307 Lane Cove Rd, Macquarie Park

EDEN GARDEN

FIRE ENGINEERING REPORT

REPORT 113350-R1

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REVISION CONTROL

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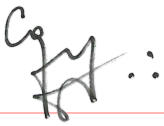
		Verified and Issued by:	Carlos Quaglia (Director of Fire Safety Engineering, C10 - BPB0334)	
		Approved by:	Harriet Peel (Fire Engineering Manager)	
2020/283 Draft R1.0	08/12/2020	Description:	Draft Report	

Stephen Grubits & Associates has been acquired by BCA Logic Pty Ltd from 28 January 2021. The staff and quality of service remain the same, however increased leverage in the market is achieved by combining resources with BCA Logic Pty Ltd. Moving forwards Stephen Grubits & Associates will be known as "SGA Fire – A Division of BCA Logic Pty Ltd".

EXECUTIVE SUMMARY

This Fire Engineering Report relates to proposed multi-storey development know as Eden Gardens located at 307 Lane Cove Rd, Macquarie Park. The building is proposed to contain modifications to the existing Neighbourhood Shops building and basement car park, a multi storey office building, restaurant, function centre and multi-story above ground car park with a ground floor Garden Centre.

SGA has been appointed by Thunderbirds Are Go Pty Ltd to develop fire engineered Performance Solutions to address departures from the Building Code of Australia (BCA)[1] Deemed-to-Satisfy (DTS) provisions listed in Table 1.

This report outlines the preferred solutions that are intended to meet legislative requirements to address the potential departures from Deemed-to-Satisfy (DTS) Provisions of the Building Code of Australia (BCA).

The fire safety strategy presented herein carried out for the building demonstrates that the Performance Solutions identified in Table 1 are considered capable of achieving compliance with the relevant Performance Requirements of the BCA, to support the DA, subject to a full fire engineering assessment. The departures have been identified by Blackett Maguire + Goldsmith Pty Ltd.

Table 1 – Building Departures from the DTS Provisions of the BCA

DTS Provision	Description of Departures from the DTS Provisions	Performance Requirements
Clause C1.1, Specification C1.1	The Neighbourhood Shops building are required to achieve the FRLs consistent with Type A construction, i.e. 180/180/180. The existing construction is expected to achieve a lower FRL of 120/120/120 or less.	CP1, CP2
Clause C3.3	The Neighbourhood Shops building and the proposed new office tower have unprotected openings within the allowable distances of Table C3.3. i.e. 6 m	CP2
Clause D1.4, D1.5	Travel Distances within the basement car park exceed the maximum allowable distances to and between exits. The distance are as follows - 70 m to an exit in lieu of 40 m - 122 m between exits in lieu of 60 m	DP4, EP2.2
Clause D1.4, D1.5	Travel Distances within the ground floor Neighbourhood Shops building and Garden Centre areas exceed the maximum allowable distances to and between exits. The distance are as follows - 49 m to an exit in lieu of 40 m - 85 m between exits in lieu of 60 m	DP4
Clause D1.7	Egress from the office tower requires passing within 6m of the external walls of the Neighbourhood Shops building which contain unprotected openings	DP5
Clause D1.8	The stairs serving the office tower are proposed to be open, external stairs in lieu of fire isolated stairs.	DP5, EP2.2
Clause D1.9	The total travel distance from the basement car park to a road or open space is up to 90 m in lieu of the maximum allowable 80 m	DP4

[1] National Construction Code Series, Volume 1 Building Code of Australia 2019, Australian Building Codes Board.

DTS Provision	Description of Departures from the DTS Provisions	Performance Requirements
Clause E1.3, E1.5, E1.8	Fire brigade equipment including the hydrant booster assembly, sprinkler booster pump and fire control room are not located as per the requirements of the BCA and AS2419. Instead, they are currently proposed to be located adjacent to the above ground car park.	EP1.3, EP1.4, EP1.6

It is considered that the identified departures from the DTS provisions of the BCA for the Eden Gardens development located at 307 Lane Cove Rd, Macquarie Park could achieve an acceptable level of fire safety by DTS upgrades and performance solutions. The proposed fire safety measures that form part of this fire safety strategy for the subject building are considered likely to provide a level of fire safety which is equivalent to a BCA-compliant design whilst limiting the impact on the design feature of this building.

The fire safety strategies presented within this report do not constitute Performance Solutions. The departures are proposed to be addressed by way of Performance Solutions in a Fire Engineering Report prepared by a qualified fire engineer.

TABLE OF CONTENTS

LIST OF ACRONYMS

AS	Australian Standard
ASET	Available Safe Evacuation Time
BCA	National Construction Code Series Volume One Building Code of Australia, 2019
CC	Construction Certificate
DA	Development Application
DTS	Deemed-to-Satisfy
FEB	Fire Engineering Brief
FER	Fire Engineering Report
FRL	Fire Resistance Level
FRNSW	Fire and Rescue NSW
IFEG	International Fire Engineering Guidelines
RSET	Required Safe Evacuation Time
SGA	SGA Fire, a Division of BCA Logic

1. INTRODUCTION

This Fire Engineering Report relates to proposed multi-storey development know as Eden Gardens located at 307 Lane Cove Rd, Macquarie Park. The building is proposed to contain modifications to the existing Neighbourhood Shops building and basement car park, a multi storey office building, restaurant, function centre and multi-story above ground car park with a ground floor Garden Centre.

SGA has been appointed by Thunderbirds Are Go Pty Ltd to develop fire engineered Performance Solutions to address departures from the Building Code of Australia (BCA)[2] Deemed-to-Satisfy (DTS) provisions listed in Table 5.

This report documents outlines the preferred solutions that are intended to meet legislative requirements to address the potential departures from Deemed-to-Satisfy (DTS) Provisions of the Building Code of Australia (BCA).

The fire safety strategy presented herein carried out for the building demonstrates that the Performance Solutions identified in Table 5 are considered capable of achieving compliance with the relevant Performance Requirements of the BCA, to support the DA, subject to a full fire engineering assessment.

The areas of departures from the DTS provisions of the BCA addressed in this report are related to the following:

- FRL of retail building elements
- Separation of fire compartments
- Travel distances within the building
- Discharge from fire isolated exits
- Fire isolation of exit stairs
- FRNSW equipment location

2. LIMITATIONS & ASSUMPTIONS

1. The scope of this report is limited to identifying preferred solution(s) that meet legislative requirements capable of fulfilling the Performance Requirements of the BCA with respect to the safety objectives stated. The departures are proposed to be addressed in a Fire Engineering Report.

2. The scope of this report is limited to an assessment of the departures from the DTS provisions identified in. No assessment has been undertaken on any other non-compliance issues in the building, nor have any other non-compliances been considered in the assessment.

3. This report does not consider property damage to the building as a result of the fire scenarios addressed in this study.

4. The assessment is based on the objectives of the BCA being that of:
   - Occupant life safety;
   - Facilitation of the Fire Brigade intervention; and
   - Protection of adjoining property.

5. Should a change in use or building alterations or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report.

6. All of the fire safety systems are assumed to operate as designed unless specifically stated otherwise.

[2] National Construction Code Series, Volume 1 Amendment 1, Building Code of Australia 2019, Australian Building Codes Board.

7. This report does not address sections B, F, H, J of the BCA, nor does it address access provisions.

8. This report does not include any consideration of hazard or risk associated with any combustible external walls or cladding in the buildings.

3. DESIGN DOCUMENTATION

The following report has been reviewed for the preparation of this report.

Table 2 – Design Documentation (Reports)

Title / Description	Report No.	Revision	Issued By	Issued Date
BCA Assessment Report	200412	R0	BM+G	04/11/2020

The following drawing sets have been reviewed for the preparation of this report.

Table 3 – Design Documentation (Drawings)

Title / Description	Drawing No.	Revision	Issued By	Issued Date
Survey Plan	DA100	-	DKO	05/02/2021
Demolition Plan_LG	DA101	-	DKO	05/02/2021
Demolition Plan_UG	DA102	-	DKO	05/02/2021
Site Plan	DA103	-	DKO	05/02/2021
Lower Ground	DA104	-	DKO	05/02/2021
Ground Level	DA105	-	DKO	05/02/2021
Level 1 – Tower Podium	DA106	-	DKO	05/02/2021
Level 3 – Tower Podium	DA107	-	DKO	05/02/2021
Level 5 – Tower Plant	DA108	-	DKO	05/02/2021
Level 6-7, 10-11, 17 – Typical Tower	DA109	-	DKO	05/02/2021
Level 8-9, 15-16 – Typical Tower	DA110	-	DKO	05/02/2021
Level 12 - Tower	DA111	-	DKO	05/02/2021
Level 18 – Tower Roof Services	DA112	-	DKO	05/02/2021
Car Park North and South Elevations	DA300	-	DKO	05/02/2021
Car Park East and West Elevations	DA301	-	DKO	05/02/2021
Car Park Sections	DA302	-	DKO	05/02/2021
Restaurant East and West Elevations	DA400	-	DKO	05/02/2021
Restaurant North and South Elevations	DA401	-	DKO	05/02/2021
Restaurant Sections	DA402	-	DKO	05/02/2021
North and South Tower Elevations	DA403	-	DKO	05/02/2021
East Tower Elevation	DA404	-	DKO	05/02/2021
West Tower Elevations	DA405	-	DKO	05/02/2021
Tower Sections	DA406	-	DKO	05/02/2021
Neighbourhood Shops/Garden Centre Elevations	DA500	-	DKO	05/02/2021
Function Centre East and West Elevations	DA600	-	DKO	05/02/2021
Function Centre North and South Elevations	DA601	-	DKO	05/02/2021
Function Centre Sections	DA602	-	DKO	05/02/2021

Title / Description	Drawing No.	Revision	Issued By	Issued Date
North Site Elevation	DA700	-	DKO	05/02/2021
South Site Elevation	DA701	-	DKO	05/02/2021
East Site Elevation	DA702	-	DKO	05/02/2021
West Site Elevation	DA703	-	DKO	05/02/2021
Site Section AA	DA800	-	DKO	05/02/2021
Site Section BB	DA801	-	DKO	05/02/2021
LG_EOTF & Function Centre_GFA	DA900	-	DKO	05/02/2021
Ground Level_GFA	DA901	-	DKO	05/02/2021
Level 1 & 2_GFA	DA902	-	DKO	05/02/2021
Level 3 & 4_GFA	DA903	-	DKO	05/02/2021
Level 5_GFA	DA904	-	DKO	05/02/2021
Level 6 & 17_GFA	DA905	-	DKO	05/02/2021
Level 6 & 17_GFA (pre 600 mm)	DA906	-	DKO	05/02/2021
Level 12_GFA	DA907	-	DKO	05/02/2021

4. BUILDING DESCRIPTION

4.1. GENERAL CHARACTERISTICS

The development comprises multiple buildings on the same site. The existing site contains a single storey retail building (Neighbourhood Shops building) and underground car park. The new works proposed to the site include modifications to the existing Neighbourhood Shops building, extension to the underground car park, and construction of a function centre, 18-storey office building, 5-storey above-ground car park with a ground floor garden centre and a restaurant at the rear of the site.

The buildings on site are generally connected by way of the underground car park though the restaurant is considered a separate building. There is also a large gardened area on site. The main office building is served by two fire isolated stairs that are proposed to be open on one side.

4.2. BCA REFERENCE CRITERIA

The following BCA criteria have been extracted from the BCA compliance report prepared by BM+G, dated 4 November 2020.

Table 4 – BCA Reference Criteria

Building Classification	5, 6, 7a, 7b and 9b
Rise in Storeys	18
Type of Construction	A
Effective Height	72.75 m

4.3. OCCUPANT CHARACTERISTICS

The characteristics of occupants would depend on the area of the site in which they are located. In general, the occupants are not expected to be overly representative of any population demographic. i.e., race, age, gender, mobility etc.

4.3.1. Occupants in the Car-Parking Areas

Occupants in the car parking area would consist of office and retail staff, visitors to the building and customers for the Neighbourhood Shops building, restaurant or function centre.

Occupants in the car-parking areas are expected to be awake during a fire incident but may not be familiar with the layout of the car park and the location of the exits.

4.3.2. Occupants in the Office Tower

Occupants in the tower are expected to consist of office staff and visitors to the building. Office staff are expected to be familiar with the building, its layout, the location of exits and any emergency procedures in the building. Visitors would not be expected to have the same familiarity as office staff but would be expected to be accompanied by staff. Occupants are expected to be awake and alert during a fire incident.

4.3.3. Occupants in the Neighbourhood Shops building, Garden Centre, Restaurant and Function Centre

Occupants in the Neighbourhood Shops building, restaurant and function centre would consist of staff and customers. Staff are expected to be familiar with the building, its layout, location of exits and any emergency procedures. Customers would not be expected to be familiar with the building. All occupants

are expected to be awake during a fire event, however, customers in the restaurant and function centre may be under the effects of alcohol and thus may not be alert to a fire incident.

5. BCA DTS DEPARTURES

Table 5 below lists the BCA DTS Departures which are assessed in this report. The departures have been identified by Blackett Maguire + Goldsmith Pty Ltd.

Table 5 – Building Departures from the DTS Provisions of the BCA

DTS Provision	Description of Departures from the DTS Provisions	Performance Requirements
Clause C1.1, Specification C1.1	The Neighbourhood Shops building are required to achieve the FRLs consistent with Type A construction, i.e. 180/180/180. The existing construction is expected to achieve a lower FRL of 120/120/120 or less.	CP1, CP2
Clause C3.3	The Neighbourhood Shops building and the proposed new office tower have unprotected openings within the allowable distances of Table C3.3. i.e. 6 m	CP2
Clause D1.4, D1.5	Travel Distances within the basement car park exceed the maximum allowable distances to and between exits. The distance are as follows - 70 m to an exit in lieu of 40 m - 122 m between exits in lieu of 60 m	DP4, EP2.2
Clause D1.4, D1.5	Travel Distances within the Neighbourhood Shops building and Garden Centre exceed the maximum allowable distances to and between exits. The distance are as follows - 49 m to an exit in lieu of 40 m - 85 m between exits in lieu of 60 m	DP4
Clause D1.7	Egress from the office tower requires passing within 6m of the external walls of the Neighbourhood Shops building which contain unprotected openings	DP5
Clause D1.8	The stairs serving the office tower are proposed to be open, external stairs in lieu of fire isolated stairs.	DP5, EP2.2
Clause D1.9	The total travel distance from the basement car park to a road or open space is up to 90 m in lieu of the maximum allowable 80 m	DP4
Clause E1.3, E1.5, E1.8	Fire brigade equipment including the hydrant booster assembly, sprinkler booster pump and fire control room are not located as per the requirements of the BCA and AS2419. Instead, they are currently proposed to be located adjacent to the above ground car park.	EP1.3, EP1.4, EP1.6

6. METHODOLOGY

In accordance with Clause A2.2 and Clause A2.4 of the BCA, the process for formulating a Performance Solution is based on determination of the following:

- The appropriate Assessment Method for assessing the Performance Solution, detailed in Clause A2.2 (2) and Clause A2.4 (2) of the BCA.
- The Performance Requirements relevant to the Performance Solution, in accordance with Clause A2.2 (3) and Clause A2.4 (3) of the BCA..

The methodology adopted in formulating a Performance Solution is that described in the International Fire Engineering Guidelines[3]. The Guidelines provide guidance for the design of performance-based

[3] International Fire Engineering Guidelines, Edition 2005, Australian Building Codes Board.

solutions for the BCA in order to achieve acceptable levels of safety so as to achieve compliance with the identified BCA Performance Requirements.

The fire safety engineering design process detailed in the Guidelines follows the general engineering design philosophy where an objective is identified, measurable performance objectives are established as expressions of that objective and solutions are analysed using appropriate techniques in order to measure the attainment of the performance objectives.

The specific method of analysis adopted for each Performance Solution is detailed in the relevant section of this report.

7. PROPOSED FIRE SAFETY STRATEGY

7.1. GENERAL

Having regard to the departures from the DTS Provision of the BCA, the general fire safety strategy for the subject building will be based on having suitable fire safety measures in order to:

- Provide a suitable structure for the building;
- Limit fire spread within and between the buildings;
- Enable occupants to egress the building safely; and
- Provide suitable equipment for fire brigade intervention

Based on the objectives above, the Proposed Fire Safety Strategy by SGA relating to potential Performance Solutions or DTS upgrades are detailed below.

7.2. ITEM 1: FRLS OF BUILDING ELEMENTS

The buildings on site are connected by the underground car park. As such, the office tower, function centre, above ground car park, and Neighbourhood Shops buildings are all considered to be connected and thus required to be of Type A construction. The Neighbourhood Shops building on site is an existing single-storey building. As such, the existing building elements are more likely to achieve the lower fire resistance requirements for a building of Type C construction. The associated DTS clauses are considered to be Clause C1.1, and Specification C1.1. The associated Performance Requirements are considered to be CP1 and CP2.

Given the existing nature of the Neighbourhood Shops building, it is proposed to keep what elements of the Neighbourhood Shops are intended to be retained at their existing FRL, rather than upgrade to Type A construction. Thus a performance solution is necessary.

Such a performance solution would primarily be based on fire severity calculations. In order to determine the Fire Resistance Level (FRL) required for building elements in the subject compartment, the expected fire severity is to be determined. Fire severity is defined as the time of exposure to the standard fire test which results in the same thermal impact on the building elements as a complete burnout of the compartment in a real fire.

The time equivalence approach using the Eurocode formula [4] with adjustment of the k_b parameter as recommended by Kirby et al. [5] has been adopted. The approach is in line with the International Fire Engineering Guidelines [6]. The results from the Eurocode formula will be compared with two other commonly used methods of determining fire severity, the CIB Formula and Law Formula.

The fire severity is expressed in minutes and estimated based on the following equation in accordance with the Eurocode method:

$$t_e = e\, k_b\, w_f$$

where t_e fire severity [min]

e fire load density [MJ/m^2]

k_b conversion factor based on thermal properties of boundary material

w_f ventilation factor based on available ventilation openings

[4] EN 1991-1-2, 2002, *Eurocode 1: Actions of structures – Part 1-2: General actions – Actions on structures exposed to fire*, Annex F.
[5] Kirby B.R. et al., 1999, Natural fires in large scale compartments, *International Journal on Engineering Performance-Based Fire Codes*, Volume 1, Number 2, p.43-58.
[6] *International Fire Engineering Guidelines,* Edition 2005, Australian Building Codes Board, p. 2.6-3 – 2.6-5

It will then be determined whether the building elements in the Neighbourhood Shops building are capable of withstanding the established fire exposure and maintaining structural adequacy and their separating function as required.

Where the existing elements cannot be demonstrated to survive burnout, consideration will be given to the use of the building in the wider context of the site. That being a single-storey building that is not significantly connected to any other building on site. Thus having a lower level of construction could be considered acceptable if it can be demonstrated that a fire in the existing Neighbourhood Shops portion would not significantly impact upon the rest of the development. Such a solution would consider the following, among any other relevant fire safety considerations:

- How the size and use of the building compares to a building of Type C construction.
- Fire separation between the Neighbourhood Shops building and other parts of the building.
- Potential impact upon other areas of the site from a fire within the Neighbourhood Shops building
- How any potential impacts on other areas of the site compare to a building of Type C construction

7.3. ITEM 2: FIRE SEPARATION BETWEEN FIRE COMPARTMENTS

Clause C3.3 of the BCA provides minimum separation for unprotected openings in different fire compartments. For openings facing each other, that minimum separation is 6 m. The ground floor of the office tower and the Neighbourhood Shops building are separate fire compartments, separated by approximately 3.9 m (see Figure 1) with predominately glass facades. Thus there is a potential for fire to spread between the different fire compartments, beyond what could be expected of the BCA-DTS-compliant building. The associated DTS clause is considered to be Clause C3.3. The associated Performance Requirement is considered to be CP2.

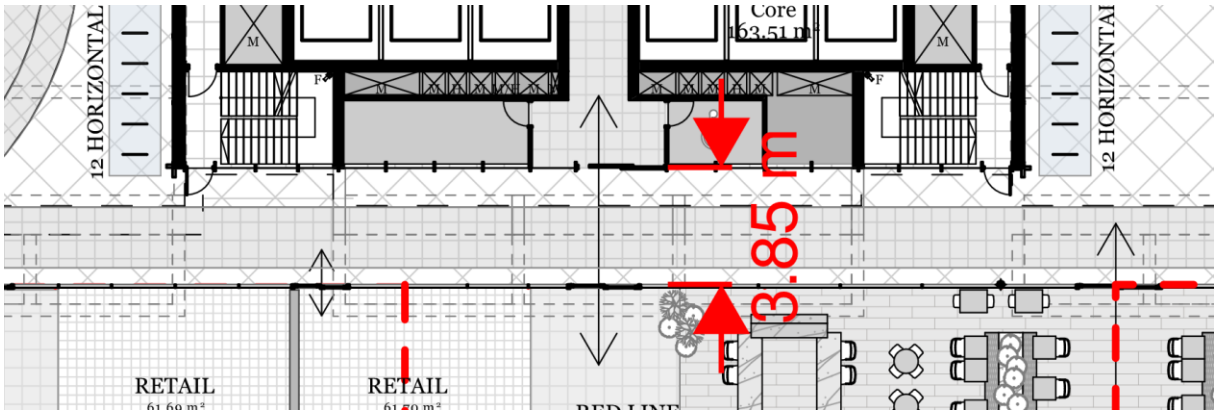


Figure 1: Separation of Neighbourhood Shops and Office Buildings.

A performance solution to address the potential for fire spread would look at the radiant heat from a fire within the different fire compartments from an engineering perspective using well established computational techniques. The following outlines the proposed methodology adopted in this assessment.

- Identify credible worst-case fire scenarios for the evaluation of fire spread between compartments, having regard to the worst configuration/s with respect to compartment size, window size, separation distance from other openings and distance from the neighbouring compartment.
- Establish the dimensions of openings that are to be considered as the potential radiant heat sources for the evaluation of potential fire spread. An augmentation factor of 25% of the opening height is to be applied[7].

[7] AS 2118.2-1995 Automatic Fire Sprinkler Systems – Part 2: Wall Wetting Sprinklers (Drenchers), Standards Australia, 1995, Appendix B.

- Using computer programs to calculate the levels of radiant heat flux at the vertical plane locations and determine whether they are less than the values required to cause fire spread between the properties. Refer to Table 6.
- Develop additional strategies to protect openings that receive more than the critical radiant heat flux levels required for fire spread.

Table 6 – Limiting Values of Radiant Heat Flux

Radiant Heat Flux (kW/m^2)	Comment
10	Limiting radiant heat intensity for normal glazing.
13	Limiting radiant heat intensity for piloted ignition of light weight furnishings after a long time.
20	Limiting radiant heat intensity for tempered glass.
25	Limiting radiant heat intensity for non-piloted ignition of light weight furnishings.

Consideration can also be given to the nature of the rooms immediately adjacent to the building façade on each side. For example, the fire stairs in the office tower are generally sterile areas where a fire is unlikely to start in or spread to, reducing the risk of fire spread.

It is noted that for any performance solution to be developed, the existing FRLs of the Neighbourhood Shops building should be determined. In particular, the slab between the Neighbourhood Shops building and the car park below would need to achieve a minimum FRL of 120/120/120 and provided with extra protection to achieve the 2 hr FRL if not.

7.4. ITEM 3: TRAVEL DISTANCES WITHIN THE BASEMENT CAR PARK

7.4.1. General

Clause D1.4 and D1.5 of the BCA provide the maximum allowable travel distances to and between exits within the building. Those distances being:

- 20 m to the nearest exit or point of choice between two exits;
- 40 m to the nearest exit through a point of choice; and
- 60 m between exits.

In the basement car park, the distances to and between exits greatly exceed these distances. The distances are.

- 70 m to the nearest exit through a point of choice; and
- 122 m between exits.

The associated DTS clauses are considered to be Clause D1.4 and D1.5. The associated Performance Requirements are considered to be DP4 and EP2.2.

Given the large variance from the allowable distances, CFD modelling of fire scenarios within the car park as part of an ASET/RSET analysis would be required in order to demonstrate that occupants are able to safely egress from the car park.

7.4.2. Available Safe Egress Time (ASET)

The ASET for occupants in the car park would be determined through CFD modelling of fires within the car park The modelling would include several fire scenarios to assess the impacts on occupant egress. These scenarios would include:

- A fire in the car park requiring egress from the building, all exits are available
- A fire blocking an exit requiring occupants to proceed to an alternate exit
- Sensitivity scenarios of the above fire scenarios.

For the fire scenarios above, the fire size would be determined through sprinkler activation calculations. The visibility and temperature throughout the car park would be assessed as part of the CFD modelling in order to determine the point at which egress is expected to be prevented. This is the ASET

7.4.3. Required Safe Egress Time (RSET)

7.4.3.1. Phases

The RSET for occupants in the car park would be determined through egress analysis. The egress analysis evaluates the times necessary to initiate an occupant response to an alarm or cue of a fire situation and secondly, the required time for occupants to reach a safe place under controlled evacuation.

The RSET is measured from the same point of origin of the fire, that is, from the time of effective ignition. In this manner both can be compared later. The calculated RSET is the addition of up to three phases namely:

- Detection phase, taken from effective ignition of a fire to the time of a cue that indicates the possible occurrence of a fire. In the absence of an alarm, the formation of a visible smoke layer under the ceiling can be taken as a reasonable cue for awake occupants [8]. In this regard, visible smoke covering approximately 10% of the ceiling height may serve as a cue for detection.
- Pre-movement phase, which extends from the alarm or cue to the time when occupants decide to egress. The degree of training and familiarity with the surroundings, as well as the general nature of the population, have an impact on reaction time. This period covers the time for occupants to assimilate the cue, resolve any ambiguity, undertake pre-evacuation actions and commence evacuation.
- The movement phase can be calculated on the basis of human walking speeds affected by crowding.

7.4.3.2. Cue Times (T_c)

Cues within the building alerting occupants to the occurrence of a fire would generally be one of the following:

- Direct visual contact with the flame and/or smoke plume;
- Warning from other occupants able to see the flame and/or smoke plume;
- The hot smoke layer at ceiling level developing to a sufficient depth so as to become noticeable, i.e. -10% of ceiling height;
- Building occupant warning system activated by sprinkler operation or smoke detector operation.
- Break-glass alarm activation.

Where travel out of an enclosed room and into a common egress path or corridor is required in order to reach the point of choice to alternative exits, occupants are likely to receive an initial cue that there is a

[8] Humans are the best detectors of fire when awake and familiar with their environment, due to their ability to sense fire at lower concentrations of combustible products than the most sophisticated detection systems (*Fire Engineering Guidelines*, p 5-11).

fire from the building occupant warning system, as there may be a delay in receiving any intrinsic cues from the fire.

Cue times will be determined based upon the activation of the smoke detectors or sprinklers depending on what is provided within the car park. The maximum distance to the nearest detector or sprinkler will be used to determine the cue time

7.4.3.3. Pre-Movement Times (T_{pm})

Pre-movement time is the time taken between when the cue was first received and the movement phase to a place of safety. Pre-movement time can be broken down into two components, response time (T_r) and delay time (T_d).

7.4.3.3.1. Occupant Response Time (T_r)

Occupant response time involves the process of interpreting the automatic or intrinsic cue and identifying it as a cause for evacuation. The response time is dependent upon the type of cue.

7.4.3.3.2. Occupant Delay Time (T_d)

Following the time for the occupants to interpret the cue and identifying it as a cause for evacuation, occupants undertake actions such as collecting belongings, looking for other occupants and investigating to obtain further information prior to beginning to move towards the exits.

7.4.3.4. Movement Time (T_m)

The movement time for occupants within the car park would be determined through egress modelling for the different fire scenarios assessed

7.4.4. ASET/RSET Analysis

Once the ASET and RSET are determined, they can be compared to assess if there is sufficient time to egress from the car park during fire scenarios. Part of the analysis would consider elements of the building design and systems that have the potential to impact upon the conditions and egress time. Such considerations could include:

- The provision of fast response sprinkler heads which would reduce the overall fire size and smoke produced, as well as decreasing the cue time for occupants resulting in earlier egress.
- Use of direct travel distances between exits rather than travel back through the point of choice as required for measuring travel distances.
- Noting the open nature of the car park is likely to result in earlier visual detection of the fire. as such, occupants are unlikely to proceed the full distance to a blocked exit before deciding to use an alternate exit
- Use of other egress paths from the building not considered exits. E.g. doors in the fire walls separating the car park from the office tower/function centre.
- Different alarm cure that could reduce the expected pre-movement time. E.g. verbal ‘evacuate now’ alarm in lieu of general alarm tone.

This performance solution will also require consultation with FRNSW as it involves Category 2 Performance Requirements.

7.5. ITEM 4: TRAVEL DISTANCES WITHIN THE GARDEN CENTRE/NEIGHBOURHOOD SHOPS

Clause D1.4 and D1.5 of the BCA provide the maximum allowable travel distances to and between exits within the building. Those distances being:

- 20 m to the nearest exit or point of choice between two exits;
- 40 m to the nearest exit through a point of choice; and
- 60 m between exits.

In the Garden Centre and Neighbourhood Shops, the distances to and between exits greatly exceed these distances. The distances are.

- 49 to the nearest exits through a point of choice from the loading bay/storage area; and
- 85 m between exits in the Neighbourhood Shops building

The associated DTS clauses are considered to be Clause D1.4 and D1.5. The associated Performance Requirements is considered to be DP4.

With these distances, the performance solution would aim to provide fire safety systems within the building that allow for occupants egressing in a similar or earlier time to a DTS compliant building. This is generally done by reducing the spacing of smoke detectors in the building which result in an earlier cue time. This earlier cue offsets any increased travel distance, resulting in a similar egress time to a DTS compliant building.

Account will also be taken of expected total travel distances for occupants in the building and how they compare to a DTS complaint design. In particular, use of direct travel distances between exits rather than travel back through the point of choice as required for measuring travel distances.

7.6. ITEM 5: TRAVEL PAST UNPROTECTED OPENINGS

Clause D1.7 of the BCA requires the paths of travel from exits to not be located within 6 m of unprotected openings in the external walls of the building. In the subject building, egress from the office tower involves passing within 6 m of the external walls of the Neighbourhood Shops building. Refer to Figure 2 for the egress paths. The associated DTS clause is considered to be Clause D1.7. The associated Performance Requirement is considered to be DP5.

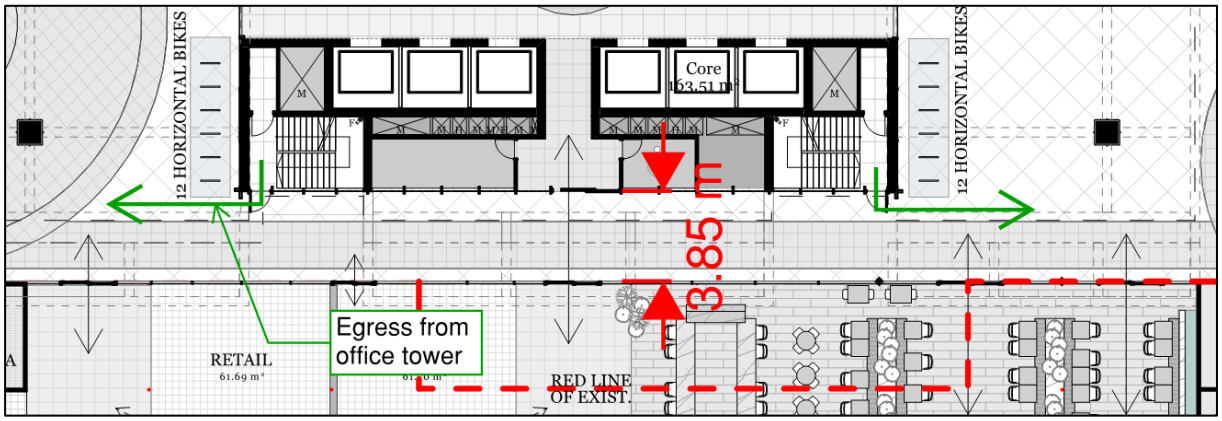


Figure 2: Egress paths from officer tower

The performance solution for addressing the discharge from the exits would look at the radiant heat levels to which egressing occupants are exposed while egressing past the unprotected openings. Where generally acceptable levels of radiant heat are exceeded, a thermal dose approach will be adopted to determine the effects of radiant heat on occupants. A paper on human resistance against thermal effects

(9) has detailed such a calculation procedure and describes the effects related to such an exposure. The thermal dose calculation detailed in this paper is as follows:

$$Thermal\,dose = tI^{\frac{4}{3}} \quad \left[s.(kW/m^2)^{\frac{4}{3}} \right]$$

where t = time (seconds)

I = radiant heat flux (kW/m^2)

The effects related to exposures calculated using the above equation are reproduced from the paper in Table 7 below.

Table 7 Effects related to thermal dose

Effect	Thermal dose (s*[kW/m^2]$^{4/3}$)	Comments/references
Pain	108-127	Ref. /A.4/, bare skin
	85-129	Ref. /Gas De France/, bare skin
Significant injury level / First degree burns	600-800	Ref. /A.7/, bare skin
	250-350	Ref. /Gas De France/, bare skin
	210-700	Ref. A.12/, bare skin
Second degree burns / 1 % lethality level for average clothing	900-1300	Ref. A.9/, bare skin
	500-3000	Ref. /A.12/, bare skin
Third degree burns / 50 % lethality level for average clothing	> 2000 – 3000	Ref./A.12/, bare skin

The assessment will take account the provision of fire safety systems in the building and how their performance during a fire would compare to compliant protection systems. Account will also be taken of the possibility for alternate egress path from the building which would reduce occupant exposure as well as the need to egress from the office tower for a fire in the Neighbourhood Shops building.

7.7. ITEM 6: FIRE ISOLATION OF EXIT STAIRS

Clause D1.8 of the BCA does not permit the use of external stairs in buildings with an effective height of more than 25 m. The office tower which has an effective height of more than 25 m (approximately 73 m) is proposed to include fire stairs with one side open, thus they would be considered external fire stairs. The associated DTS clause is considered to be Clause D1.8. The associated Performance Requirements are considered to be DP5 and EP2.2.

The reasons that external stairways are not permitted above 25 m are outlined in the Guide to the BCA. The reasons are

- the risk that people would potentially suffer vertigo above this level;
- the risk that weather conditions, particularly wind, may become more severe above this height; and

9 *Human Resistance against Thermal Effects, Explosion Effects, Toxic Effects and Obscuration of Vision*, DNV Technica / Scandpower A/S, 20 March 2001

- the need to enable any person who gets into difficulties on the stairway to be rescued by way of fire brigade ladders or other rescue equipment, which generally do not reach above this height.

Of these three reasons, only the last reason (access to occupants by fire brigades) is related to fire safety in the building. The other two are considerations outside of fire safety and thus would be the domain of the relevant specialists.

Thus the performance solution would aim at demonstrating that the stairs are sufficiently fire and smoke separated from the interior of the building such that occupant egress would not be affected. Account would be taken of existing fire separation provisions in the building, the ability to smoke-isolate the stairs, fire safety systems in the building and how these compare to a fully isolated fire stair ot other DTS compliant egress options. Additional consideration would be given to the ability for fire brigade to reach occupants on the stairs and how this would compare to properly fire isolated stairs.

It is noted that the performance solution is subject to analysis from the relevant human movement, environmental analysis or other appropriate specialist confirming that vertigo and wind considerations are acceptable for occupant egress.

This performance solution will also require consultation with FRNSW as it involves Category 2 Performance Requirements.

7.8. ITEM 7: TRAVEL DISTANCES TO A ROAD OR OPEN SPACE

The basement car park is served by two existing non-fire isolated stairs that discharge directly to the outside car park. Upon discharging from the stairs on ground level, occupants enter a covered area which results in increased travel distance to an open space above what is allowed under Clause D1.9 of the BCA. The total travel distance is 90 m in lieu of 80 m. The associated DTS clause is considered to be Clause D1.9. The associated Performance Requirement is considered to be DP4.

Given the comparatively short increase of the DTS travel distances, the performance solution would be based on reducing the cue and pre-movement time of occupants utilising the non-fire-isolated stairs for egress from the car park, thus compensating for the increased travel distances. This would be done by way of reduced detector spacing and/or fast-response sprinkler heads within the basement car parks. The earlier response time by occupants is intended to show that occupants would egress in a similar or earlier time to occupants in a DTS-compliant building.

Account will also be taken of likely conditions upon discharge from the fire stairs. That is, what conditions are occupants likely to be exposed to along the last 10 m of travel to the road or open space.

7.9. ITEM 8: LOCATION OF FIRE BRIGADE EQUIPMENT

The BCA DTS Provisions and applicable Australian standards (e.g. AS 2419.1) outline where equipment for use by the fire brigade needs to be located. The general requirements for the hydrant booster assembly are to be located next the main vehicle entry, in sight of the main building entrance and protected from fire. The sprinkler booster and fire control rooms are to be readily accessible from the ground floor of the building.

In the proposed design, the layout of the building effectively prevents the hydrant booster being installed in a compliant location. Additionally, the sprinkler pump room and fire control room are proposed to be installed on the ground floor of the above-ground car park rather than the main office building. The associated DTS clauses are considered to be Clause E1.3, E1.5 and E1.8. The associated Performance Requirements are considered to be EP1.3, EP1.4 and EP1.6.

The location requirements for the affected fire services are in the aid of streamlining firefighting operations by making the equipment easy to locate for fire brigade personnel. Therefore, any performance solution would aim at providing FRNSW personnel with sufficient wayfinding tools to quickly locate the equipment.

In particular, the hydrant booster is currently proposed to be located adjacent to the driveway leading up to the car park, allowing ready access by FRNSW personnel. The sprinkler pump and fire control centre are proposed to be located nearby the booster assembly for ready access by FRNSW.

While the final location of the fire brigade equipment might vary in the final design, the performance solution would still be based around providing appropriate access and signage to the equipment to facilitate FRNSW wayfinding. This would likely include site maps near the vehicle entrance and fire equipment.

This performance solution will also require consultation with FRNSW as it involves Category 2 Performance Requirements. It is noted that any performance solution would be dependent on concurrence with FRNSW on the provisions provided for their use.

8. SUMMARY

It is considered that the identified departures from the DTS Provisions of the BCA for the Eden Gardens development located at 307 Lane Cove Rd, Macquarie Park could achieve an acceptable level of fire safety by DTS upgrades and performance solutions. The proposed fire safety measures that form part of this fire safety strategy for the subject building are considered likely to provide a level of fire safety which is equivalent to a BCA-compliant design whilst limiting the impact on the design feature of this building.

The fire safety strategies presented within this report do not constitute Performance Solutions. The departures are proposed to be addressed by way of Performance Solutions in a Fire Engineering Report prepared by a qualified fire engineer.

9. REFERENCES

International Fire Engineering Guidelines, Edition 2005, Australian Building Codes Board.

National Construction Code Series, Volume 1, Building Code of Australia 2019, Australian Building Codes Board.

National Construction Code Series, *Guide to Volume 1, Building Code of Australia 2019,* Australian Building Codes Board.

APPENDIX A. PERFORMANCE REQUIREMENTS

CP1 *A building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to-*

(a) the function or use of the building; and

(b) the fire load; and

(c) the potential fire intensity; and

(d) the fire hazard; and

(e) the height of the building; and

(f) its proximity to other property; and

(g) any active fire safety systems installed in the building; and

(h) the size of any fire compartment; and

(i) fire brigade intervention; and

(j) other elements they support; and

(k) the evacuation time.

CP2 *(a) A building must have elements which will, to the degree necessary, avoid the spread of fire-*

(i) to exits; and

(ii) to sole-occupancy units and public corridors; and

(iii) between buildings; and

(iv) in a building.

(b) Avoidance of the spread of fire referred to in (a) must be appropriate to-

(i) the function or use of the building; and

(ii) the fire load; and

(iii) the potential fire intensity; and

(iv) the fire hazard; and

(v) the number of storeys in the building; and

(vi) its proximity to other property; and

(vii) any active fire safety systems installed in the building; and

(viii) the size of any fire compartment; and

(ix) fire brigade intervention; and

(x) other elements they support; and

(xi) the evacuation time.

DP4 *Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to-*

(a) the travel distance; and

(b) the number, mobility and other characteristics of occupants; and

(c) the function or use of the building; and

(d) the height of the building; and

(e) whether the exit is from above or below ground level.

DP5 *To protect evacuating occupants from a fire in the building exits must be fire isolated, to the degree necessary. appropriate to-*

(a) the number of storeys connected by the exits; and

(b) the fire safety system installed in the building; and

(c) the function or use of the building; and

(d) the number of storeys passed through by the exits; and

(e) fire brigade intervention.

EP1.3 *A fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to-*

(a) fire-fighting operations; and

(b) the floor area of the building; and

(c) the fire hazard.

EP1.4 *An automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire appropriate to-*

(a) the size of the fire compartment; and

(b) the function or use of the building; and

(c) the fire hazard; and

(d) the height of the building.

EP1.6 *Suitable facilities must be provided to the degree necessary in a building to co-ordinate fire brigade intervention during an emergency appropriate to-*

(a) the function or use of the building; and

(b) the floor area of the building; and

(c) the height of the building.

EP2.2 *(a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that-*

(i) the temperature will not endanger human life; and

(ii) the level of visibility will enable the evacuation route to be determined; and

(iii) the level of toxicity will not endanger human life.

(b) The period of time occupants take to evacuate referred to in (a) must be appropriate to-

(i) the number, mobility and other characteristics of the occupants; and

(ii) the function or use of the building; and

(iii) the travel distance and other characteristics of the building; and

(iv) the fire load; and

(v) the potential fire intensity; and

(vi) the fire hazard; and

(vii) any active fire safety systems installed in the building; and

(viii) fire brigade intervention.