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1 Introduction

1.1 Background & purpose of this document

- 1.1.1 Ashton Fire have been commissioned by Foras (Sparkle Street) Limited to provide fire safety consultancy services for the proposed Sparkle Street development located in Manchester.
- 1.1.2 Sparkle Street is a residential development comprising residential dwellings and ancillary accommodation. The development is occupied by residents until the topmost storey (Level 27), with the building a total of 28-storeys (Ground + 27). The building measures approximately 82.4 m from Ground Level/fire service access level to the to the Finished Floor Level (FFL) of the topmost occupied storey.
- 1.1.3 The purpose of this document is to set out the framework for the qualitative design review (QDR). A QDR is a structured technique applied by a team of relevant stakeholders to identify possible ways fire hazards might arise for a given building design, and to subsequently establish the strategies and provisions needed to maintain risk at an acceptable level in the event of these hazards.
- 1.1.4 QDRs are most commonly needed for building designs which are considered uncommon or complex and are therefore not adequately addressed through the application of prescriptive guidance recommendations.
- 1.1.5 In this instance, a QDR is being undertaken due to the height of the building being very tall (i.e., over 45 m in height). As such, all fire safety provisions for the building need to be evaluated to ensure appropriate resilience and robustness with regards to the height of the building.
- 1.1.6 This QDR document has been prepared at an early stage in support of the ongoing design process. It should therefore be treated as a 'live' document and is subject to discussion, coordination and agreement with the wider design team and other relevant stakeholders (summarised in Section 3).

1.2 Qualitative design review structure

- 1.2.1 In accordance with BS 7974, the main stages of a QDR are to:

- Review the architectural design.

- Establish functional objectives for fire.
- Identify fire hazards and possible consequences.
- Establish trial designs.
- Set acceptance criteria.
- Identify methods of analysis.
- Establish fire scenarios for analysis.
- Document outputs of the QDR.

1.2.2 As the QDR is an iterative process engaging multiple stakeholders at various times, the above order is not strictly followed in this document, although all stages described in BS 7974 will be captured in the overall process. Certain areas of this QDR document will be addressed in more detail as the design develops, either as part of the fire strategy documentation or in the preparation of detailed analyses.

2 Project description

2.1 General

- 2.1.1 The proposed development, namely 'Sparkle Street', is a residential development comprising residential areas and a number of ancillary areas which are also associated with the building. The development is arranged over 28-storeys (Ground + 27th Floor). The building measures approximately 82.4 m from Ground Level/fire service access level to the to the FFL of the topmost occupied storey (27th Floor).
- 2.1.2 All storeys within the building are served by multiple stair cores (Stairs 1, 2 & 3), forming a multi-stair arrangement at all levels. Stairs 1 & 2 serve all floors within the building, while Stair 3 terminates at 10th Floor due to the 'stepped' nature of the buildings design. Vertical circulation within the building is also facilitated by lifts associated with each staircase.
- 2.1.3 Residential flats are located on all upper floors of the development, consisting of single storey, open-plan flats, with bedrooms accessible from the living/kitchen area.
- 2.1.4 In addition to the residential flats, there are also five, two-storey townhouses located on the Ground Floor, which are accessible directly from the outside. Access is also provided from the internal corridor. Within the townhouses, vertical circulation is via an enclosed stairway.
- 2.1.5 Ancillary accommodation is located on the Ground Floor, 10th Floor and 26th Floor and consists of a management office, refuse storage, cycle storage, substations, LV switch rooms, entrance, internal and external amenity spaces.
- 2.1.6 Table 1 summarises the accommodation provided at each level, as well as the associated escape routes.

Table 1 – Summary of accommodation

Level	Accommodation	Escape route/(s)	Reference
Level 27	Single storey flats	1 x protected stair (Stair 1) 1 x firefighting stairs (Stair 2)	Figure 1
Levels 26	Single storey flats	1 x protected stair (Stair 1)	Figure 2
	Residential amenity	1 x firefighting stairs (Stairs 2)	
Level 11-25	Single storey flats	1 x protected stair (Stair 1) 1 x firefighting stairs (Stairs 2)	Figure 3
Level 10	Single storey flats	1 x protected stair (Stair 1)	Figure 4
	Residential amenity	2 x firefighting stairs (Stairs 2 & 3)	
Levels 02-09	Single storey flats	1 x protected stair (Stair 1) 2 x firefighting stairs (Stairs 2 & 3)	Figure 5
Level 01	Single storey, open-plan flats	1 x protected stair (Stair 1) 2 x firefighting stairs (Stairs 2 & 3)	Figure 6
	Two-storey townhouses	1 x Internal protected stair	
Ground	Two-storey townhouses	1 x Internal protected stair	Figure 7
	Management office	Via residential entrance	
	Cycle store	Via ventilated lobby + final escape route from Stair 1 to outside	
	Refuse store	Via ventilated lobby + final escape route from Stair 1 to outside	
	Storage	Via ventilated lobby to outside	
	LV switch room	Via ventilated lobby to outside	
	Plant	Directly to the outside	
	Plant	Via ventilated lobby + final escape route from Stair 1 to outside.	
	Substation	Directly to the outside	
	Entrance	Directly to the outside	

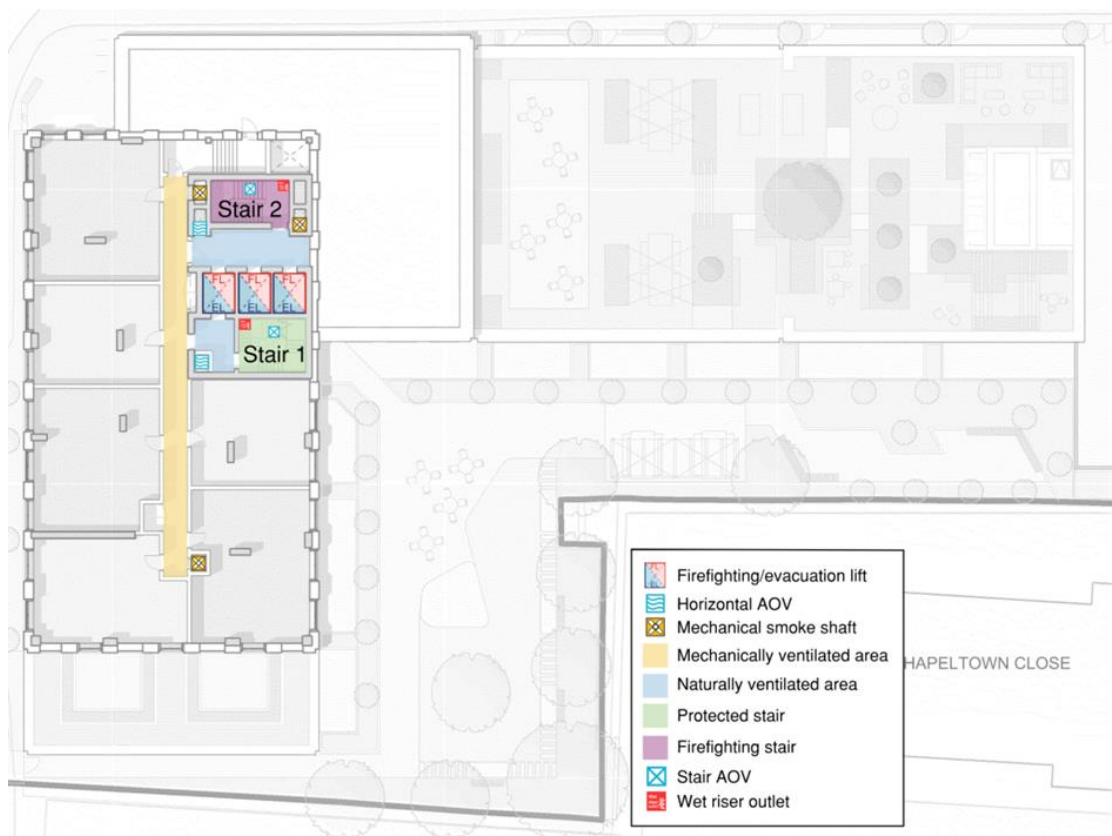


Figure 1: Level 27

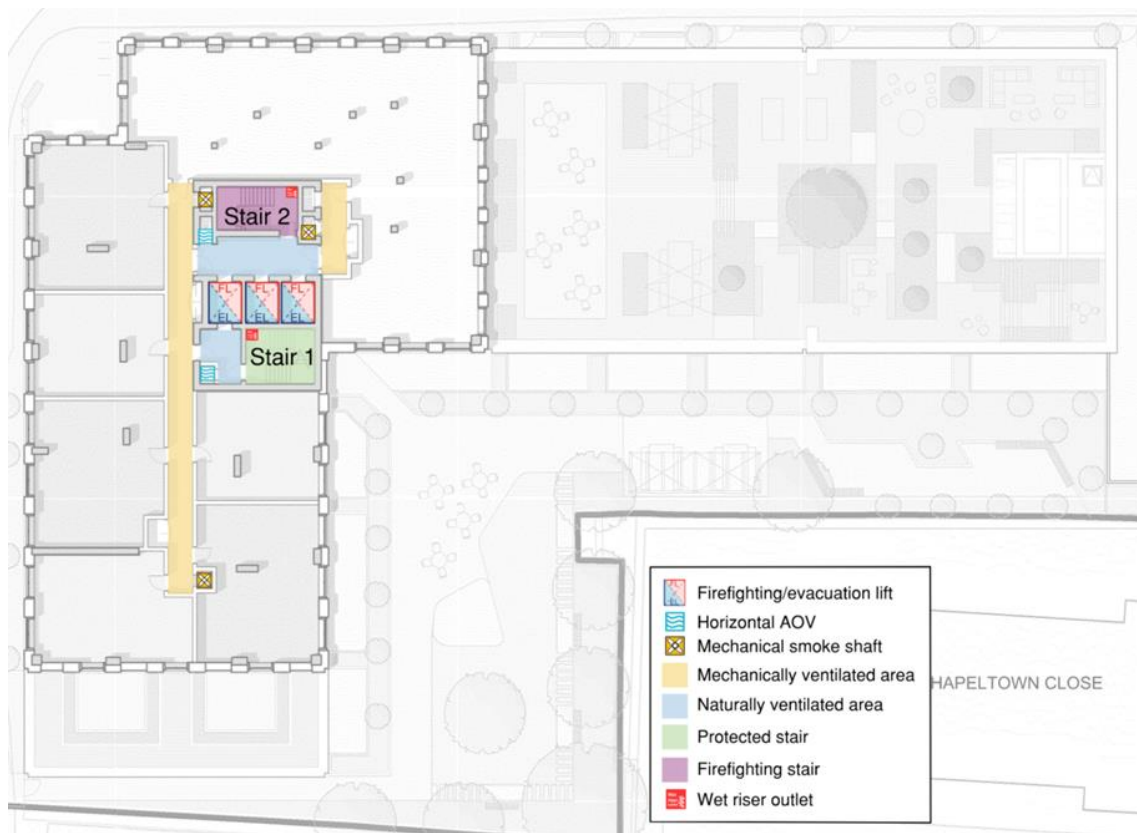


Figure 2: Level 26

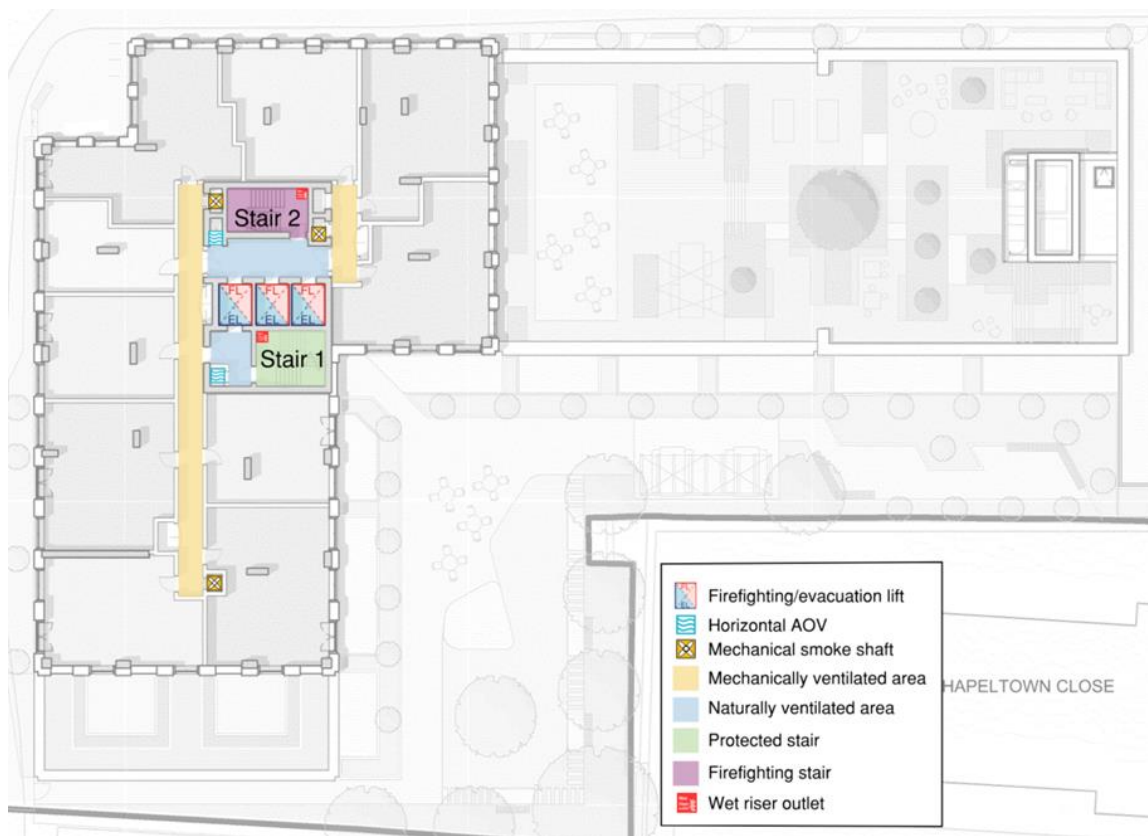


Figure 3 - Level 11-25

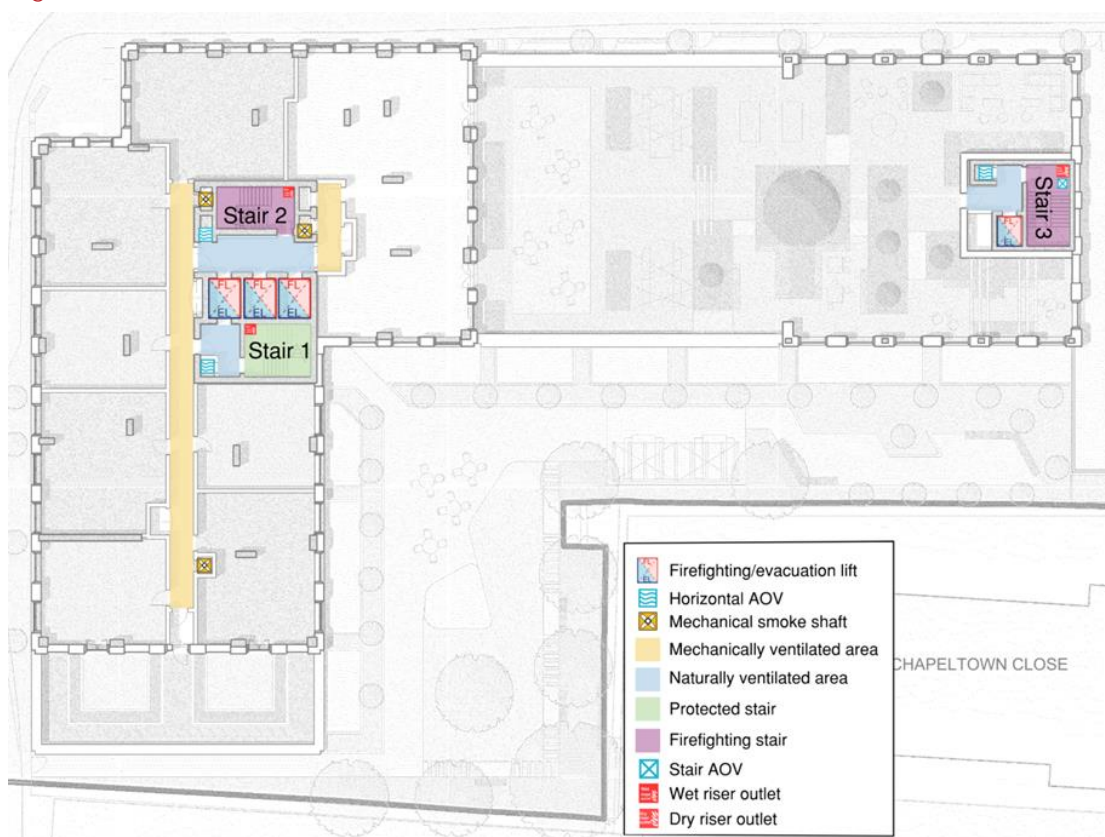


Figure 4 - Level 10

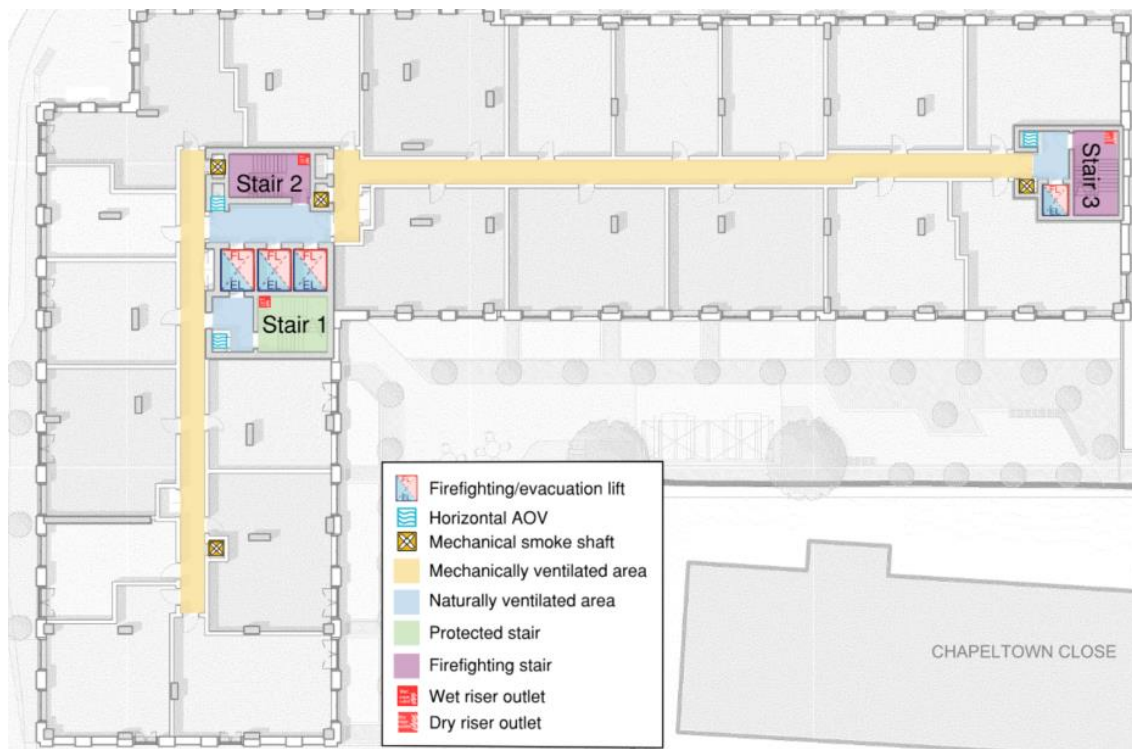


Figure 5 - Level 2-9



Figure 6 - Level 01

4 Establishing the functional objectives

4.1 Life safety

- 4.1.1 The functional objectives for the fire safety design of the development are to consider requirements for life safety only. Consideration has therefore not been given to loss control and organisational resilience, or to environmental impact and protection.
- 4.1.2 If requested, client requirements for areas of consideration other than life safety can be explored as part of a separate assessment. However, these are outside the scope of our current appointment and are likely to require engagement with additional stakeholders not listed in Section 3.
- 4.1.3 However, features included for life safety will to some extent contribute to property protection and continuity of use following a fire.

Functional requirements

- 4.1.4 The primary point of reference for establishing the functional objectives for the design are the requirements B1 to B5 of Schedule 1 to the Building Regulations. Table 3 has been reproduced from Section 0 of Approved Document B (ADB) and summarises these requirements.

Table 3 – Summary of the functional requirements for B1 to B5

Functional requirement	Description summary
B1: Means of warning and escape	Where there is a fire, ensure both: a. Satisfactory means of sounding an alarm b. Satisfactory means of escape for people
B2: Internal fire spread (linings)	Inhibit spread of fire over internal linings of buildings
B3: Internal fire spread (structure)	The building must be built such that all of the following are achieved in the event of a fire: a. The premature collapse of the building is avoided b. Sufficient fire separation is provided buildings and between adjoining buildings c. Automatic fire suppression is provided where necessary d. The unseen spread of fire and smoke in cavities is restricted
B4: External fire spread	Restrict both: a. The potential for fire to spread over external walls and roofs b. The spread of fire from one building to another
B5: Access and facilities for the fire service	Ensure both: a. Satisfactory access for the fire service and its appliances b. Facilities in buildings to help firefighters save lives of people in and around buildings

Seven layers of fire safety

- 4.1.5 In addition to the functional requirements, the QDR documentation is also supplemented with reference to the seven layers of safety described in the EU fire safety guide provided by the Modern Building Alliance. In this guide, it is suggested there are seven layers of fire safety which should be holistically addressed to protect building occupants. These layers of protection are summarised in Table 4.

Table 4 – The seven layers of fire safety

Layer	Abbreviated summary of the fire safety layer objectives
1: Prevention	The start of a fire should be prevented where practicable Understanding the causes and risk factors of this is the starting point for informing effective fire prevention
2: Detection and alarm	When a fire occurs, early detection and alarm should provide building occupants with sufficient time to react to a fire and evacuate
3: Suppression	When a fire occurs, it has the potential to be stopped early in its development, for example, by an automatic suppression system
4: Evacuation	If a fire starts and cannot be extinguished (or its spread is not sufficiently prohibited), safe evacuation of a building's occupants is a priority Occupants should be aware of and have access to adequately protected escape routes
5: Compartmentation	Fire compartmentation helps to contain fire and smoke within the compartment of fire origin, reducing the likelihood of fire spread to other areas Fire compartmentation can also help to protect escape routes
6: Structural safety	The building should be designed and constructed so that in the event of a fire, its stability is maintained for a reasonable period so that it will not collapse on occupants or firefighters
7: Firefighting	Access and provisions should be adequate to facilitate fire service access and operations, so that they can fight the fire and prevent any further fire spread

5 Review of the architectural design

5.1 Uncommon building situations

- 5.1.1 ADB and other guidance documents (including BS 9991 and BS 9999) provide guidance for common building situations and, as such, designs which sit outside the definition of common buildings may require the adoption of alternative methods to demonstrate compliance with the Building Regulations requirements.
- 5.1.2 Given the above, a QDR is typically undertaken when a building design is deemed to be 'uncommon'. While a certain degree of subjective judgement is required for assessing what can be classified as uncommon, the manual to the Building Regulations provides the following examples of 'non-standard' conditions:
- Difficult ground conditions.
 - Buildings with unusual occupancies or high levels of complexity.
 - Very large or very tall buildings.
 - Large timber buildings.
 - Buildings that incorporate modern methods of construction.
- 5.1.3 ADB in particular notes that fire safety engineering analysis may be the only practical way to achieve a satisfactory standard of safety in some complex buildings and buildings which contain different uses.
- 5.1.4 For this development, the following aspects are considered to be uncommon and thus warrant further review under the QDR:
- The building can be classified as a very tall building (over 45m from the access level (Ground Level) to the topmost occupied storey).
 - The building incorporates multiple uses, including residential and commercial.

5.2 Key guidance deviations and design challenges

- 5.2.1 In addition to uncommon building aspects, consideration also needs to be given to elements of the design which deviate from guidance, i.e., in situations where guidance would typically be considered adequate. For this, ADB suggests that fire safety engineering analysis may be suitable for solving a specific problem with a design that otherwise follows guidance recommendations. Clause 4.2 of BS 9999 notes that a fire safety engineering approach as detailed in BS 7974 gives greater flexibility in the design of complex buildings and spaces.
- 5.2.2 Table 5 presents the key deviations for Sparkle Street from the recommendations of the prescriptive guidance documents. Design challenges are also detailed below.

Table 5 - Key design challenges

Item	Level	Description	Comments
Building height	All	The building height is measured from the fire service access level to the finished floor level of the topmost occupied storey. For this development the building height is circa 82.4 m.	Guidance provides fire safety recommendations for common buildings. The proposed height of the building classifies the building as an uncommon situation and a review of the fire safety provision is carried through the QDR report.
Evacuation lifts	All	The design incorporates the provision of evacuation lifts associated with each communal staircase.	Current ADB does not provide guidance in regard to protection of the evacuation lift. However, additional fire safety provisions should be provided in support of this arrangement. In support of the evacuation lift arrangement, the lift should be accessed from a protected lobby.
Cooking hob locations	Upper levels	Cooking facilities in flats should be located 1.8 m from the flat entrance doors and escape routes.	The escape route within the flats is located within 1.8 m of the exit/internal escape routes from the flats. The escape route is recommended to achieve a 900 mm clear width.
Travel distance in communal corridors	Upper levels	The single direction travel distance within communal corridor connecting Stair 1 and Stair 2 is circa 14.2m, which is above the limit of 7.5m.	To address the extended travel distance, a mechanical smoke control system will be employed.

6 Fire hazards

6.1 Definitions

6.1.1 BS 7974 describes a fire hazard as a source of possible injury or damage from fire. The risk associated with a given hazard is a function of:

- The likelihood of the hazard occurring, e.g., the likelihood of fire ignition.
- The severity of the hazard, e.g., the size of the fire and the extent of fire spread.
- The consequence or harm resulting from the hazard, e.g., the number of occupants within the affected enclosures or building.

6.1.2 The following section considers these three elements in identifying unique hazards and the possible consequences.

6.2 Identification of unique hazards and possible consequences

6.2.1 This section specifically focusses on a review of potential hazards and consequences which are unique to the building in relation to the uncommon building aspects and key guidance deviations identified in the architectural design review (Section 5).

6.2.2 Table 6 presents a summary of unique hazards and consequences for each key design aspect or fire safety provision, with reference to the functional requirements and seven layers of safety (Section 4).

6.2.3 Where the design aspect or fire safety provision is considered common and adequately addressed by guidance, then the proposed route to compliance is listed as 'adherence to guidance'. Where the design aspect of fire safety provision deviates from guidance or is considered uncommon, then a quantitative or qualitative analysis is required. The proposed analyses resulting from this hazard review are discussed in Section 7, including discussion on the methods of analysis and a brief overview of the proposed acceptance criteria.

Table 6 – Summary of unique hazards and consequences

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
B1: Means of escape and warning				
1	Evacuation philosophy - Stay-put evacuation for the residential areas	Evacuation	The stay-put fire strategy is based on evacuation being triggered only in the compartment of fire origin. A fire event on the upper floors could lead to prolonged time for evacuation and could expose the staircase to the effects of smoke and fire during the escape of occupants and firefighting intervention. Buildings over 18 m are equipped with an EAS (Evacuation Alert System), which allows FRS to trigger the evacuation of the entire building. Also, occupants may be more likely to feel unsafe in the confines of their flat and look to evacuate during firefighting operations.	The building will incorporate multiple staircases to facilitate evacuation strategy and Fire Service intervention. The evacuation strategy will be further supported by multiple lifts which will have a dual role and will be designed as evacuation/ firefighting lifts.
2	Evacuation philosophy – simultaneous for the amenity areas on the upper floors	Evacuation	A fire event on the upper floors could lead to prolonged time for evacuation and could expose the staircase to the effects of smoke and fire during the escape of occupants and firefighting intervention.	The building will incorporate multiple staircases to facilitate evacuation strategy and fire service intervention. Staircases will be protected from the ingress of smoke by mechanically ventilated lobbies and sprinklers will reduce the fire.
3	Means of escape within flats	Evacuation	The flats incorporate unenclosed kitchens which have the potential to impede escape in the event of a fire. Hob locations are within 1.8 m of the exit and internal escape routes of flats.	Qualitative analysis

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
4	Horizontal means of escape – communal corridors	Evacuation	Communal corridors could be exposed to smoke during escape of occupants from the compartment of fire origin or during firefighting intervention. The communal corridors providing access to staircases will be provided with a smoke ventilation system. Due to height of the building, a pronounced stack effect might occur. A mechanical smoke ventilation system is to be used within the communal corridors instead of guidance-based natural provisions to address the stack effect and extended travel distances.	Quantitative analysis
5	Vertical means of escape – provision and protection of evacuation lifts	Evacuation	As a building gets taller, it is likely to house more occupants. With a larger density of occupants, it is likely that flats could be occupied by people which might not be able to navigate the staircase in the event of a fire. In addition to the staircase, evacuation lifts are introduced in the building to enhance the evacuation procedure. In the event of fire, it is likely that occupants will need to wait for a period of time in order to access the evacuation lift. Therefore, the evacuation lift will be provided with a refuge space located within a protected lobby which should only provide access to staircase and communal corridors. Protection to the evacuation lift lobbies against the ingress of smoke should be afforded at all levels by separating the compartment of fire origin via mechanically ventilated corridors. An emergency voice communication (EVC) system will be located adjacent to the evacuation lifts to allow occupants to communicate with fire service if needed.	Quantitative analysis

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
6	Vertical means of escape – provision and protection of escape stairs	Evacuation	An unexpected number of occupants could evacuate simultaneously, putting both strains on the escape capability of the building design, as well as issues arising with contraflow against firefighters travelling upwards to tackle a fire, both slowing the response time of the fire service, and the evacuation of occupants. Three staircases are incorporated in the design, with at least two serving all floors to provide flexibility for occupants evacuating and support firefighting operations. A staircase could be exposed to effects of fire and smoke during the escape and firefighting intervention. The staircase will be protected from the ingress of smoke via mechanically ventilated corridors and naturally ventilated lift lobbies. Staircase are intended to provide vertical evacuation for the occupants. However, people with impairments might not be able to navigate the stairs safely. Therefore, evacuation lifts are incorporated in the building.	Qualitative + quantitative analysis
7	Fire detection and alarm – flats & townhouses	Detection and alarm	None An early detection within the flat of fire origin would reduce the evacuation time and potentially reduce the fire service intervention time. An LD1 fire detection system, with detection in all rooms, should be incorporated in the design.	Adherence to guidance
8	Fire detection – communal corridors	Detection and alarm	None The escape route should be maintained fire sterile. The scope of the detection within the communal corridor is to activate other life safety systems, such as smoke ventilation.	Adherence to guidance

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
9	Fire detection – ancillary areas	Detection and alarm	None An early detection within the ancillary areas would reduce the evacuation time and potentially reduce the fire service intervention time. An automatic detection and alarm system, with detection in all rooms, should be incorporated in the design.	Adherence to guidance
10	Fire alarm – evacuation alert system	Detection and alarm	None The baseline strategy relies on a “stay put” strategy. However, in the event of an uncontrollable fire, the fire service has the capability to trigger a simultaneous or floor-by-floor evacuation of the building automatically, reducing the time to carry such procedures manually.	Adherence to guidance
B2: Internal fire spread (linings)				
11	Internal linings	Prevention	None Linings could contribute to the extent of fire spread and generation of smoke. The linings contribution to fire will be limited by restricting the combustibility function of their location.	Adherence to guidance
B3: Internal fire spread (structure)				
12	Structural fire resistance	Structural safety	The building would be classified as consequence class 3 (CC3) under Approved Document A. This refers to buildings where the progressive collapse hazard would constitute in high societal perceived consequences and a larger risk of loss of human life.	Quantitative analysis to be carried out by the structural engineer
13	Suppression system – pumping capacity	Suppression	The height of the building will put more demand on the pumping requirements, due to the pressure required to transfer suppressant to upper storeys.	Quantitative analysis to be completed by specialist designer

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
14	Suppression system – system reliability	Suppression	With the height of the building increased, the resilience of the system should be commensurate with the building height.	Adherence to BS 9251 recommendations for reliability Design of system is the responsibility of the sprinkler specialist
15	Compartmentation (internal separation)	Compartmentation	None A fire has the potential to occur within flats and other ancillary areas. Therefore, escape routes will be separated from the potential fire location by compartment walls and floors. Flats where a fire is likely to occur will be compartmentalized. All other spaces will be bounded by compartment walls and floors.	Adherence to the guidance
16	Fire doors	Compartmentation	None Typically, smoke control systems and evacuation of very tall buildings relies on compartmentation created by closed fire doors along fire escape routes. Performance of fire doors should be adequate to support the fire strategy for the building.	Adherence to guidance
17	Concealed fire spread	Compartmentation	None Concealed spaces provide a way for fire and smoke to travel between different fire compartments. Fire spread within concealed spaces will be restricted by providing cavity barriers and adequate fire stopping between compartments.	Adherence to guidance

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
B4: External fire spread				
18	External wall construction	Prevention	None The envelope of a building could constitute a way for fire to spread across the building. Restriction on the build-up of the external walls is imposed by Regulation 7(2).	Adherence to guidance
19	Space separation and unprotected openings	Prevention	In the event of a fire within a compartment, fire could potentially spread via radiation or flame impingement to adjacent buildings. As a function of the distances to neighboring properties, restrictions will be imposed on the unprotected areas within the façade of the building.	Quantitative analysis
20	Roof coverings	Prevention	None A fire could potentially spread across a roof to affect multiple compartments. The fire spread over the roof will be restricted by using materials with limited fire spread capacity.	Adherence to guidance
B5: Access and facilities for the fire service				
15	Access into and through the building	Firefighting	An increased building height will result in slower response times to a fire, in which time the fire may have grown significantly. It is essential that first responders have access to the required facilities (stairs, lifts, fire mains etc.) to successfully tackle a fire. Two firefighting shafts are provided, and they are accessible either directly from the outside or via dedicated corridors.	The building will incorporate two firefighting stairs. A third stair designed as a protected stair is provided, which is provided with an equivalent level of protection as the firefighting stair on the upper floors. Firefighting operations would also be supported by 4 firefighting lifts which could be used during firefighting operations.

Item	Design aspect or fire safety provision	Primary fire safety layer	Unique hazards and consequences posed by design	Proposed design route
16	Firefighter communication	Firefighting	As a building gets taller and more complex, firefighting communication can be disrupted. The lobbies in front of staircases are equipped with an emergency voice communication system. The EVC will include both a Type A and Type B to facilitate firefighting communication.	Adherence to guidance
17	Water suppliers – fire mains	Firefighting	The height of the building will pose challenges to pump water through the fire main up to the top floors. Therefore, wet fire mains will be provided as opposed to dry fire mains.	Adherence to guidance
18	Water supplies – fire main	Firefighting	The increased height of the building will require additional capacity for the pump to deliver water at adequate pressure at the topmost floor served by the fire main.	Quantitative analysis to be completed by specialist designer
19	Water supplies – fire mains	Firefighting	The building will have installed three fire mains. Given the increased height of the building, the capacity of the pumps to deliver water to all mains when in operations should be considered.	Quantitative analysis to be completed by specialist designer

7 Proposed analyses

7.1 Methods of analysis and acceptance criteria

7.1.1 As acknowledged in BS 7974, there are several routes which can be followed when undertaking performance-based analysis. As a first step, the method of analysis needs to be considered and, following this, the acceptance criteria need to be identified.

7.1.2 For the method of analysis, BS 7974 recommends that the following approaches can be adopted:

- **Quantitative – deterministic:** Analysis which quantifies fire growth, fire spread, smoke movement and the consequence of these for the building and its occupants. Deterministic analysis involves the evaluation of a fixed set of circumstances (a ‘reasonable worst-case’ scenario) for a single or limited number of outcomes.
- **Quantitative – probabilistic:** As above, except the method of analysis uses statistical methods and / or iterative modelling to capture a range of possible outcomes and their associated likelihood.
- **Qualitative:** A non-numerical evaluation of fire safety engineering proposals using experience, knowledge and engineering judgement.

7.1.3 For the acceptance criteria, there are two categories which can be considered:

- **Absolute:** Numerical values set to show that a particular condition has been met, a specific limit has not been exceeded or a threshold value has been reached, with the purpose of demonstrating that the specific functional objective has been met.
- **Comparative:** Criteria that indicate the functional objectives are met through comparison to established designs provided in guidance documents.

7.2 Common mode failures

7.2.1 A key element which needs to be considered in a fire engineering analysis is common mode failures. Common mode failure refers to a failure which has the potential to cause a coincidence of failures, due to dependencies between different fire safety systems or components. A common mode failure can therefore refer to situation where the failure of one fire safety system has an adverse impact on the performance of another.

7.2.2 The following is a non-exhaustive list of common mode failure examples relating to the seven layers of protection introduced previously in Section 4.1. It should be noted that these are not necessarily applicable to this development, but provided as commentary to assist with the following section:

- **Prevention:** Fire scenarios typically consider the ignition and fast development of a fire, and hence there is an inherent assumption that fire prevention methods have not been able to prohibit the start of a fire.
- **Detection and alarm:** When addressing the effects smoke may have on common escape routes, it is often assumed that occupants escape from the fire-affected enclosure a substantial length of time after the onset of untenable conditions within that enclosure. In such situations, the benefit provided by detection and alarm systems are effectively excluded from the analyses.
- **Suppression:** To consider a more severe fire scenario, analyses may capture the possibility that the suppression system is not able to adequately control fire growth, i.e., an 'unsprinklered' fire scenario is addressed. For example, this may be considered when evaluating the performance of smoke control systems, such that sprinkler effectiveness is not a prerequisite for the system successfully achieving its performance objectives.
- **Evacuation:** Analyses may consider the possibility that the proposed evacuation strategy is not strictly followed by the building occupants. For example, where a defend-in-place strategy is adopted as the evacuation philosophy, consideration may also be given to the implications of a floor-or-floor or simultaneous evacuation, e.g., as prompted by an evacuation alert system.
- **Compartmentation:** In certain analyses, it may be assumed that fire doors are held open for prolonged periods, either during escape or during firefighting operations (e.g., any doors situated between the location of the rising mains and the fire-affected enclosure). In these circumstances, the potential for smoke and heat spread across multiple protected enclosures is possible and inherently captured in the analyses. In relation to this, it may be reasonably assumed that fire doors represent the most probable source of compartmentation failure, owing to a number of factors, including: their regular use and possible failure of closer mechanisms; the potential for doors to be propped open; and their relative fire rating classification compared to the compartment walls in which they are located.
- **Structural safety:** Consideration of structural safety as a common mode failure is rarely captured, as collapse of the structure is likely to have a catastrophic impact on the safety of the entire building. However, structural fire safety assessments may capture a number of other common mode failures, such as failure of suppression systems and compartmentation, to verify adequate performance of the structure in preventing collapse.
- **Firefighting:** Rarely do analyses capture the impact firefighting operations can have on the limitation of fire development. For example, most analyses do not capture the impact that the

water spray of a firefighting hose may have on the fire following fire service arrival, with firefighting operations often represented for a prolonged period. Thus, there is an unintentional but implicit assumption in many analyses that the fire service are unable to extinguish the fire, e.g., owing to inadequate water supply or limitations with fire service access.

7.3 Summary of proposed analyses

- 7.3.1 Table 7 presents a summary of the analyses which are to be undertaken to support the design and demonstrate that the building is able to achieve an adequate level of safety. This summary highlights areas of the design previously acknowledged in Section 6.2 to require analysis, for areas where the design deviates from the adopted guidance document, or where it is considered that guidance recommendations are not able adequately address the complexity or uncommon design aspects.
- 7.3.2 For the analyses, fire scenarios are to be developed in detail elsewhere, such as in the outline fire strategy or design intent reports for specific quantitative assessments. These documents are to be distributed to relevant stakeholders as they are developed.

Table 7 – Proposed performance-based analyses

Design aspect	Method of analysis	Acceptance criteria		Expected common mode failures
		Category	Objective	
Large open plan flats with unenclosed kitchens	Qualitative	Comparative	Demonstrate proposed design achieves equivalent level of safety to a guidance-based design with reference to published literature	None
Horizontal means of escape – communal corridors Vertical means of escape – protection of the evacuation lift lobby and staircase	Quantitative, deterministic (CFD analysis)	Absolute	Demonstrate adequate protection of the stair and lift lobby from smoke ingress	Suppression (sprinklers) Compartmentation (fire doors)
Structural fire resistance	Structural analysis – to be confirmed by the structural engineer	To be confirmed by structural engineer	Demonstrate the fire resistance proposed for the building adequately addresses the risk of structural failure, i.e., as a function of failure consequence	Suppression (sprinklers) Compartmentation (structural member)
Suppression system	Quantitative (to be confirmed by Sprinkler Specialist)	Absolute	Demonstrate the pump sets serving the building will have the capacity to serve the building	Suppression (pump)
Space separation and unprotected openings	Quantitative (Fire engineering analysis)	Absolute	Demonstrate fire spread does not occur to neighboring building	None

Design aspect	Method of analysis	Acceptance criteria		Expected common mode failures
		Category	Objective	
Water supplies - Fire mains	Quantitative - to be confirmed with specialist designer	Absolute	Demonstrate adequate pumping capacity for wet fire mains across all storeys. Demonstrate adequate pumping capacity for all mains	Note

8 Next steps

- 8.1.1 This document is to be distributed to the design team in the first instance. Following design team coordination, the QDR document should be distributed to other relevant stakeholders, including the approvals body and any appropriate third parties, to provide comment and reach an agreement over the proposed solutions.
- 8.1.2 Where required, individual fire safety workshops are to be organised with specific stakeholders, such as the building control body and the fire service, to assist in verifying the adequacy of proposals and to progress the design.
- 8.1.3 In addition to the analyses proposed and recommended in this document, it is important to highlight that active and passive fire safety systems throughout the building have a key role in preventing fire and smoke spread in the building. It is highly recommended that adequate and very strict construction, installation, commissioning, and maintenance practices be adopted for fire compartmentation and smoke control systems.



Ashton Fire engineers have dealt with hundreds of successful fire engineering and fire risk assessment projects across the UK and worldwide.

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