

Clarendon Phase 4

QUALITATIVE DESIGN REVIEW

August 2023



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1 Introduction

1.1 Scope

It is recommended that for tall and very tall buildings more than 50m in height, a qualitative design review (QDR) is carried out. The QDR process is detailed within BS7974:0 – Application of fire safety engineering principles to the design of buildings – Code of practice.

The purpose of the QDR is to determine whether the codes used for buildings less than 50m in height will be suitable to use for these buildings, which are higher than 50m. Following this conclusion, either a further analysis using BS7974 will be used or the relevant building codes will be sufficient. The aim is to determine whether any additional measures are required to the design of the building.

Blocks H1 and H3 contain a floor in excess of 50m in height, while Block H2 is less than 50m in height. Nevertheless, a QDR for all three blocks has been undertaken within this report as requested by the client.

1.2 QDR Team

In line with the recommendations in BS7974, the following members will be part of the QDR team:

- Michel Wizenberg, Senior Principal – Head of Fire Engineering (Introba)
- Dale McCubbin, Senior Fire Engineer (Introba)
- Mai Jarkas, Graduate Fire Engineer (Introba)
- Jenny Goh, Design & Technical Manager (St. William)
- William Mackey, Development Manager (St. William)
- Runyuan Xu, Associate (Sheppard Robson)
- Rosa Gimeno Hidalgo, Architect (Sheppard Robson)

This QDR document should be reviewed and agreed upon by all members of the team.

2 Legislation

2.1 Building Regulations 2010

The development will consist of new buildings, hence, will be undergoing building works as defined in Regulation 3 of The Building Regulations 2010. All buildings will therefore have to comply with the requirements of Schedule 1 of the Regulations.

The requirements of the Schedule relating to fire safety are:

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

The principle aim of the Building Regulations is to ensure the health and safety of people in and around a building.

The 'requirements' set out broad objectives or functions, which the individual aspects of the building design and construction must set out to achieve. They are therefore often referred to as 'functional requirements' and are expressed in terms of what is 'reasonable', 'adequate' or 'appropriate'.

2.2 Approved Document B (ADB)

The Department for Levelling Up, Housing and Communities (DLUHC) has produced several guidance documents to assist designers in meeting the relevant requirements of the Building Regulations. These 'Approved Documents' provide guidance on different aspects of the Regulations. Approved Document B – Fire safety (ADB) provides general design guidance on ways in which the functional fire safety requirements can be satisfied.

The Building Regulations 2022 require reasonable standards of health and safety for persons in or about the building to be provided.

However, as with many "deemed to satisfy" documents, the ADB is general in its approach and cannot contain sufficient detail for the multiplicity of building designs and varieties of building fire loads and occupancies encountered in practice.

The recommendations presented in the ADB provide guidance on how to satisfy the functional requirements of the Building Regulations. However, there is no obligation to adopt any solution contained in the document. The document recognises this and accepts that, if the requirement can be demonstrated to have been satisfied by alternative solutions, then this is equally acceptable.

This report considers the amendments to the Approved Documents in May 2020 and June 2022 and considers Regulation 7.

2.3 BS7974

BS7974 is intended to facilitate a fire engineered approach to buildings, to allow safety levels of designs to be compared and to provide a basis for the selection of appropriate fire protection systems, and to provide information and assessment methods to support the design, construction, management, and operation of buildings.

2.4 Regulatory Reform (Fire Safety) Order

Once the buildings are occupied, the Regulatory Reform (Fire Safety) Order (RRO) becomes the controlling fire safety legislation.

The Order came into force on 1st October 2006 and revoked the existing Fire Precautions Act and the Workplace Regulations. Under this order it will be necessary for the owner/ occupier of the building to carry out and maintain a fire safety risk assessment.

The building management team will also be responsible under this order to ensure that the buildings' fire safety provisions are appropriately managed, maintained and tested over the whole life of the building.

2.5 Statutory Consultation

During the Building Regulations application process, the building control body is required to formally consult with the local fire authority. The purpose of this consultation is to give to fire authority the opportunity to make observations with respect to the Building Regulations and to provide an opportunity to make the applicant aware of action that may have to be taken to meet the requirements of the Fire Safety Order.

The consultation should allow both parties to reach mutually compatible views on whether the building meets the requirements of both pieces of legislation. In the exceptional event that the fire authority proposes to require physical changes to the building to meet the requirements of the Fire Safety Order, the building control body should make the applicant aware.

3 Qualitative Design Review (QDR)

3.1 QDR Process

The QDR is a structured technique that allows the team to think of the possible ways in which a fire hazard might arise and establish a range of strategies to maintain the risk at an acceptable level. The fire safety design can then be evaluated quantitatively or qualitatively against the acceptance criteria set by the team.

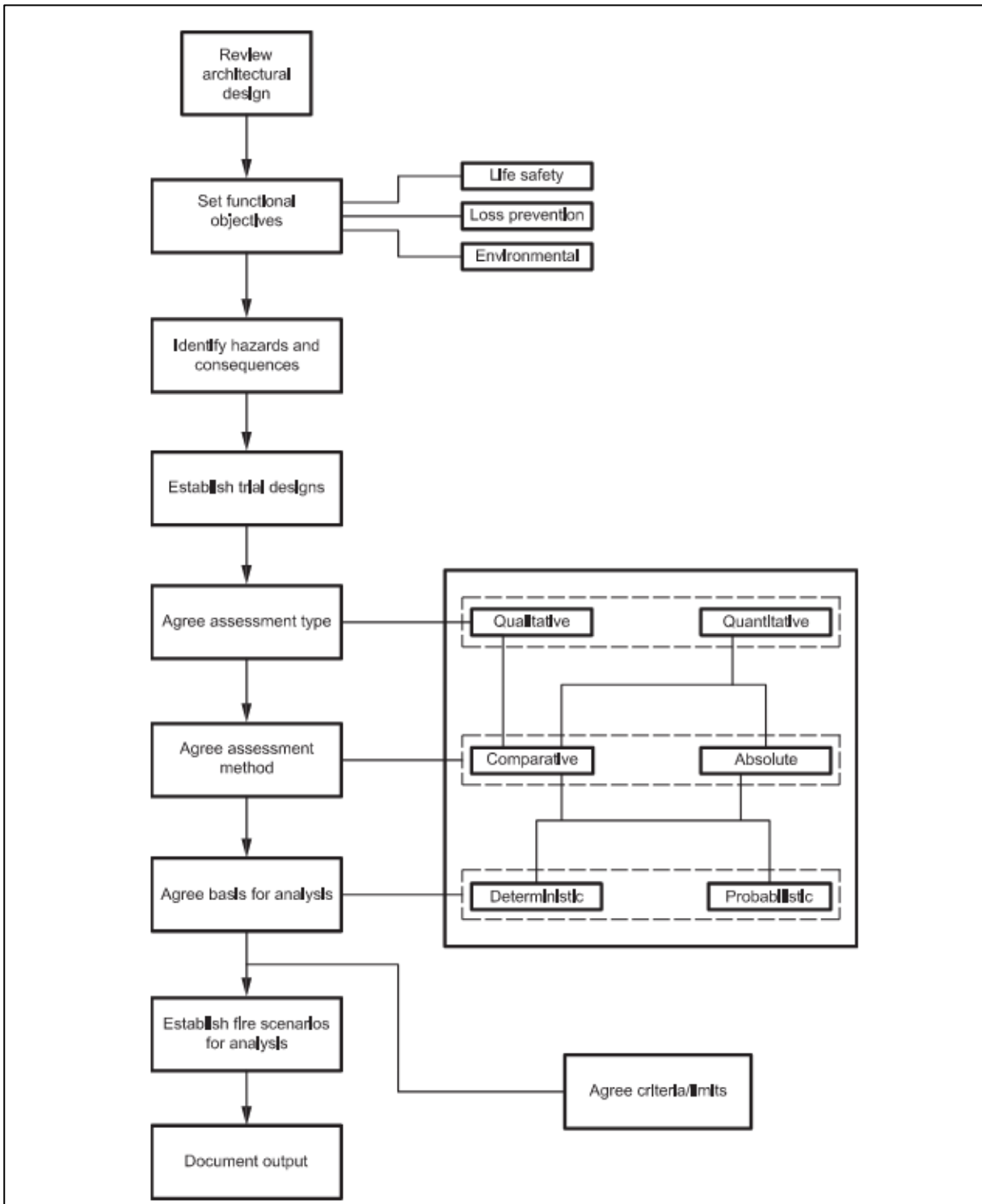


Figure 1 – QDR process

How this applies to this document is illustrated below:

1. Review of architectural design – A review that describes the project using schematic drawings, models etc., that outlines any aspects that may be significant in the fire safety strategy.
2. Functional objectives – Life safety, loss control, business continuation, environmental impact. This could be either single objectives or a combination of several.
3. Identify hazards and consequences – Analysis of all possible factors that could contribute to a fire in the building or the results thereof.
4. Establish trial designs – Consideration to fire protection systems that will support the functional objectives as well as the failure of these systems by a “what if” analysis.
5. Set acceptance criteria – Development of criteria to satisfy functional objectives.
6. Identify method of analysis – Either deterministic, probabilistic or qualitative.
7. Establish fire scenarios for analysis – QDR team to establish possible worst-case scenarios that should be used for analysis.
8. Document output

3.2 Review of Architectural Design

The architectural design is reviewed at the early outline stage of scheme development to ensure that the fire safety measures, and architectural design are developed in harmony.

3.2.1 All Blocks Characteristics

Item	Block H1	Block H2	Block H3
Number of storeys	Basement + 27 Storeys	Basement + 17 Storeys	Basement + 20 Storeys
General Dimensions	22.1m x 33.5m	27.4m x 35.3m	27.4m x 21.5m
Nature of Construction	Concrete, mortar brick and reinforced concrete		
Geometry and interconnection of spaces	As per Block H1 Floor Plan drawings	As per Block H2 Floor Plan drawings	As per Block H3 Floor Plan drawings
Internal subdivision of building	As per Block H1 Floor Plan drawings	As per Block H2 Floor Plan drawings	As per Block H3 Floor Plan drawings
Normal circulation Routes	As per Block H1 Floor Plan drawings	As per Block H2 Floor Plan drawings	As per Block H3 Floor Plan drawings
Escape routes	The occupants will escape from the apartments, into a protected corridor that leads to two protected staircases from each block, which ultimately leads to outside on the ground floor. At least one core in each block will be designed as a firefighting shaft.		
Wall and ceiling linings	Wall and ceiling linings will meet the classifications of Table 4.1 of Approved Document B.		
Provision for dispersal of people from the vicinity of the building	The final exits of the buildings allow the dispersal of persons into public space, away from the buildings.		
Possible fire and smoke spread routes	Corridors, openings, and voids		
Proposed fire detection and fire alarm system	Residential – LD2 & LD1 Automatic fire detection and alarm system with a minimum Grade D power supply, designed, installed and maintained in accordance with BS5839 Part 6. Commercial – Manual and L3 Standard fire detection and alarm system in accordance with BS5839 Part 1.		

	Ancillary Accommodation – L3 Automatic fire detection and alarm system in accordance with BS5839 Part 1. Car Park – L5 Automatic fire detection and alarm system in accordance with BS5839 Part 1.		
Location relative to other buildings or site boundary	North façade is around 7.5m from Coburg Road, the East façade is around 7.5m from Block H2, the South façade is 36.5m from Phase 3B building and the West façade is around 9.5m from Phase 5 building.	North façade is around 7.5m from Coburg Road, the East façade is around 11m from Bittern Place building and the West façade is 7.5m from Block H1. To the South is a party wall to Block H3.	East façade is around 11m from Bittern Place building, the South façade is 8.5m from Phase 3B building and the West façade is 39.5m from Phase 5 building. To the North is a party wall to Block H2.
Any other factor that might influence the fire safety design	Building top storey height is approximately 85m from the ground floor to the top storey excluding the roof.	Building top storey height is approximately 55m from the ground floor to the top-storey excluding the roof.	Building top storey height is approximately 63m from the ground floor to the top storey, excluding the roof.

Table 1 – All Blocks Building Characteristic

3.2.2 Fire Hazards

Item	Result
Unusual fire hazards	None
Potential ignition sources	- Electrical (fluorescent lights, electrical extensions, switchboards, cooking, etc.) - Mechanical (maintenance, malfunctioning equipment, etc.) - Heating equipment (Cooking stove, oven, cooking gas, water heater, incense, etc.) - Cars, motorcycles, vans
Combustible contents and structure	- Typical residential apartments - Ancillary areas (electrical / plant rooms) - Commercial Units (workplace and restaurant) - Vehicles in Car Park
Heat Release Rate	- Up to 650 kW/m² (Office) - Up to 320kW/m² (Residential) - Up to 1000kW/m² (Commercial) - Up to 750kW/m² (Car)
Any other factor that might influence the fire safety design	None

Table 2 – All Blocks Fire Hazards

3.2.3 Environmental Influences

Item	Result
Ambient noise levels	NA
Any other factor that might influence the fire safety design	No extreme weather condition exists

Table 3 - Environmental Influences

3.2.4 Occupants Characterisation

Item	Result
Number and distribution	<u>Residential</u> Block H1 – 384 persons Block H2 – 219 persons Block H3 – 256 persons <u>Workplace</u> H1 Total Area = 260m ² (44 persons) H2 / H3 Total Area = 825m ² (138 persons) <u>Restaurant</u> H1 Total Area = 157m ² (157 persons) H3 Total Area = 168m ² (168 persons)
Single or multiple tenancy of use	Multiple
Mobility, vulnerability and need for assistance	Disabled occupants
State of wakefulness	- Asleep – Residential - Awake – Communal terraces, Workplace, Restaurant, Ancillary and Car Park
Familiarity with the building	- Familiar – Residential, communal terraces, ancillary areas, car park and workplace - Unfamiliar – Restaurant
Social groupings	Open air communal Terrace Restaurants (all at ground floor)
Roles and responsibilities of key individuals	Management to assist with potential disabled occupants
Commitment to an activity (e.g., eating in a restaurant)	Restaurant (all at ground floor). Independent from residential accommodation.
Presence of a focal point (e.g., stage)	NA
Any other factor that might influence the fire safety design	None

Table 4 – All Blocks Occupants Characterisation

3.2.5 Management of Fire Safety

Item	Result
Quality and extent of continuing management control	Information will be provided (as outlined in Section R38 of Approved Document B) so that the person responsible for the building has all the information to enable them to: a. Understand and implement the fire safety strategy of the building.
Number of people on site responsible for the fire safety management	
Staff-to-occupant ratio	
Level of fire safety training	
Security arrangements that might conflict with evacuation strategy	

Level of control over work on site (e.g., hot works)	b. Maintain any fire safety system provided in the building. c. Carry out an effective fire risk assessment of the building.
Level of planning and adaptability for changes to risk on site	
Level of knowledge and understanding to implement the fire safety strategy	
Contacts for provision of additional information	
Any other factor that might influence the fire safety design	

Table 5 - Management of Safety

3.2.6 Firefighting

Item	Result
Fire-fighting Fire and rescue service response time	Local fire brigade to confirm
Access for fire appliances	Fire tender access to main entrance of building.
Fire-fighting access to, safety within and safe egress from the building	Building to be provided with a firefighting shaft, which will provide a protected stair that will be used for evacuation purposes.
Water supplies	Wet risers will be supplied from a dedicated tank. The sprinkler system will have a shared tank with the potable water.
Any other factor that might influence the fire safety design	None

Table 6 - Firefighting

3.2.7 Client requirements

Item	Result
Any commercialization of the space (e.g., mall areas)	Ground and first floors to contain workplaces and restaurants. Designed as independently operated units that will not interact with the residential accommodation.
Fire protection systems specified by client (e.g., sprinklers for loss control)	None
Any other factor that might influence the fire safety design	BQA TS002 – Lift for evacuation purposes to be provided
Impact of fire on business continuity as set out in a business impact analysis (BIA) if available	NA

Table 7 - Client Requirements

3.3 Functional objectives

The functional objective of the fire safety design is specified below.

Life safety

The occupants of a building, firefighters and members of the public who are in the vicinity of a building can be put at risk by fire. The main life safety functional objectives are defined as design objectives below:

- The occupants are ultimately able to leave the building in reasonable safety or the risk to occupants is acceptably low.
- Common corridors allow the escape of occupants and enable fire-fighters to suppress the fire.

- c) The escape from high levels should be possible for the required time, by ensuring the escape stairs are clear of smoke.
- d) Firefighters can operate without undue risk to:
 - assist evacuation when necessary.
 - effect rescue when necessary.
 - prevent conflagration.
- e) Collapse does not endanger people (including firefighters) who are likely to be in or near the building.

3.4 Identify Fire Hazard and Possible Consequences

3.4.1 Hazards

A systematic review is conducted to establish the potential fire-related hazards within the buildings and their potential consequences. The following aspects have been considered:

3.4.1.1 Ignition sources

- Electrical appliances
- Mechanical sparks
- Naked flames
- Fluorescent lights
- Electrical extensions
- Switchboards
- Cooking
- Mechanical operations
- Maintenance
- Malfunctioning equipment
- Cooking stove
- Oven
- Cooking gas
- Water heater
- Incense
- Electrical vehicles

3.4.1.2 Combustible contents

- Furniture
- Packaging materials
- Appliances
- Combustible waste materials
- Textiles
- Flammable gases

3.4.1.3 Nature of the activities in the buildings

- Cooking
- General residential activities
- Restaurant
- Offices
- Plant room activities for building operation

3.4.2 Consequences

The consequences of a particular fire hazard vary significantly depending upon the contents and construction of a building, the following are typical situations that might give rise to a fire scenario.

3.4.2.1 Cooking

- Unattended cooking activity leads to ignition
- Ignites material adjacent to cooker

- Fire spreads across combustible materials surrounding cooker
- Fire penetrates ceiling to floor above
- Fire spreads to other rooms via open doors
- Building and contents written off

3.4.2.2 Malfunctioning appliance

- Kitchen appliance containing combustible / flammable material has electrical malfunction that leads to ignition
- Ignites combustible material adjacent to the appliance
- Fire spreads across combustible materials within apartment
- Fire penetrates ceiling to floor above
- Fire spreads to other rooms via open doors
- Building and contents are written off

3.5 Establish Trial Fire Safety Designs

Fire protection system	Possible QDR considerations
Control on materials	Non-combustible materials in: - Construction - Linings
	Flame retardant materials in: - Furniture - Furnishings
Automatic suppression	Throughout building
	Extinguishing medium: Water
Detection	Design standard: BS9251 – Residential Design standard: BS12845 – Non-residential units and ancillary accommodation that serves the residential which cannot be supplied by the residential system.
	LD2 & LD1 Grade D – Apartments L3 – Ancillary Accommodation L5 – Car Park Manual System & L3 – Workplace and Restaurants Design standard: BS5839 Part 6 – Residential Design standard: BS5839 Part 1 – Non-residential
Structural protection and compartmentation	<u>Structural Fire resistance:</u> • Block H1 upper floors: 120 minutes • Block H2 upper floors: 120 Minutes • Block H3 upper floors: 120 minutes <u>The calculation to escape building from the furthest apartment on the highest possible storey:</u> • Total travel distance from the furthest apartment at L27 down the staircase of Block H1 to the ground floor: 11m + (9m x 27) + 18m = 272m • Total travel distance from the furthest apartment at L17 down the staircase of Block H2 to the ground floor: 12m + (9m x 17) + 18m = 183m • Total travel distance from the furthest apartment at L20 down the staircase of Block H3 to the ground floor: 12m + (9m x 20) + 18m = 210m Minimum descending walking speed: 0.1m/s (Table G.5 – Disabled subjects) <u>Total time to travel to the ground floor:</u>

	• Block H1: 46 minutes • Block H2: 31 minutes • Block H3: 35 minutes
	Compartment size: Varies, as per the design and in accordance with ADB
	Location boundaries: To be discussed in the fire strategy
	Passive fire protection systems: fire-resistant elements of structure, compartmentation, fire doors, passive fire protections systems and cavity barriers
	Automatic systems
Automatic systems	Dampers: Interconnected with detection system
	Automatic doors hold open devices
	Smoke Fans
	Vents (e.g., AOV)
	Automatic Fire Sprinkler System
Smoke control	Mechanical Smoke Extraction within common corridors to maintain tenability and keep stairs and lift lobbies clear of smoke to ensure a safe egress route. The car park ventilation system is provided for two purposes. The first purpose is to provide a suitable environment for the daily use of the car park. The second is to provide protection to the building and the fire fighters in the event of a fire. It is normal practice for both purposes to be satisfied by a single unified system operating in two modes. A mechanical ventilation system utilizing impulse ventilation will be provided to give 6 air changes per hour under normal operation or ensure carbon monoxide levels do not exceed: • 30ppm over an 8-hour period and, • 90ppm over a 15-minute period Under fire conditions the system will be ramped up to provide a minimum of 10 air changes per hour. The smoke outputs and ventilation requirements should be assessed in accordance with BS7346 Part 7.
Alarm and warning systems	No automatic communal alarm system, only within apartments. Evacuation alert system in accordance with BS8629 for the fire service to operate – Residential Communal alarm system – Non-residential
Evacuation strategy	Stay-put evacuation – Residential Simultaneous evacuation – Non-residential As part of Policy D5, it is a requirement to provide a dignified means of escape for all occupants, therefore the building shall be provided with a lift that is suitable for evacuation purposes. The building management forms an integral part of the design and ongoing functionality of the building after occupation. The building will have a management team whose responsibilities will include ensuring the fire safety strategy is adopted and enforced. One of the responsibilities of this team will be to develop a management strategy for the building.

	This strategy will incorporate details of how the building satisfies the requirements of the Equality Act 2010. The management strategy should include information on staff training, 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 and will have to be developed by the building management ahead of the building handover.
Escape routes	Escape routes and number: Two staircases will be provided as escape routes for the residential floors, except for the commercial spaces, that will have escape routes directly to outside.
	Travel distances: A maximum travel distance from apartment door to staircase lobby will be within 7.5m.
	Exit widths: Exits into the staircases shall be 850mm wide from each floor. At ground floor the staircase door and final exit door shall be the same width of the staircase.
	Stairways: Two staircases will be provided in each block with a minimum width 1100mm (but will be 1200mm as per client requirements)
	Refuges for disabled: Not required for residential, however if provided, in front of lifts.
	Lifts – 1 Firefighting Lift + 1 Lift for Evacuation (in each block)
	All workplace and restaurant units will have separate escape routes directly to outside. The restaurants that have single stories located on the ground floor are not required to provide a disabled refuge. However, the offices are located at ground and first levels, will require disabled refuge on first floor located within a protected corridor/stair and be provided with an EVCS.
	Escape lighting: <u>Residential</u> All common escape routes <u>Commercial</u> - Windowless accommodation - Stairways serving a central core or serving storey (s) more than 18m above ground level - Internal corridors more than 30m long - Open-plan areas of more than 60m² <u>Ancillary Accommodation</u> - Underground or windowless accommodation - Stairs either: - o in a central core - o that serve the storey (s) more than 18m above ground level - Internal corridors more than 30m long - Open-plan areas of more than 60m²
First aid firefighting	Extinguishers to be provided as per BS5306
	Availability of trained staff: To be confirmed with a management plan
Fire service facilities	Access routes: The firefighting tender will be provided access from Coburg Road, Silsoe Road to the main entrance of the buildings. Fire vehicle access shall be available to 15% of the perimeter of the workplace and restaurant units.

Fire safety management	Rising mains: A wet riser shall be provided in Blocks H1, H2 & H3. The inlet to the riser mains shall be located close to the entrance of the building.
	Firefighting shafts: A single firefighting shaft will be provided in each block.
	Management plan: To be confirmed with the management team
	Staff availability: To be confirmed with a management plan
	Staff training: To be confirmed with a management plan
	A third-party audit of procedures: To be confirmed with the management plan
	Maintenance schedules: To be confirmed with a management plan

Table 8 – All Blocks Trial Fire Safety Designs

3.5.1 “What if” Analysis

As part of the hazard assessment process, an assessment of “what if” events should be made to identify system failures or foreseeable events that might have a significant influence on the outcome of the study.

“What if” event	Impact on fire safety	Further measures required?
Fire door (stair or apartment) propped open	The fire doors will be fitted with self-closers to prevent this in everyday use. However, should a stair or apartment door be left open, this is no different from the situation that will occur when the fire service is fighting a fire.	No
	It will be shown in the CFD modelling that the smoke extract system can keep the stair clear of smoke in this scenario.	No
Combustible Displays introduced into sterile areas	There will be a defined management strategy for the building which will be adhered to whose role will include ensuring the communal spaces remain sterile, or a fire risk assessment is conducted on any other materials present. There will be separation between sterile areas and furnished lobbies. If goods were placed in the common corridors, this would prevent the general use / access to the apartments, so unlikely that this would take place.	No
Failure in compartmentation	To prevent compartmentation failure, several checks will be put in place during the building construction. There will be regular site inspections conducted by Elementa or another suitable contractor on the compartmentation, with issues identified to the client and / or contractor. Photographic evidence during installation.	No
	The construction and fire stopping will be carried out by competent persons with appropriate accreditations and experience.	

	Building Control will also conduct inspections to ensure the compartmentation is built as designed.	
	There will be a management system in place to ensure any work carried out during the occupation of the building maintains the original compartmentation. The management will also ensure that adequate maintenance and monitoring of the installed compartmentation is completed and recorded.	
	If compartmentation does fail, the provision of sprinklers throughout the building will ensure the fire does not continue to grow beyond the area of origin. Should smoke spread through breaches in compartmentation this will be cold smoke which may result in an evacuation but will not propagate the fire to another location. If compartmentation fails between apartments, the fire could spread, however the stairs will remain smoke free and the ventilation system will limit the amount of smoke in the corridor. If compartmentation between the corridor and apartment fails, smoke could fill the corridor, however the stairs will remain smoke free.	
	The evacuation alert system will allow the fire service to initiate a partial / full evacuation should they require to.	
	The elements of structure will achieve 120 minutes of fire resistance.	
Smoke ventilation fails	There will be a dual power supply to all of the life safety equipment	No
	There will be a maintenance strategy to maintain all equipment within the building.	
	The installation will be done in accordance with approved standards using approved materials and equipment to ensure component failure is minimized.	No
	There will be a standby fan that operates 100% of the required duty if the primary fan were to fail.	
	The doors to the staircase, lobby and to the apartment are on self-closers, therefore during means of escape there will be a limited amount of smoke that will spread into the corridor and worst-case scenario, some smoke could spill into the lobby and staircase, but will not be sufficient to prevent it from being used by other occupants.	No

	During firefighting, it would be expected that the evacuation alert system would be used to evacuate the building prior to undertaking the firefighting operations so that there is not a risk that the staircase could not be tenable for use by other residents.	
Sprinkler system failure	Dual pump sets are provided to the sprinkler system, each with a connection to the electrical supply and to the secondary power supply in the event of mains failure.	No
	In the event of a water supply issue in the building, it will be unoccupiable and hence there will not be an issue of no water and apartments requiring sprinkler protection at the same time.	
	There will be a maintenance strategy to maintain all equipment within the building.	
	The fire resistance of the structure will not be reduced, as the performance specification does not require a sprinkler system to reduce the exposure of fire.	
	Increased fire size but this would likely cause window failure (as outlined / advised in the SCA guide). The mechanical ventilation system in the common corridors is capable of protecting the staircase from smoke ingress with an unsprinklered apartment fire.	No
Sensitive detection systems adversely affected by movement of ventilation air	There will be no aspirating detection within the common corridors or the apartments.	No
The fire is located where it blocks an exit	The building will operate under a stay-put policy and so a fire blocking a final exit will not block the escape of occupants as they are safe in their apartments due to the level of compartmentation provided.	No
	<u>Residential:</u> Should occupants wish to evacuate, a protected escape route will lead directly outside at ground floor level, so there is no requirement for occupants to pass through the furnished lobby / foyer. <u>Non-Residential:</u> Escape routes of the commercial and office uses will be separate from the residential cores. They will lead directly to outside.	

Management fails to implement fire safety procedures	There will be a defined management strategy for the building which will be adhered to.	No
Basement Fire	The stairs that serve the basement are independent from the stairs that serve the upper levels. Therefore, it is considered there is no risk from a fire at the basement level spreading to the upper levels. Ventilation systems (with secondary power supply) and commercial sprinkler system is designed to BS EN 12845. Occupancy – transient area, car park and plant space predominantly.	No

Table 9 - "What if" Analysis

3.5.2 Common Mode Failures

Further on Section 3.5.1, a common mode analysis is required to assess the failure effects on fire protection measures that effect another measure.

Failure	Effect on Another Measure	Solution
Power Supply	- Sprinkler System - Automatic Detection System - Smoke Ventilation - Wet Risers	- Independent backup power supply - Ensure maintenance by relevant standards
Detection System	- Delayed Evacuation	- Ensure maintenance by relevant standards
Smoke Extraction	- Delayed / Difficult Evacuation - Difficulties with firefighting - False alarms from the detection system	- Ensure maintenance by relevant standards
Sprinkler System	- Uncontrolled fire leads to greater demand for firefighting measures	- Dual pump supply - Ensure maintenance by relevant standards
Open Fire Door	- Fire spread beyond the origin	- Ensure maintenance by relevant standards

Table 10 - Common Mode Failure

3.6 Set acceptance criteria

Acceptance that the functional objectives set out in Section 3.3 has been met requires a set of criteria against which an assessment can be measured. The acceptance criteria are set as appropriate to the specific scenario under consideration, and it should be recognized that elimination of all risk from the effects of a fire is an unrealistic expectation. Dependent upon the type of assessment undertaken acceptance criteria may be an absolute or comparative numerical value. They may also be a qualitative descriptor as part of a narrative assessment. Figure 2 below illustrates the process of setting up the required criteria.

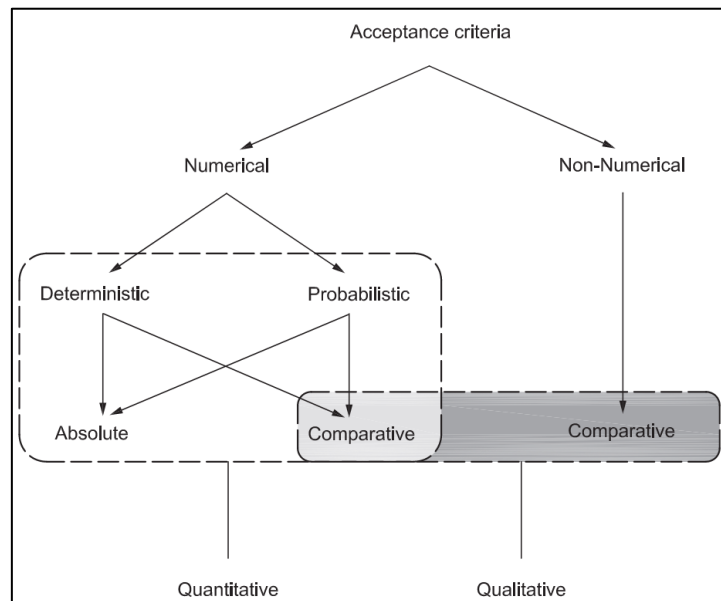


Figure 2 - BS7974 (Relationship for setting quantitative and qualitative acceptance criteria)

For the purposes of determining whether the building regulations are suitable to apply to this building, a qualitative criterion by means of argument is best suited for this application.

3.7 Identify Method of Analysis

At QDR stage, the method of analysis should be agreed. All parties should be made aware of the advantages and disadvantages of each method so that an informed decision can be made. They should also be made aware that many assumptions made in the analysis might not always be valid in every circumstance.

The analysis that can be applied for this building, can be of a qualitative nature.

3.8 Establish Fire Scenarios for Analysis

The number of possible fire scenarios in even a relatively simple building can become very large and it is not feasible (or necessary) to assess the effects of them all. Therefore, when carrying out an FSE analysis, the QDR team discuss and agree one or more reasonable worst-case scenarios for detailed evacuation.

Depending upon the functional and design objectives of the FSE analysis the definition of a fire scenario should consider some or all the following factors:

- a) Design fire.
- b) Fire location.
- c) Occupant characteristics.

The detailed analysis and quantification of fire scenarios for a specific building should be limited to the most significant fire scenarios.

The characterization of a fire scenario for analysis purposes includes a description of the following, where appropriate:

1. Type of fire.
2. Natural ventilation conditions.
3. Performance of each of the safety measures.
4. Type, size, and location of the ignition source.
5. Distribution and type of fuel.
6. Fire load density.
7. Fire suppression.
8. State of doors (i.e., Are the doors open or closed).
9. Breakage of windows.
10. Mechanical building ventilation system.

The possible consequences of each fire scenario should also be determined.

The two main quantities used to describe design fires are the heat release rate and temperature-time profiles. The most widely used pre-flashover design fires are t_2 fires, whereas a host of empirical correlations are available for post-flashover design fires.

Block H1

3.8.1 Scenario 1

A fire scenario is considered on Level 12 for an apartment (2b3p Type 02a) on the left of Block H1 with a size of 67.9m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- LD1/LD2 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

30cm Pan fire in kitchen on cooker

Distribution and type of fuel

Furniture and appliances throughout the apartment

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment Area	67.9m ²
HRR per unit area	320kW/m ²
Fuel controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 11 - Scenario 1 Design Fire

State of doors

Doors to the corridor are to be closed once the occupant escapes and held open when the fire department initiates firefighting.

3.8.2 Scenario 2

A fire scenario is considered on the workplace unit for an area of 260m² which has a separate escape route independent of the residential cores. The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable doors with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- Manual Fire Detection System
- Sprinkler System

Type, size, and location of the ignition source

Free standing plastic goods with electrical faults or overheating machinery

Distribution and type of fuel

Mixed plastic goods with carton packaging

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Area of Operation	72m ²
HRR per unit area	650kW/m ²
Fuel controlled maximum HRR	47MW
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	420MJ/m ²
Total fire load density	30240MJ

Table 12 - Scenario 2 Design Fire

State of doors

Doors to outside to be open when evacuation initiates and held open when fire department initiates firefighting.

3.8.3 Scenario 3

A fire scenario is considered on the ground floor restaurant for an area of 156.5m². This operates solely on the ground floor and has escape routes directly to outside. The fire is to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable doors with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- Manual Fire Detection System
- Sprinkler System

Type, size, and location of the ignition source

Kitchen fire, free standing plastic goods with electrical faults or overheating machinery

Distribution and type of fuel

Pan oil, mixed plastic goods with carton packaging

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Area of Operation	72m ²
HRR per unit area	1000kW/m ²
Fuel controlled maximum HRR	72MW

HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	298MJ/m ²
Total fire load density	21456MJ

Table 13 - Scenario 2 Design Fire

State of doors

Doors to outside to be open when evacuation initiates and held open when fire department initiates firefighting.

3.8.4 Scenario 4

A fire scenario is considered on L25 for apartment (1b1p Type 01a) with area 45.2m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if analysis is performed.

Performance of each of the safety measures

- LD1/LD2 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

Plastics and paper documents with electrical faults or overheating machinery

Distribution and type of fuel

Furniture and appliances throughout office

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment area	45.2m ²
HRR per unit area	320kW/m ²
Fuel-controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 14 - Scenario 3 Design Fire

State of doors

Doors to corridor to be closed once occupant escapes and held open when fire department initiates firefighting.

Block H2**3.8.5 Scenario 1**

A fire scenario is considered on Level 2 for an apartment (2b3p Type 09a) on the left of Block H2 with a size of 63.9m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- LD1 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

30cm Pan fire in kitchen on cooker

Distribution and type of fuel

Furniture and appliances throughout the apartment

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment area	63.9m ²
HRR per unit area	320kW/m ²
Fuel controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 15 - Scenario 1 Design Fire

State of doors

Doors to the corridor are to be closed once the occupant escapes and held open when the fire department initiates firefighting.

3.8.6 Scenario 2

A fire scenario is considered for the H2 / H3 workplace unit for an area of 825m² which has a separate escape route independent of the residential cores. The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable doors with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- Manual Fire Detection System
- Sprinkler System

Type, size, and location of the ignition source

Free standing plastic goods with electrical faults or overheating machinery

Distribution and type of fuel

Mixed plastic goods with carton packaging

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Workplace Area	72m ²
HRR per unit area	650kW/m ²
Fuel controlled maximum HRR	47MW
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	420MJ/m ²
Total fire load density	30240MJ

Table 16 - Scenario 2 Design Fire

State of doors

Doors to outside to be open when evacuation initiates and held open when fire department initiates firefighting.

3.8.7 Scenario 3

A fire scenario is considered on L14 for apartment (2b3P Type 14a) with area 76.7m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if analysis is performed.

Performance of each of the safety measures

- LD1/LD2 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

Plastics and paper documents with electrical faults or overheating machinery

Distribution and type of fuel

Furniture and appliances throughout office

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment area	76.7m ²
HRR per unit area	320kW/m ²
Fuel-controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 17 - Scenario 3 Design Fire

State of doors

Doors to corridor to be closed once occupant escapes and held open when fire department initiates firefighting.

Block H3

3.8.8 Scenario 1

A fire scenario is considered on Level 2 for an apartment (1b2p Type 15b) on the left of Block H3 with a size of 44.3m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- LD1/LD2 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

30cm Pan fire in kitchen on cooker

Distribution and type of fuel

Furniture and appliances throughout the apartment

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment area	44.3m ²
HRR per unit area	320kW/m ²
Fuel controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 18 - Scenario 1 Design Fire

State of doors

Doors to the corridor are to be closed once the occupant escapes and held open when the fire department initiates firefighting.

3.8.9 Scenario 2

A fire scenario is considered on the ground floor restaurant for an area of 168m². This operates solely on the ground floor and has escape routes directly to outside. The fire is to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable doors with dimensions to be confirmed if the analysis is performed.

Performance of each of the safety measures

- Manual Fire Detection System
- Sprinkler System

Type, size, and location of the ignition source

Kitchen fire, free standing plastic goods with electrical faults or overheating machinery

Distribution and type of fuel

Pan oil, mixed plastic goods with carton packaging

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Restaurant Area	72m ²
HRR per unit area	1000kW/m ²
Fuel controlled maximum HRR	72MW
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	298MJ/m ²
Total fire load density	21456MJ

Table 19 - Scenario 2 Design Fire

State of doors

Doors to outside to be open when evacuation initiates and held open when fire department initiates firefighting.

3.8.10 Scenario 3

A fire scenario is considered on L19 for apartment (3b6p Type 18) with area 96.3m². The fire is assumed to be sprinkler-controlled.

Type of fire

Class A Fire - Ordinary Combustible Fire

Natural ventilation conditions

Openable windows with dimensions to be confirmed if analysis is performed.

Performance of each of the safety measures

- LD1 Grade D Fire Detection System
- Sprinkler System
- 60 Minute Compartment Walls
- 30 Minute Fire Rated Smoke Sealed Door to protected corridor

Type, size, and location of the ignition source

Plastics and paper documents with electrical faults or overheating machinery

Distribution and type of fuel

Furniture and appliances throughout office

Fire load density

From BS7974-1, Table A.4 and A.5, the design fire has the following characteristics:

Feature	Value
Apartment area	96.3m ²
HRR per unit area	320kW/m ²
Fuel-controlled maximum HRR	1MW (sprinkler controlled)
HRR growth rate	0.012kW/s ² (Medium growth)
Total fire load density per unit area	780MJ/m ²
Total fire load density	2527MJ

Table 20 - Scenario 3 Design Fire

State of doors

Doors to corridor to be closed once occupant escapes and held open when fire department initiates firefighting.

4 Conclusions

The Building Regulations are deemed to be satisfactory to encapsulate the possible fire scenarios that could occur at the building height in this design. The type of fire that could occur is not influenced by the height.

