may inhibit the efficiency of the smoke ventilation system;
- Travel distance between the apartment of fire origin to the storey exit (stair door);
- Travel time for evacuees (unimpeded horizontal travel speed = 1.2 m/s. In accordance with PD 7974-6:2019 [8]); and
- Location of the apartment bedroom of fire origin.

Generally speaking the Means of escape scenarios will consider the apartments with the greatest travel distances from the apartment door to the stair door. While the fire service access scenarios will consider the apartment doors which are located closest to the stair door to represent the apartment fires which represent the greatest possibilities of smoke spread into the single stair.

As the apartment and corridor layouts are still subject to change currently the number of fire scenarios could change. This will be assessed in more detail at the detailed design stage of the project.

11. Conclusion

This document outlines the qualitative design review for the proposed fire engineered design of the extended travel distances in the common corridors in the Stag Brewery development. The QDR report has been structured to follow the process outlined in BS 7974 and including the appropriate sections within. The design of the building with respect to the extended travel distances is considered to fulfil the functional requirements of the Building Regulations.

This document is considered to address the concerns raised by the HSE in relation to the proposed extended common corridor travel distance as part of their Planning Gateway One review process.

This document has been prepared for Reselton only and solely for the purposes expressly defined herein. We owe no duty of care to any third parties in respect of its content. Therefore, unless expressly agreed by us in signed writing, we hereby exclude all liability to third parties, including liability for negligence, save only for liabilities that cannot be so excluded by operation of applicable law. The consequences of climate change and the effects of future changes in climatic conditions cannot be accurately predicted. This document has been based solely on the specific design assumptions and criteria stated herein.