FIRE ENGINEERING REPORT

FOR

MODIFICATIONS TO FRESH FOOD MARKET
WARRINGAH MALL

Report 2020 / 1686FFM – R3.0
02 March 2022

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REPORT HISTORY

Version	Status	Date	Purpose
Revision 0.0	Draft	24/12/2021	For internal review
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REPORT AUTHORISATION – FOR THE CURRENT REVISION

Report by:	Reviewed by:	Authorised by:
Nick Felstead Fire Safety Engineer	Daniel Burgess Fire Safety Engineer	Atul Bhargava Director
		
Date: 02/03/2022	Date: 02/03/2022	Date: 02/03/2022

1. EXECUTIVE SUMMARY

This Performance Solution report documents the findings of a fire safety engineering assessment undertaken to determine whether the proposed modifications to the Fresh Food Market which forms part of the Target backfill project on Ground Level at Warringah Mall comply with the relevant Performance Requirements of the Building Code of Australia 2019 Amdt 1 (BCA). Fire Engineering Professionals Pty Ltd (FEP) undertook the assessment at the request of Scentre Design and Construction Pty Ltd.

Warringah Mall is an existing major urban shopping centre development located in Brookvale, NSW 2100. The building is located within an industrial business precinct and is bound by Cross Street, Pittwater Road, Condamine Street and Old Pittwater Road.

The existing building is spread over three (3) interconnected retail levels and currently accommodates a number of major tenancies (Myer, David Jones, Coles, Woolworths, Target and Big W). The shopping centre also contains a number of mini-major and specialty tenancies. There are a number of multi-level undercover and open deck carparks and a cinema complex, library and a community centre forming part of the building.

The original building is understood to have been constructed in the mid-1960s with two major developments occurring from 1997 through to 2002 known as Stage 1 and 2. A recent extension to the building was completed in 2016.

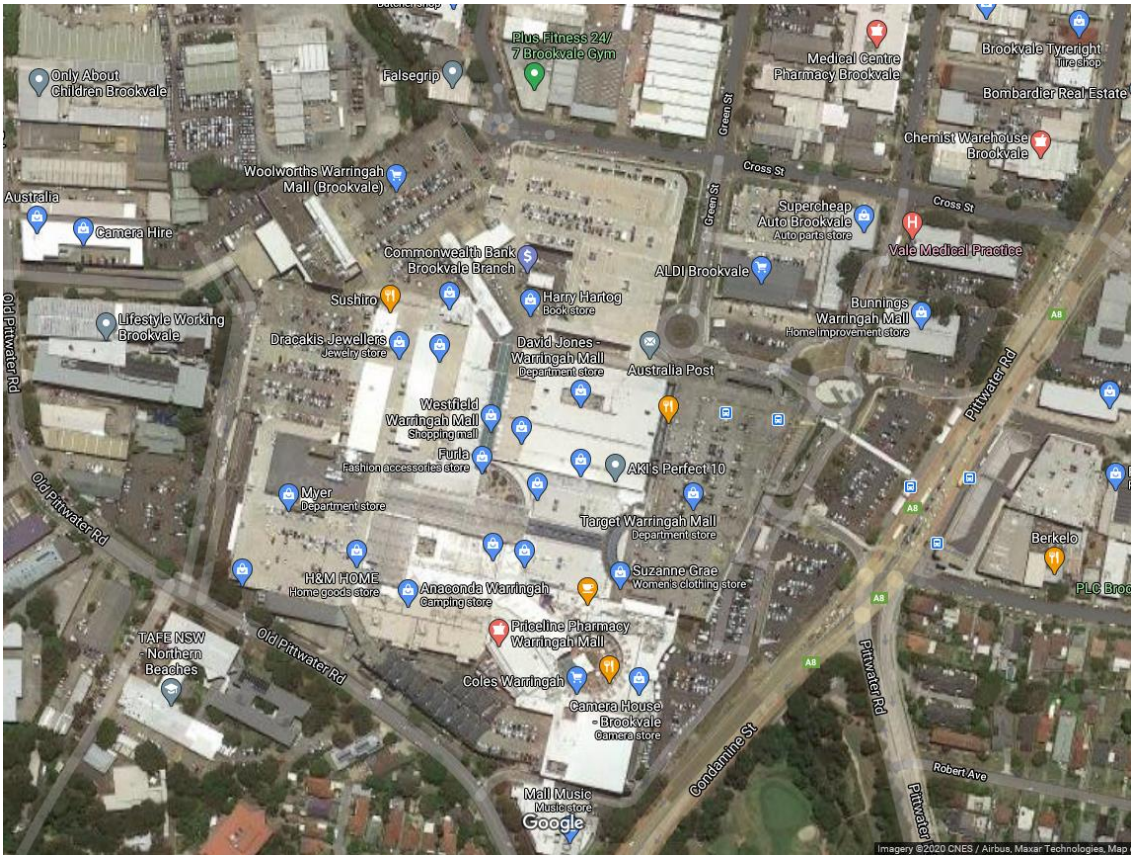

Figure 1-1: Aerial snapshot of the Warringah Mall shopping centre and surrounding streets (Courtesy Google).

The works associated with the proposed development are located in the eastern portion of the shopping centre, on Ground Level of Westfield Warringah Mall. The proposed works are as outlined below:

- Construction of four (4) new speciality tenancies; and
- Construction of a new mini-major tenancy (MM1010), incorporating a floor area of approximately 2211m^2**;** and
- Reconfiguration of existing amenities; and
- Replacement of the existing ramp connections from the eastern carpark to the retail levels with new travelators which are to serve as a means of vertical transportation.
- Replacement of the existing glazed roof structure above the mall providing access to the Fresh Food market with an awning.

It is understood that all new works associated with the proposed modifications to the Fresh Food Market at Warringah Mall are required to comply with requirements of BCA 2019 Amdt 1 and all existing areas of the shopping centre are required to be maintained in accordance with the existing fire safety strategy for those areas including compliance of egress widths, travel distances, distance between alternative exits, smoke control and all other base building fire safety requirements. This Performance Solution Report does not carry out any assessment of fire safety or compliance within the existing areas located outside of the areas forming part of the Fresh Food Market modifications.

This report addresses the issues of BCA DTS non-compliance identified with the new works associated with the modifications to the Fresh Food Market at Warringah Mall (as identified in this report and shown on the referenced architectural drawings) only. The objective of this assessment was to demonstrate that the proposed new works achieve compliance with the relevant Performance Requirements of BCA 2019 Amdt 1 in respect to the identified non-compliances.

The issues of non-compliance with the Building Code of Australia (BCA) “Deemed-to-Satisfy” (DTS) provisions requiring a Performance Solution as identified by Steve Watson & Partners Pty Ltd, who are the Principal Certifying Authority (PCA) for the project, were as follows:

- The existing eastern carpark has been constructed to the lesser FRLs prescribed by Table 3.9 of Specification C1.1 which requires the carpark to be separated from the retail portions of the building by way of a fire wall in accordance with Clause C2.7 of BCA DTS provisions. Carpark entry from the mall/travelator on Level 1, Level 1M and Level 2 which form part of the firewall are to be protected on a performance basis (no protection provided to Level 2 rooftop carpark), which does not comply with Clause C2.7 of the DTS provisions of BCA 2019 Amdt 1; and
- The proposed new travelator connects four (4) storeys in the building (Ground Level, Level 1, Level 1M and Level 2) which does not comply with the requirements of Clause C1.12 of the DTS provisions of BCA 2019 Amdt 1; and
- The maximum travel distance to an exit in the areas forming part of the new works associated with Fresh Food Market modifications is up to a maximum on 60m, in lieu of 40m, which does not comply with Clause D1.4(c)(i) of the DTS provisions of BCA 2019 Amdt 1; and
- The maximum travel distance between alternative exits in the areas forming part of the new works associated with Fresh Food Market modifications is up to a maximum of 90m, in lieu of 60m, which does not comply with Clause D1.5(c)(iii) of the DTS provisions of BCA 2019 Amdt 1; and
- The mechanical smoke hazard management system serving Tenancy MM-1010 and natural smoke ventilation serving the mall is to be designed on a performance basis

with respect to the smoke exhaust rates and natural ventilation openings and smoke baffle depths, which does not comply with the requirements of Table E2.2b and Specification E2.2b of the DTS provisions of BCA 2019 Amdt 1.

The Performance Requirements associated with these areas of non-compliance with the BCA DTS provisions were identified as CP1, CP2, DP4 and EP2.2.

The method of assessment and the acceptance criteria relevant to the proposed "Performance Solution" is outlined in **Table 1-1** provided below.

Table 1-1: Assessment methodology and acceptance criteria for the proposed "Performance Solution"

Perform. Sol.	Non-compliance	Assessment Methodology	Acceptance Criteria
1	**C2.7** The required firewall between eastern carpark and the retail portions of the building incorporate carpark entries which are to be protected on a performance basis by way of the installation of a fire and smoke curtain (**CP1 & CP2)**	An absolute assessment in accordance with BCA Clause A2.2(1)(a) and **Assessment Method A2.2(2)(b)(ii)** supported by qualitative, deterministic analysis will be carried out to demonstrate that the fire spread between the carpark and retail portions via the firewall which incorporates fire and smoke curtains is unlikely to occur	*The incorporation of fire and smoke curtains within the firewall separating the carpark and retail portions are able to adequately prevent fire spread to facilitate occupant evacuation and fire brigade intervention*
2	**D1.12(c)(i)** Travelators connect up to four (4) storeys in lieu of three (3) **(CP2, EP2.2)**	Equivalence assessment in accordance with BCA **A2.2(2)(d)** will be carried out to compare the performance of the Proposed Design (travelators not constructed in accordance with Spec. D1.12 connecting 4 storeys with only three retail levels connected in a fire emergency) with a BCA DTS compliant design (travelators connecting 3 retail storeys and therefore no fire separation required)	*The number of levels adversely affected as a result of fire and smoke spread between retail levels via the travelator void in the Proposed Design must be less than or equivalent to that inherent to the BCA DTS complying design*
3	**D1.4(c)(i)** The maximum travel distance to an exit in the Fresh Food Market areas forming part of new works is up to a maximum of 60m, in lieu of 40m. **(DP4 & EP2.2)**	Absolute assessment supported by quantitative deterministic analysis in accordance with BCA Clause A2.2(1)(a) and **Assessment Method A2.2(2)(b)(ii),** using smoke production and development and egress modelling to determine the requirements for a performance based smoke	**ASET versus RSET comparison** *ASET calculated for the reasonable worst credible design fire scenarios must be better than or at least equivalent to the RSET for the reasonable worst credible design fire*

Perform. Sol.	Non-compliance	Assessment Methodology	Acceptance Criteria
	D1.5(c)(iii) The maximum travel distance between alternative exits in the Fresh Food Market areas forming part of new works is up to a maximum of 90m, in lieu of 60m. **(DP4 & EP2.2)**	hazard management systems (natural in the mall and mechanical in the tenancy), and to justify, where appropriate, that extended travel distances to the nearest exit and between alternative exits, will facilitate safe occupant evacuation from the building in the event of the identified reasonable worst credible design and redundancy fire scenarios agreed by all relevant stakeholders.	*scenarios incorporating a safety factor of 1.5; and* *ASET calculated for the redundancy fire scenarios must be better or at least equivalent to the RSET for the redundancy fire scenarios.*
	E2.2 NSW Table E2.2b and Specification E2.2b The smoke hazard management system serving Tenancy MM-1010 and the adjoining mall is to be designed on a performance basis with respect to the mechanical smoke exhaust rates and smoke baffle depth (MM-1010) and natural ventilation openings. **(EP2.2)**		

This performance assessment provides supporting evidence demonstrating that the works associated with the modifications to the Fresh Food Market and the vertical transportation serving the eastern carpark as part of the Target Backfill project on Ground Level of Warringah Mall are capable of satisfying Performance Requirements CP1, CP2, DP4 and EP2.2 of the BCA, subject to the following recommendations:

- The provisions listed in **Section 11** (Building Requirements) of this report are to be strictly adhered to. The requirements listed in that Section are Essential Services and as such all fire safety systems should be identified as requiring maintenance and certification at appropriate intervals relative to their Australian Standard of Performance.
- Should a change in configuration or use of the Fresh Food Market areas forming part of this development or building alterations or additions occur in the future, a reassessment will be needed to verify consistency with the analysis contained within this report.

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2. INTRODUCTION

This Performance Solution report documents the findings of a fire safety engineering assessment undertaken to determine whether the proposed modifications to the Fresh Food Market which forms part of the Target backfill project on Ground Level at Warringah Mall comply with the relevant Performance Requirements of the Building Code of Australia 2019 Amdt 1 (BCA). Fire Engineering Professionals Pty Ltd (FEP) undertook the assessment at the request of Scentre Design and Construction Pty Ltd.

The works associated with the proposed development are located in the eastern portion of the shopping centre, on Ground Level of Westfield Warringah Mall. The proposed works are as outlined below:

- Construction of four (4) new speciality tenancies; and
- Construction of a new mini-major tenancy (MM1010), incorporating a floor area of approximately 2211m^2**;** and
- Reconfiguration of existing amenities; and
- Replacement of the existing ramp connections from the eastern carpark to the retail levels with new travelators which are to serve as a means of vertical transportation.
- Replacement of the existing glazed roof structure above the mall providing access to the Fresh Food market with an awning.

It is understood that all new works associated with the proposed modifications to the Fresh Food Market at Warringah Mall are required to comply with requirements of BCA 2019 Amdt 1 and all existing areas of the shopping centre are required to be maintained in accordance with the existing fire safety strategy for those areas including compliance of egress widths, travel distances, distance between alternative exits, smoke control and all other base building fire safety requirements. This Performance Solution Report does not carry out any assessment of fire safety or compliance within the existing areas located outside of the areas forming part of the Fresh Food Market modifications.

This report only addresses the issues of BCA DTS non-compliance associated with the modifications to the Fresh Food Market areas including construction of Tenancy MM-1010 and the new travelator as means of vertical transportation which form part of the Target Backfill project. The report is based on the understanding that all fire systems serving existing parts of the centre that are not being refurbished or modified as part of the proposed works, will be maintained in accordance with the requirements of the approved fire safety strategy for those areas. The objective of the fire engineering report is to demonstrate that the proposed new works achieve compliance with the relevant Performance Requirements of the BCA with respect to the non-compliances identified with the design of modified areas of the building.

The new works related to the proposed construction are understood to be designed to comply with the Building Code of Australia (BCA) through a combination of:

- compliance with BCA DTS provisions; and
- compliance with BCA performance provisions; and
- compliance with the approved base building fire safety strategy.

The non-compliances with BCA DTS provisions associated with the new works have been identified by Steve Watson & Partners Pty Ltd who are the Principal Certifying Authority (PCA) for this project to be as follows:

- The existing eastern carpark has been constructed to the lesser FRLs prescribed by Table 3.9 of Specification C1.1 which requires the carpark to be separated from the retail portions of the building by way of a fire wall in accordance with Clause C2.7 of BCA DTS provisions. Carpark entry from the mall/travelator on Level 1, Level 1M and Level 2 which form part of the firewall are to be protected on a performance basis (no protection provided to Level 2 rooftop carpark), which does not comply with Clause C2.7 of the DTS provisions of BCA 2019 Amdt 1; and
- The proposed new travelator connects four (4) storeys in the building (Ground Level, Level 1, Level 1M and Level 2) which does not comply with the requirements of Clause C1.12 of the DTS provisions of BCA 2019 Amdt 1; and
- The maximum travel distance to an exit in the areas forming part of the new works associated with Fresh Food Market modifications is up to a maximum on 60m, in lieu of 40m, which does not comply with Clause D1.4(c)(i) of the DTS provisions of BCA 2019 Amdt 1; and
- The maximum travel distance between alternative exits in the areas forming part of the new works associated with Fresh Food Market modifications is up to a maximum of 90m, in lieu of 60m, which does not comply with Clause D1.5(c)(iii) of the DTS provisions of BCA 2019 Amdt 1; and
- The smoke hazard management system serving Tenancy MM-1010 and natural smoke ventilation serving the mall is to be designed on a performance basis with respect to the smoke exhaust rates and natural ventilation openings and smoke baffle depths, which does not comply with the requirements of Table E2.2b and Specification E2.2b of the DTS provisions of BCA 2019 Amdt 1.

The Performance Requirements associated with these areas of non-compliance with BCA DTS provisions have been identified as CP1, CP2, DP4 and EP2.2.

3. PURPOSE

The purpose of this fire engineering report is to assess the ability of the proposed design for the modifications to the Fresh Food Market areas including construction of specialty tenancies and a mini-major tenancy; the new travelator as means of vertical transportation and associated works which form part of the Target Backfill project on Ground Level at Warringah Mall, to demonstrate that the proposed Trial Concept Fire Safety design (refer **Section 11**), to address the BCA DTS non-compliances identified in **Table 9-1**, facilitates the safe evacuation of occupants and fire brigade intervention, and hence satisfies Performance Requirements CP1, CP2, DP4 and EP2.2 of BCA 2019 Amdt 1.

4. GENERAL OBJECTIVES

The objective of this assessment is to demonstrate that the proposed new works associated with modifications to the Fresh Food Market areas including construction of specialty tenancies and a mini-major tenancy; the new travelator as means of vertical transportation which form part of the Target Backfill on Ground Level of Warringah Mall achieve compliance with BCA Performance Requirements (in respect to fire safety) with respect to the identified non-compliances.

The applicable BCA fire safety objectives, and hence core fire safety objectives, of this project are to:

- Prevent fire spread within the building; and
- Facilitate safe evacuation of building occupants in the event of fire; and
- Facilitate Fire & Rescue NSW intervention in the event of fire.

Objectives such as protection of property; protection of furnishings; protection of reputation and ensuring business continuity; safety other than fire safety; have not been identified as design objectives of this assessment. However, by satisfying the core fire safety objectives some of the above objectives may also be satisfied.

5. ASSUMPTIONS & LIMITATIONS

The following assumptions and limitations apply to this fire safety assessment:

a) This report has been produced for review and acceptance by relevant stakeholders and the approval authorities (PCA and Client) and provides no guarantee of acceptance. No action should be taken in respect to this report until such time as full approval has been obtained from the Principal Certifying Authority or any other relevant approval authorities; and

b) This report is limited to the assessment of the proposed construction incorporating modifications to the Fresh Food Market areas including construction of specialty tenancies and a mini-major tenancy; the new travelator as means of vertical transportation and associated works which form part of the Target Backfill project on Ground Level of Warringah Mall, in its ability to satisfy Performance Requirements CP1, CP2, DP4 and EP2.2 in relation to the BCA DTS non-compliances identified in **Table 9-1**; and

c) It is assumed that all building works will comply fully with the DTS fire safety provisions of BCA 2019 Amdt 1 except for the non-compliances identified in **Table 9-1** of this report; and

d) This report assumes that all fire safety systems serving the existing building (outside of the areas forming part of new works) which are affected by the proposed works will be upgraded as necessary to maintain compliance with the existing fire safety strategy at Warringah Mall and any additional requirements identified by the Principal Certifying Authority; and

e) The assessment is limited to the analysis of fire safety; specifically, the ability of the proposed design to satisfy BCA Performance Requirements in respect to fire safety. The assessment specifically excludes all other types of emergency situations and assumes that suitable measures will be set in place to handle all other types of emergencies. The PCA must ensure that they are satisfied that the proposed building design has adequate provisions for life safety in emergency situations other than those originating from accidental fires; and

f) The fire safety report may use in parts comparative assessment to determine compliance with the BCA Performance Requirements and may rely on the BCA DTS provisions and approved fire safety strategy of the building to achieve an adequate level of fire safety; and

g) “Performance Solutions” are developed to demonstrate compliance with the BCA Performance Requirements and may not provide the level of property protection, business interruption protection, inherent in a BCA DTS design; and

h) Should a change in use or building alterations and/or additions occur in the future, a reassessment will be needed to verify consistency with the analysis contained within this report; and

i) This report has been produced and issued by Fire Engineering Professionals and any intellectual property contained within this report is to remain the property of Fire Engineering Professionals and must not be distributed to parties except for those directly involved in the project to which this report relates without written approval of Fire Engineering Professionals Pty Ltd; and

j) This report assumes that the building fire safety systems will be complete and operate as designed. This report does not cover times when the building is incomplete or when fire safety systems are not designed and maintained to be capable of operating in accordance with the requirements set out in this report; and

k) The BCA Performance Requirements identified in this report may have parts which are not entirely fire safety related and which are not specifically covered by this fire safety assessment. Such aspects include but are not limited to: general occupation health and safety matters (i.e. safety during day to day operations, or during emergencies other than those arising from accidental fires); or access and amenity. This report assumes that the PCA or other specialist parties will be responsible for assessing and certifying the ability of the design to satisfy those portions of the BCA Performance Requirements that are not fire safety related and for ensuring that the design provides adequate safety for day to day operation and/or emergencies other than those arising from accidental fires; and

l) This report does not address any special fire safety measures which need to be implemented to accommodate the occupation of the building by persons with disabilities and special needs that are over and above those required under BCA provisions. The report assumes that specialist consultant advice shall be sought to address fire safety requirements for persons with disabilities and special needs, which are not covered through compliance with minimum BCA provisions; and

m) This report may in parts rely on input from stakeholders in the determination of an appropriate fire engineering brief for the assessment. This report assumes that the fire scenarios identified during the FEB process as being worst credible fire scenarios, are representative of such scenarios. This report does not assess system performance and the ability of the design to meet BCA Performance Requirements for fire scenarios that are more severe or hazardous than the fire scenarios identified as requiring assessment. This report assumes that the fire engineering methodologies and acceptance criteria identified during the FEB process as being appropriate for this project are appropriate for justifying compliance with the BCA Performance Requirement. Acceptance of this report by the stakeholders is considered to be acceptance that the report satisfies the requirements set out in the Fire Engineering Brief; and

n) The assessment is limited to assessing the ability of the design to satisfy the identified BCA Performance Requirements in respect to fire safety arising out of accidental fires only. The report specifically excludes assessment of non-fire safety related issues or property damage / loss of business continuity as a result of a fire; or insurer requirements; or environmental protection requirements, unless specifically stated otherwise in this report. The assessment is based on the applicable objectives of the BCA, being that of:

- Facilitating the safe evacuation of the occupants in the event of a fire; and
- Facilitating fire brigade intervention in the event of a fire.

o) This report only takes into consideration accidental fires originating from a single source, with fuel load and distribution compatible with the use of the area under consideration and excludes any acts of arson, terrorism or any other fires initiated due to malicious acts of one or more individuals; and

p) This report relies on third parties for the identification of non-compliances with BCA DTS provisions. This report takes no responsibility for the accuracy of the information provided by third parties; and

q) This fire safety report does not apply to those situations where a person is directly involved, either accidentally or intentionally, with the fire ignition or early stages of fire development; and

r) This assessment assumes that all of the fire safety systems operate as designed to comply with BCA DTS provisions and the relevant Australian Standards unless specifically stated otherwise.

This fire safety assessment aims to provide appropriate supporting evidence that the "Performance Solution" is capable of satisfying the nominated BCA Performance Requirements in respect to fire safety. This report may in parts rely on:

1. The accuracy of conclusions and opinions drawn in past research when assessing the level of performance achieved by the proposed design; and
2. The opinions of the fire engineers and other stakeholders working on the project in respect to the intent of BCA Performance Requirements (i.e. BCA DTS provisions require the fire safety design to facilitate the safe evacuation of the occupants, however, no fire safety design can guarantee occupants will be safe in the event of a fire. This report has been produced on the basis that new building fire safety designs need to provide suitable measures that can be shown (using appropriate supporting evidence) to either, be shown to facilitate the safe evacuation of the occupants in the event of identified reasonable worst credible fire scenarios; or be shown to provide at least equivalent fire safety performance to a design complying with BCA DTS provisions); and
3. Opinions of other professionals as part of the FEB process (i.e. in confirming acceptance of nominated reasonable credible fire scenarios and appropriate assessment methodologies, tenability criteria and acceptance criteria, etc); and
4. Opinion of the PCA in respect of the suitability of the selected base case BCA DTS compliant designs used for comparative assessments; and
5. Modelling tools developed by other organisations as a means of assessing performance; and
6. Minimum BCA DTS provisions for achieving an acceptable level of fire safety and compliance with the BCA Performance Requirement.

This report must in no way be construed as a compliance certificate. This report is provided for the exclusive use of the client for the specific project and purpose described in the report. The report must not be used by or relied upon for other projects or purposes on the same or other sites or by a third party. Any reliance of this report by third parties is at those party's sole risk.

6. DESCRIPTION OF THE BUILDING AND PROPOSED WORKS

Warringah Mall is an existing major urban shopping centre development located in Brookvale, NSW 2100. The building is located within an industrial business precinct and is bounded by Cross Street, Pittwater Road, Condamine Street and Old Pittwater Road.

The existing building is spread over three (3) interconnected retail levels and currently accommodates a number of major tenancies (Myer, David Jones, Coles, Woolworths, Target and Big W). The shopping centre also contains a number of mini-major and specialty tenancies. There are a number of multi-level undercover and open deck carparks and a cinema complex, library and a community centre forming part of the building.

The original building is understood to have been constructed in the mid-1960s with two major developments occurring from 1997 through to 2002 known as Stage 1 and 2. A recent extension to the building was completed in 2016.
In accordance with the DTS provisions of the BCA, the building is understood to have the following characteristics:

Table 6-1: BCA descriptive characteristics for Warringah Mall

Characteristic	Description
Building Use	Shopping Mall, Car Park, Cinema
Classification	**Class 6** – Retail) **Class 7a** – Carpark **Class 9b** – Cinemas
Type of Extension Required	Type A
Effective height	Less than 25m.

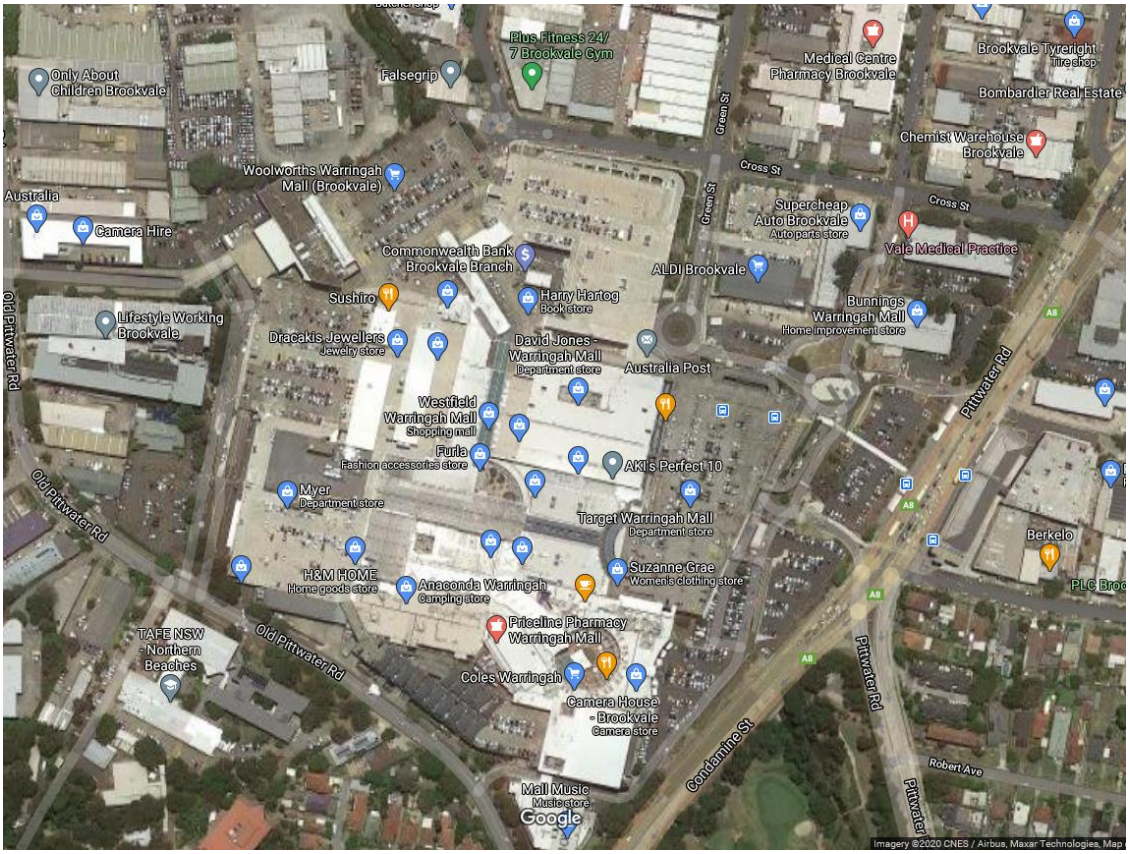

Figure 6-1: Aerial snapshot of the Warringah Mall shopping centre and surrounding streets (Courtesy Google).

The works associated with the proposed development are located in the eastern portion of the shopping centre, on Ground Level of Westfield Warringah Mall. The proposed works are as outlined below and highlighted in the part floor plan of the Ground Level in **Figure 6-2** below.

- Construction of four (4) new speciality tenancies as highlighted in 'purple' in **Figure 6-2 and Figure 6-3**; and
- Construction of a new mini-major tenancy (MM1010), incorporating a floor area of approximately 2211m2, as highlighted in 'green' in **Figure 6-3;** and
- Reconfiguration of existing amenities, as highlighted in 'orange' in **Figure 6-3; and**
- Replacement of the existing ramp connections from the eastern carpark to the retail levels with new travelators which are to serve as a means of vertical transportation. These travelators are highlighted in 'pink' in **Figure 6-3**.
- Replacement of the existing glazed roof structure above the mall providing access to the Fresh Food market with an awning. The extent of the awning is conceptually highlighted in 'blue' in **Figure 6-2** and a section is shown in **Figure 6-5** showing natural ventilation openings.

It should be noted that the proposed new travelator is to form part of the retail fire compartment and is fire separated from the carpark levels on the Ground Level Mezzanine; Level 1; Level 1M and Level 2. The retail mall entries are to be fire separated from the eastern carpark by way of the installation of fire and smoke curtains on Level 1 and Level 2. A Section through the travelator lobby showing the configuration of entry lobbies and the proposed fire separation is shown in **Figure 6-6** below.

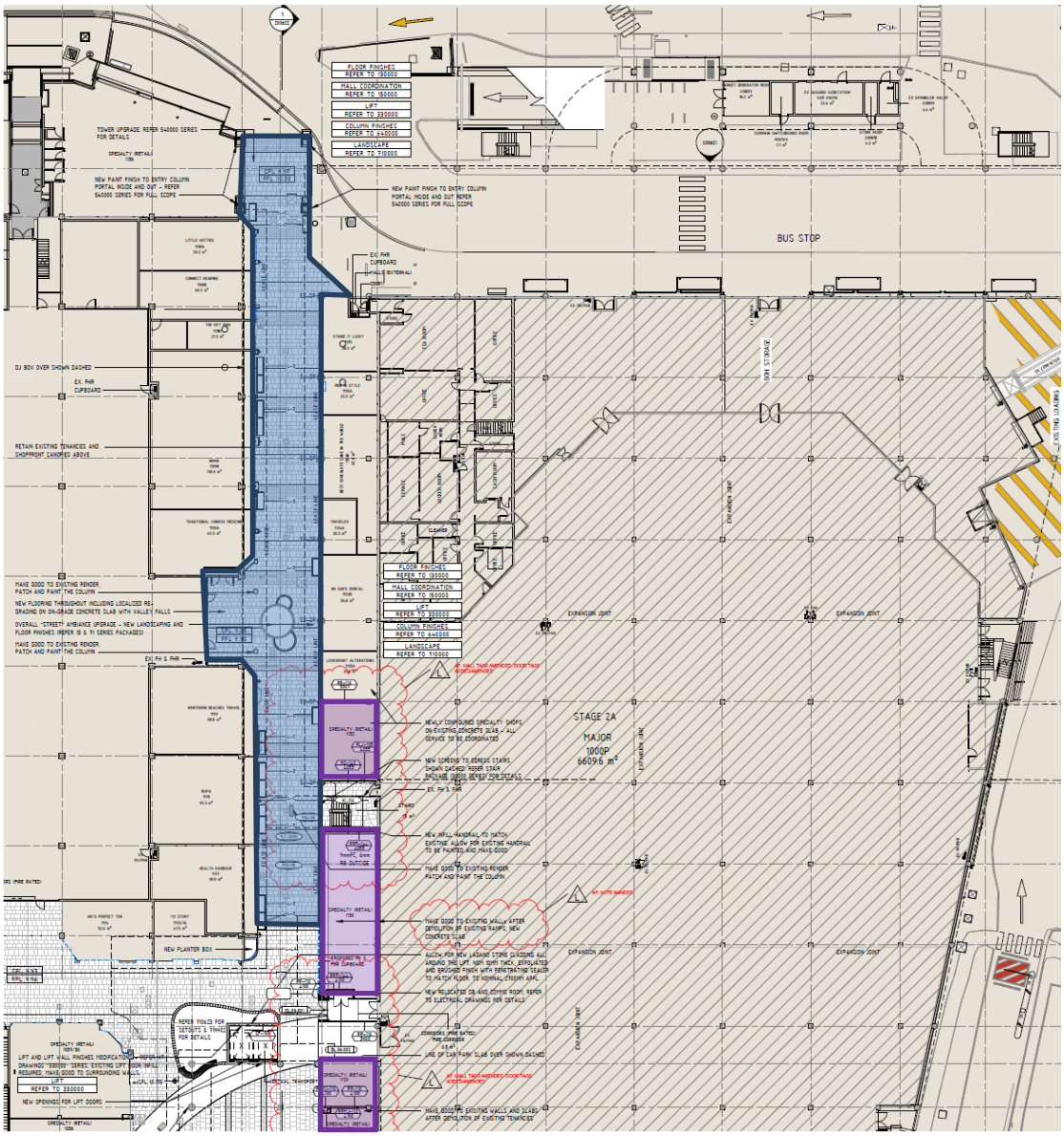

Figure 6-2: Part retail Ground Level floor plan – Location of proposed works

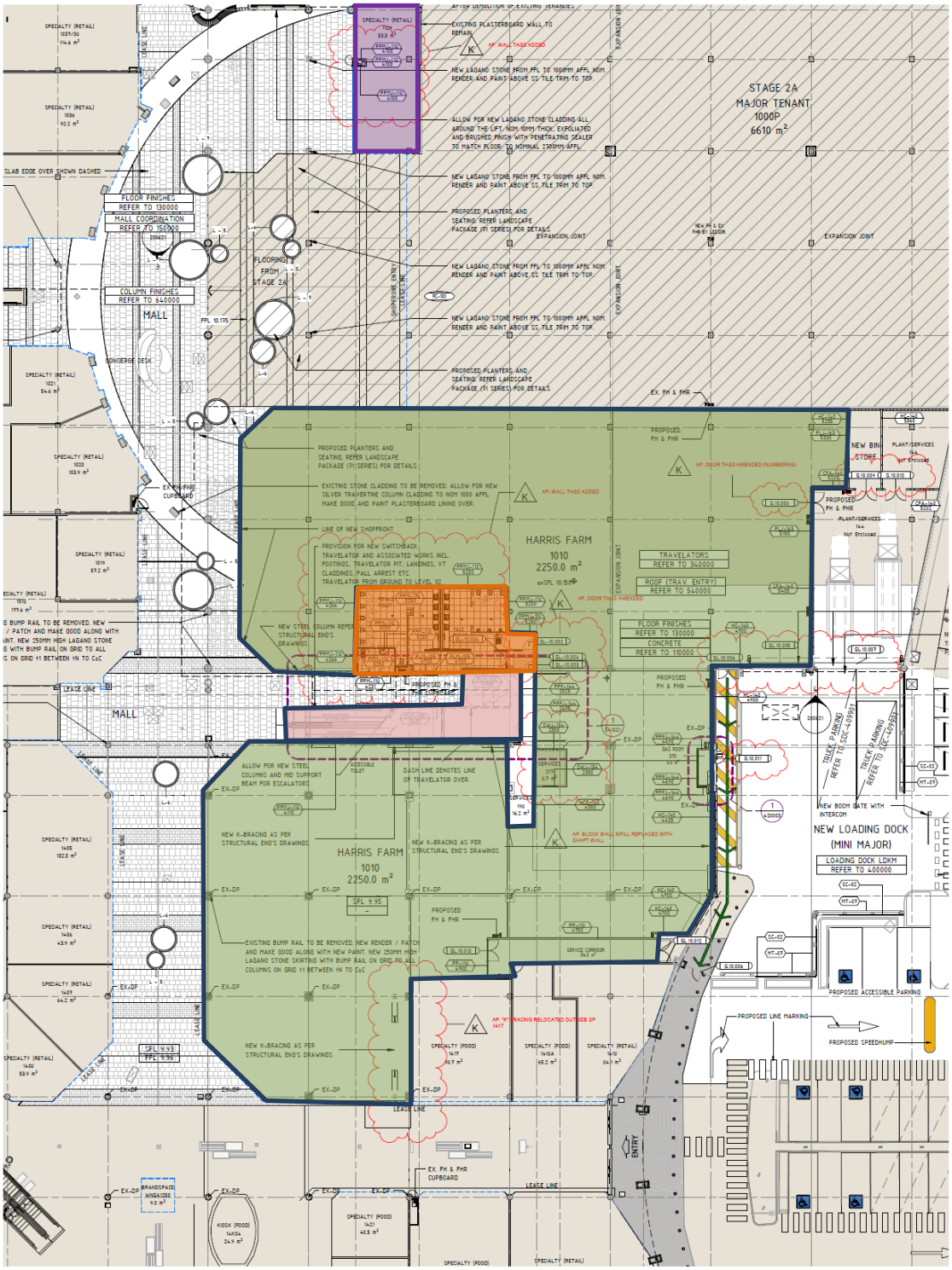

Figure 6-3: Part retail Ground Level floor plan – Location of proposed works

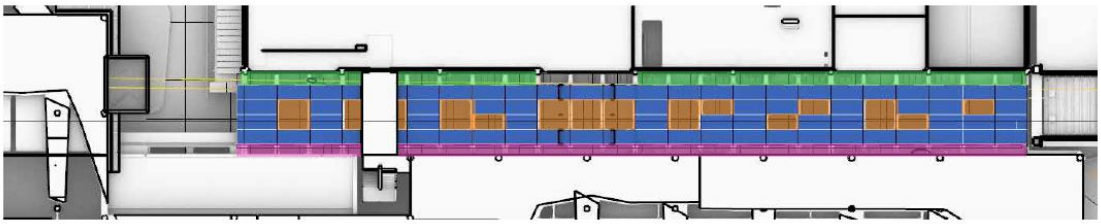

Figure 6-4: Layout of proposed canopy above Ground floor Warringah mall showing natural ventilation opening.

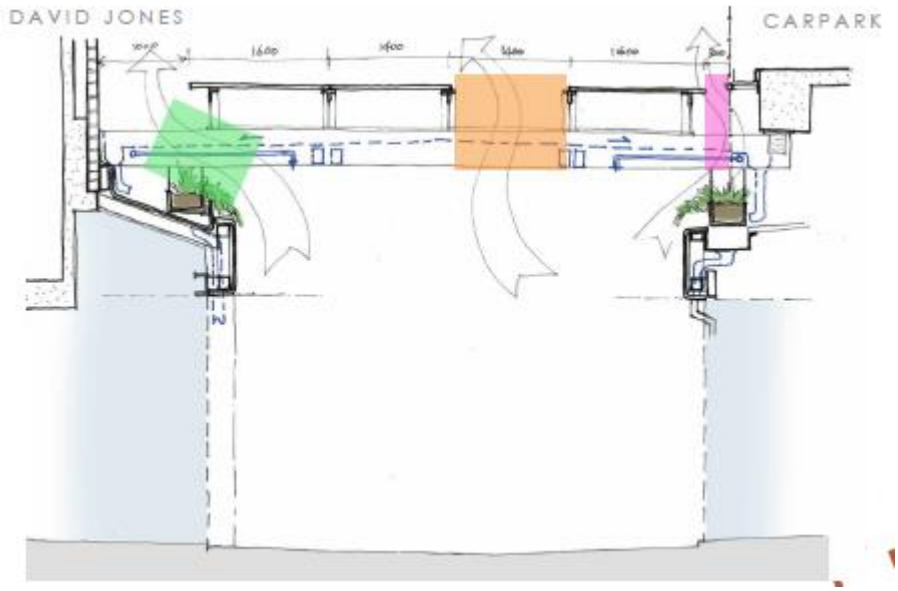

Figure 6-5 Retail Mall Section with roof configuration showing natrual ventilation openings on each side of the roof (between roof and the external building wall on east and west)

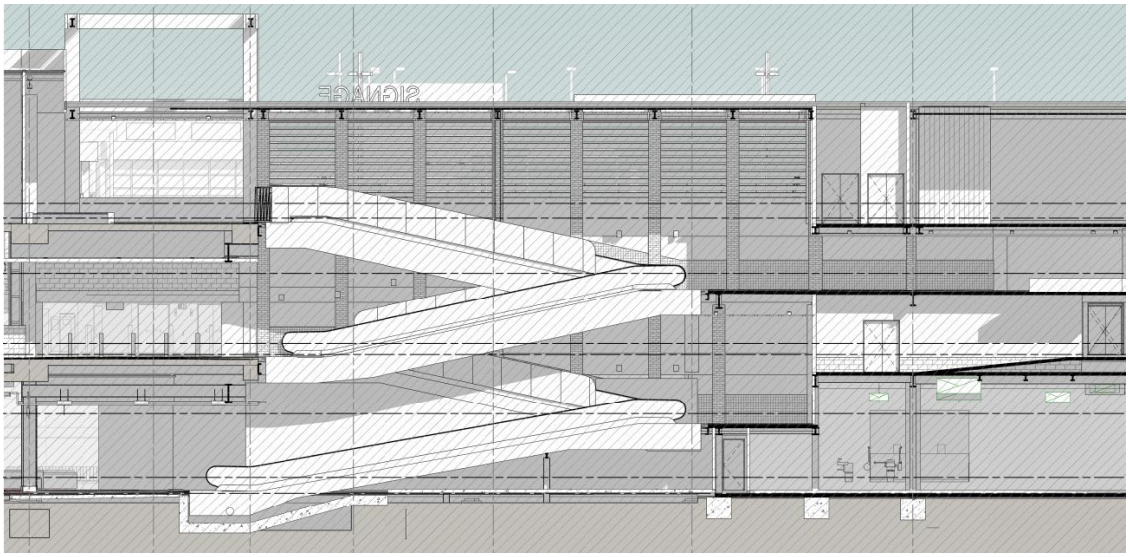

Figure 6-6 Section through travelator lobby showing the entry lobby and the proposed fire separation by way of a fire curtain

6.1 PREVENTIVE AND PROTECTIVE MEASURES

The fire preventive and protective measures for the proposed modified areas of the Fresh Food Market on Ground Level of Warringah Mall involve various passive and active fire protection systems. The International Fire Engineering Guidelines (IFEG) indicate that to assist in analysing a fire safety system, it is convenient to consider the system as comprising six 'sub-systems' [ABCB, 2005a]. Therefore, preventive and protective measures detailed in **Table 6-2** are grouped in accordance with the different 'sub-systems' recommended by the IFEG.

Table 6-2: Preventive and protective measures

Sub-System	Comment
Sub-System A Fire Initiation and Development and Control	Strict enforcement of the "No-Smoking" policy is understood to be implemented throughout the shopping centre portions, which forms the subject of this assessment; and Regular maintenance and inspection of all electrical equipment and appliances is understood to be enforced in accordance with the relevant regulations.
Sub-System B Smoke Spread and Control	The provision of a fire detection and alarm system throughout Tenancy MM-1010 which forms part of the proposed works is expected to provide a fire alarm in the early stages of fire development and activate the smoke hazard management systems serving the tenancy to prevent fire spread throughout the tenancy and the rest of the Warringah Mall building; and The areas forming part of the Fresh Food Market (including associated mall and travelator lobby areas) are required to be fully sprinkler protected, which is expected to limit fire size and smoke generation; and The mini-major tenancy MM-1010 is to be provided with a dedicated smoke exhaust system, which is expected to limit smoke spread between the tenancy and the adjacent zones. It is to be noted that the smoke exhaust system serving the mini-major is designed and assessed on a performance basis with respect to smoke exhaust rates and smoke baffle requirements in order to maintain tenable conditions during occupant evacuation; and The mall forming part of the modified areas of the Fresh Food Market are to be provided with natural smoke ventilation with openings designed on a performance basis. All air-handling systems shall comply with the DTS provisions of Part E2.2 of BCA 2019 Amdt 1 and, if they do not form part of the smoke hazard management systems, shall shut-down on fire trip, which shall prevent smoke spread between different smoke zones.

Sub-System	Comment
Sub-System C Fire Spread and Impact and Control	Potential fire spread is considered to be suppressed and/or controlled by the automatic fire sprinkler system provided throughout the mini-major tenancy; travelator lobby and the adjoining mall areas; and Should the sprinkler system fail to operate as designed, non-fire-rated bounding construction of the tenancies is expected to provide a temporary barrier in the path of spreading fire within the retail areas. The non-sprinkler protected 'open deck' carpark is to be fire separated from retail areas by the provision of a firewall. Portions of this fire wall are to be fitted with fire and smoke curtains which are to be activated by way of the installation of a local thermal detector which is installed locally to the fire and curtains.
Sub-System D Fire Detection, Warning and Suppression	A fire detection and alarm system shall be provided throughout the areas forming part of the proposed works comprising of smoke detectors installed in accordance with Specification E2.2a of BCA DTS provisions with the exception that detectors within Tenancy MM-1010 located and spaced in accordance with Section 5 of AS1670.1-2018; and Automatic sprinkler protection is to be provided throughout all areas forming part of the new works in accordance with AS2118.1-2018. The sprinkler system is required to incorporate 'standard response' sprinkler heads as per the existing sprinkler; and Portable fire extinguishers and fire hose reels are understood to be installed (where required) throughout the areas forming part of new works in accordance with the DTS provisions of BCA 2019 Amdt 1.
Sub-System E Occupant Evacuation	Emergency lighting and exit signage are required to be installed throughout the areas forming part of new works in accordance with the DTS provisions of BCA 2019 Amdt 1; and A building occupant warning system is to be provided to achieve full coverage to all buildings areas which form part of the new works associated with Fresh Food Market modifications project in accordance with BCA 2019 Amdt 1 and AS1670.4-2018. Activation of the sprinkler system and the fire detection and alarm system shall activate the building occupant warning system.
Sub-System F Fire Services Intervention	Professional fire service (Fire & Rescue NSW) is available 24/7; and Fire hydrant protection is provided from fire hydrants installed throughout the building in accordance with the existing fire engineering strategy of the building. The performance (pressure and flow) of the fire hydrant system serving areas forming part of the new works is understood to comply with AS2419.1-2005.

6.2 HAZARDS

Identification of hazards that are expected to affect life safety of building occupants is crucial to undertaking a fire safety engineering assessment. Special attention must be paid to those hazards that are not commonly associated with the type of the occupancy.

Hazards associated with the general layout and activities as well as the ignition and fuel sources for the areas forming part of the proposed modifications to the Fresh Food Market at Warringah Mall as part of Target Backfill project have been identified in **Table 6-3**.

Table 6-3: Hazards and ignition sources

Type	Comment
General Layout	The layout of the mini-major tenancy with multiple shopfronts is considered to be relatively simple and is not expected to cause confusion during evacuation of occupants or fire brigade intervention; and No areas forming part of the new works have bene identified with extended dead end travel distances; and The Principal Certifying Authority (SWP) have identified that the areas forming part of the new works have extended travel distances to an exit of up to 60m, and between alternative exits of up to 90m.
Activities	Activities associated with the day-to-day operation of the modified Fresh Food Market areas including the mini-major tenancy; the adjoining mall areas and the travelators/amenities forming part of the proposed works are considered to present a low to medium fire risk.
Ignition Sources	The main ignition sources within the modified Fresh Food Market areas forming part of the new works are considered to be faulty electrical wiring; lighting and/or electrical equipment, such as lighting, power outlets, computers etc.
Fuel Sources	The main fuel source within the mini-major tenancy is expected to be general merchandise (fresh good; grocery type items and plastic packaging etc) which forms the stock within the tenancy. The fuel sources in the mall are expected to comprise of seating (generally timber or metal); concierge desks and associated furniture etc. The travelator lobby is likely to remain sterile with the exception of the travelator components and machinery (greases etc used in the travelator).

6.3 OCCUPANT CHARACTERISTICS

The characteristics of the occupant groups expected to be present in the modified areas of the Fresh Food Market associated with the Target Backfill project are detailed below:

- ***Centre Management Staff and Security*** – Good familiarity with the building and the fire safety systems, fully trained in emergency procedures. This occupant group is considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. This occupant group is expected to be awake and fully conscious at all times when inside the building; and

- ***Tenancy Staff*** – Good familiarity with the tenancy and the means of exits from within the tenancy. Generally familiar with the building and the location of main exits. This occupant group is considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. This occupant group is expected to be awake and fully conscious at all times when inside the building; and
- ***General Public (Customers)*** – This occupant group may include children who may or may not be familiar with the layout of the tenancy and may require assistance in locating the exits. This occupant group may require assistance with evacuating the area and may have hearing and visual impairment in line with general public; and
- ***External Maintenance Contractors*** – This occupant group is expected to have a reasonable familiarity with the tenancy. This occupant group is also expected to be mobile and able to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. The contractors are expected to be awake and aware of their surroundings at all times when inside the tenancy; and
- ***Fire & Rescue NSW Personnel*** – This occupant group will be equipped with safety equipment and will be educated in fire-fighting activities and the dangers associated with fire incidents. This occupant group would be expected to be in a position to assist other occupants requiring assistance to evacuate. It is not expected that this occupant group would be present in the building at the time of fire ignition; however, they are expected to enter the building at a later stage to assist with the evacuation of occupants, if required and to undertake fire suppression activities.

7. RELEVANT STAKEHOLDERS

This Fire Engineering Report has been developed by Fire Engineering Professionals Pty Ltd in collaboration and consultation with the following relevant stakeholders as identified in **Table 7-1** below.

Table 7-1: Relevant Stakeholders for the project

Role	Company
Client / Project Manager	Scentre Design and Construction Pty Ltd
Principal Certifying Authority	Steve Watson & Partners Pty Ltd
Fire Services	Fire & Rescue NSW
Fire Engineers	Fire Engineering Professionals Pty Ltd

8. FIRE ENGINEERING BRIEF

The Fire Engineering Brief (FEB) was conducted by way of the following:

1. Telephone and e-mail briefing from Mr. Blake Kendall of Scentre Design and Construction Pty Ltd with regard to the project details and client objectives; and
2. Issue of a fee proposal by Fire Engineering Professionals Pty Ltd (FEP) via email outlining the scope of works for review and acceptance by Scentre Design and Construction Pty Ltd; and
3. Email acceptance of the fee proposal by Scentre Design and Construction Pty Ltd.; and

4. Receipt of a written correspondence from Steve Watson & Partners nominating the non-compliances with BCA DTS provisions; and
5. An internal discussion between FEP staff regarding the identified non- compliances and the proposed trial concept design.
6. Issue of a Performance Based Design Brief (PBDB) in the form of an FEBQ issued to the Project Manager for distribution to Scentre Group and all relevant consultants. The PBDB was also issued to PCA and FRNSW for review and comments; and
7. Comments received from the relevant stakeholders and incorporating in this Performance Solution Report.

9. BCA REQUIREMENTS ASSOCIATED WITH THE PROPOSED PERFORMANCE SOLUTION

Table 9-1 provides a description of the non-compliances with the BCA DTS provisions and the BCA Performance Requirements associated with the "Performance Solution".

Table 9-1: BCA Requirements Associated with the Fire Engineering Assessment

Perf. Sol. No.	Description of Non-Compliance	DTS Provisions	Perform. Req's	Method of Meeting Performance Requirement	Assessment Method
1	The required firewall between eastern carpark and the retail portions of the building incorporate carpark entries which are to be protected on a performance basis by way of the installation of a fire and smoke curtaina	C2.7	CP1 and CP2	A2.2(1)(a)	A2.2(2)(b)(ii)
2	Travelators connect up to four (4) storeys in lieu of three (3)	D1.12(c)(i)	CP2 and EP2.2	A2.2(1)(b)	A2.2(2)(d)
3	Extended travel distance to an exit in the areas forming part of the new works. (up to a maximum of 60m in lieu of 40m)	D1.4(c)(i) D1.5(c)(iii) Spec.E2.2b	DP4; EP2.2	A2.2(1)(a)	A2.2(2)(b)(ii)
	Extended travel distance between alternative exits in the areas forming part of the new works. (up to a maximum of 90m in lieu of 60m)				
	The mechanical smoke hazard management system with regards to exhaust rates and smoke baffle depths for the Tenancy MM-1010 and the openings for natural ventilation in the mall areas is to be provided on a performance basis.				

10. PERFORMANCE REQUIREMENTS

The Performance Requirements of BCA 2019 Amdt 1 identified in **Table 9-1** are provided in **Table 10-1** below.

Table 10-1: Relevant Performance Requirements

Performance Requirement	Description
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* *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.*

Performance Requirement	Description
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.*
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.*

11. TRIAL CONCEPT FIRE SAFETY DESIGN

11.1 GENERAL REQUIREMENTS

1. The works associated with the proposed modifications to the Fresh Food Market areas and means of vertical transportation which form part of the Target Backfill project at Warringah Mall shopping centre, shall comply with the DTS Provisions of the BCA except where specifically identified otherwise in **Table 9-1**; and
2. This Trial Concept Design section does not aim to provide a comprehensive list of fire safety measures associated with the proposed works incorporating modifications to the Fresh Food Market areas and means of vertical transportation which form part of the Target Backfill project at Warringah Mall shopping centre. This section aims to identify those fire safety measures associated with the new works that relate to the "Performance Solutions" assessed in this report and which are not covered under BCA DTS provisions. Fire safety measures associated with the new works must be provided to comply fully with BCA DTS provisions, except where specifically identified otherwise in **Table 9-1** of this report. All work must comply with the requirements of the Principal Certifying Authority; and
3. All base building fire safety systems, where not required by the consent authority to be upgraded to comply with current BCA provisions, must, where affected by the proposed works, be modified / upgraded / relocated as necessary to maintain the requirements of the approved fire safety strategy for the building, unless specifically identified otherwise in this Trial Concept Design (i.e. **Section 11**) and **Table 9-1** of this document; and
4. All base building fire safety systems, where not required by the consent authority to be upgraded to comply with current BCA provisions, must, where affected by the proposed works, be modified / upgraded / relocated as necessary to maintain the requirements of the approved fire safety strategy for the building, unless specifically identified otherwise in this Trial Concept Design of this document; and
5. Fire safety measures for those portions of the building that are located outside of the proposed new redevelopment works, including but not limited to, construction and fire separation, fire services, smoke management systems and emergency egress provisions must be maintained in accordance with existing building approvals and as built drawings, except where required to be upgraded by the PCA; and
6. Should a change in use or building alterations and / or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report; and
7. The provisions listed in this Section are to be strictly adhered to. The requirements listed in this Section are Essential Services and, as all fire safety systems, should be identified as requiring maintenance and certification at appropriate intervals as per AS1851-2012 and the EP&A Regulation 2000.

11.2 FIRE SAFETY SYSTEMS

11.2.1 FIRE RESISTANCE AND COMPARTMENTATION

8. The proposed mini-major tenancy (MM-1010) is to be designed to act as a separate smoke zone to the adjoining mall smoke zone, with the provision of an independent mechanical smoke exhaust within the tenancy and high-level smoke separation in the

form of some baffles / bulkheads to separate the tenancy smoke zone from adjacent smoke zones; and

9. All openings into the mini-major tenancy (MM-1010), which is required to form an independent smoke zone, shall be situated not greater than the depth of the baffles nominated in **Item 30** of this Trial Concept Design, except for suitably protected openings which prevent passage of smoke in the event of a fire; and

10. The new travelator and the associated lobby shall be fire separated from the eastern carpark by a firewall complying with BCA DTS provisions with the exception that the direct connection between the carpark and the retail (carpark entry) forming part of this firewall on Level 1 and Level 1M shall be protected with fire and smoke curtains; and

11. The fire and smoke curtains nominated to protect the openings between the retail and carpark portions on Level 1 and Level 1M shall only be installed where this entry is not required for emergency egress purposes. The location of the proposed fire and smoke curtains on Level 1 and Level 1M is shown in **Figure 11-1** and **Figure 11-2** respectively.

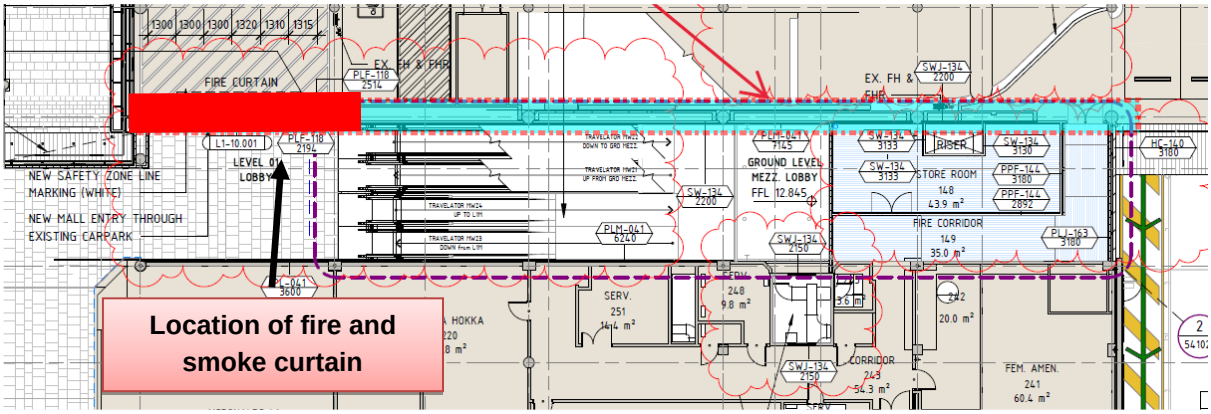

Figure 11-1 Travelator entry on Level 1 showing the location of fire and smoke curtain (shown in 'RED')

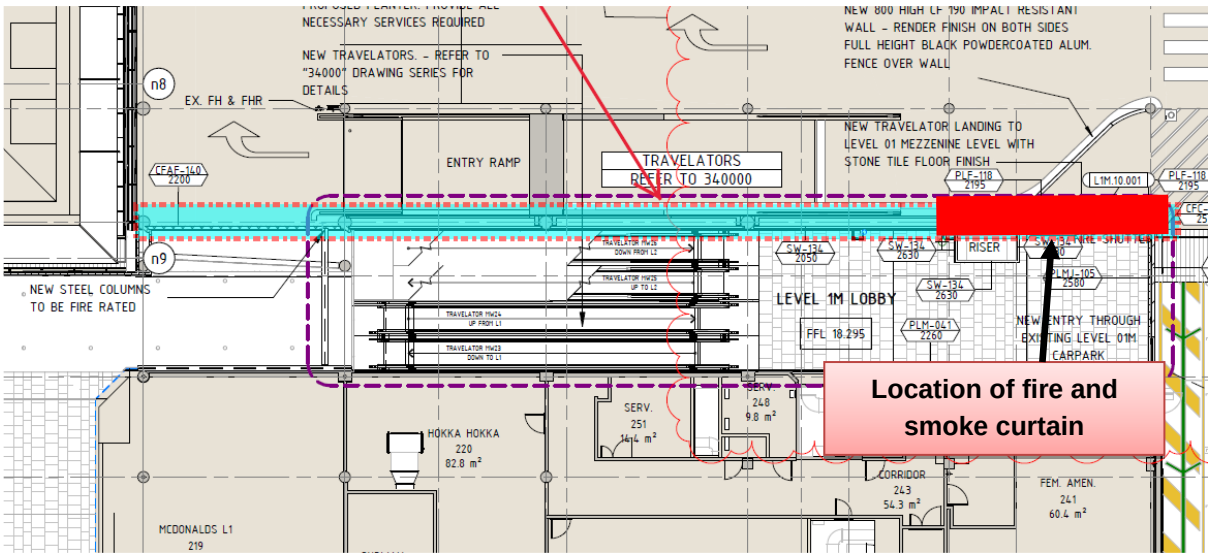

Figure 11-2 Travelator entry on Level 1M showing the location of fire and smoke curtain (shown in 'RED')

12. The fire and smoke curtains (as nominated in **Item 10** above) proposed to protect the carpark entry from retail mall on Level 1 and Level 1M shall be:

a. capable of achieving a minimum FRL of -/120/- with low radiant heat emission; and

b. capable of achieving smoke leakage rates of less than 15 m^3/hour (at 25 Pa pressure differential) when tested to the requirements of AS1530.7 – 2007; and

c. installed with a single span – i.e. no overlapping curtains; and

d. supplied by the emergency power supply serving the building or provided with a battery back-up that is inspected at regular intervals (minimum frequency of every six (6) months); and

e. provided with appropriate measures (i.e. infrared light beam or equivalent) to monitor the opening and sound a local alarm if any obstructions are left in the path of the curtain for more than three (3) minutes. The local alarm shall achieve a minimum sound level of 10 dB above ambient, and not be less than 65 dB or more than 105 dB; and

f. provided with an audible warning device located near the smoke curtain and a red flashing warning light of adequate intensity on each side of the curtain. These devices shall activate upon operation of the curtain and verbally warn occupants that the curtain is closing; and

g. provided with signage installed on each side of smoke curtain, located directly over the opening, stating "**WARNING – FIRE CURTAIN CLOSING**". The signage shall be written in capital letters in large lettering (minimum 50mm high) on a colour contrasting background.

13. The installation of fire and smoke curtains as nominated in **Item 10** above shall meet the following additional requirements:

    a. Suitable barriers (i.e. balustrades and bollards etc.) shall be provided to protect the fire and smoke curtain guide rails from the potential impact of the general day-to-day operations of the carpark (e.g. impact from vehicles; trolleys etc.); and

    b. The entire fire and smoke curtain assembly (system) must be certified as a complete tested prototype and not the individual elements which make up the system; and

    c. Activation of the local thermal detectors located within 1.5m of each side of the fire and smoke curtain shall cause the closure of the fire and smoke curtain.

11.2.2 EMERGENCY EGRESS PROVISIONS

14. Emergency egress provisions throughout the areas forming part of the new works related to the proposed modifications to the Fresh Food Market which form part of the Target Backfill project at Warringah Mall shopping centre, shall comply with the DTS provisions of BCA 2019 Amdt 1 in all areas except for the following:

    a. travel distances to the nearest of the alternative exits may be increased to a maximum of 60m where the extended portion of the travel path is through a mechanically exhausted tenancy or mall area (including specialty tenancies);

    b. travel distance between alternative exits, when measured through the point of choice, may be increased to a maximum of 90m where the extended portion of the travel path is through a mechanically exhausted tenancy or mall area (including specialty tenancies).

11.2.3 SERVICES

15. All **fire hydrants** proposed to serve the areas forming part of the new work associated with the modifications to the Fresh Food Market including tenancies, mall; travelator and associated lobbies and ancillary areas shall be fitted with Storz hose couplings which comply with Clause 7.1 of AS2419.1-2005. This Clause states in part: "hose couplings shall be compatible with those used by the fire brigade serving the area". Storz hermaphrodite fire hose couplings must be fitted to all fire hydrants and fire hydrant booster assembly connections as required by Appendix D of AS2419.1-2005. The Storz fittings must be manufactured to DIN 14303, aluminium alloy delivery couplings, in accordance with Appendix A of AS2419.2-1994. Blank caps must be provided in accordance with Clause 2.8 of AS2419.2-1994; and

16. A**utomatic sprinkler system** shall be provided to serve all areas forming part of the proposed works associated with modifications to the Fresh Food Market in accordance with Clause E1.5 of BCA 2019 Amdt 1 and AS2118.1-2017; and

17. Sprinkler heads serving Tenancy MM-1010 shall be of 'fast response' type with a maximum RTI of 50ms$^{1/2}$. Recessed or flush mounted concealed sprinkler heads are not permitted within Tenancy MM-1010. Sprinkler heads in all areas shall remain consistent with the existing sprinkler head type serving the adjoining building areas where they are not separated by BCA DTS compliant smoke baffles; and

18. A **fire detection and alarm system** shall be provided throughout the areas forming part of the proposed modification works within the Fresh Food Market at Warringah Mall comprising of smoke detectors located and spaced in accordance with Clause 6 of Specification E2.2a of BCA DTS provisions with the following additional requirements:

    a. Smoke detectors located on the underside of the ceiling / roof, shall be provided throughout Tenancy MM-1010 in accordance with Clause 5.1.2 (level surfaces) and Clause 5.1.3 (sloping surfaces) of AS1670.1-2018 resulting in maximum distance to a detector being no more than 7m (i.e. maximum nominal 10m x 10m smoke detector spacing); and

    b. No verification time shall be incorporated in the activation of the smoke detection system serving Tenancy MM-1010.

19. The **smoke detection and alarm system** must:

    a. activate the occupant warning system within the relevant tenancy or ancillary/common areas and the rest of the building in accordance with the alarm cascading strategy for the building; and

    b. when activated in the mini-major tenancy (MM-1010), activate the smoke hazard management systems (i.e. smoke exhaust fans, make-up air etc.) serving the tenancy; and

    c. when activated in the mini-major tenancy (MM-1010), shut down the applicable air-handling systems serving the tenancy; and

    d. where applicable, shut down any audio-visual devices serving the Tenancy (MM-1010).

20. **A sound and intercom system** shall be provided throughout the areas forming part of the new works in accordance with Clause E4.9 of BCA DTS provisions and AS1670.4-2018. The sound and intercom system shall be capable of providing pre-recorded evacuation messaging and allowing for live directives to be broadcast from the fire panel

or at a point within the security office. Activation of either the fire detection and alarm or sprinkler systems shall activate the sound and intercom system; and

21. The **automatic fire sprinkler and fire detection and alarm systems** serving all areas of the shopping centre shall be interfaced with the Fire Indicator Panel (FIP) and shall be linked to a 24 hour Monitoring Station via Alarm Signalling Equipment (ASE); and

22. **Block Plans** for all primary fire services serving al modified areas forming part of the Target Backfill project at Warringah Mall including but not limited to fire hydrant system, automatic sprinkler system, smoke detection and EWIS system and smoke exhaust system shall be updated to incorporate the new construction and any other modifications and provided within the Fire Control Centre, Sprinkler Valve Room, Hydrant and Sprinkler Pump Rooms, Hydrant and Sprinkler boosters; and

23. **Emergency lighting and exit signage** in those areas affected by the proposed work shall be provided in accordance with AS/NZS2293.1-2018.

11.2.4 SMOKE HAZARD MANAGEMENT

24. A dedicated smoke exhaust system shall be provided to serve the proposed mini-major tenancy (MM-1010) in accordance with the DTS provisions of Clause E2.2 and Specification E2.2(b) of BCA 2019 Amdt 1 with the exception of the following:

    a. The tenancy trading floor shall not be provided with BCA DTS compliant smoke baffles, which may result in the smoke reservoir exceeding 2,000m^2 in area; and

    b. Smoke exhaust system fan capacity, after hour make up air velocity and the smoke baffle depth for the tenancy has been determined on a performance basis through Computational Fluid Dynamics (CFD) modelling in lieu of compliance with Specification E2.2b of the BCA.

25. The activation of the smoke exhaust systems in the mini-major tenancy (MM-1010) shall be triggered by the activation of the fire detection system installed throughout the tenancy. The tenancy detection zone shall be programmed to be identifiable at the FIP and shall operate the local smoke exhaust systems within the tenancy smoke zone (i.e. all smoke exhaust fans serving Tenancy MM-1010 shall operate simultaneously if fire is detected in the tenancy); and

26. All smoke exhaust fans serving the Tenancy MM-1010 shall be controllable and provide status indication at the Fire Fan Control Panel; and

27. Make-up air for the operation of mechanical smoke extraction within Tenancy MM-1010 shall be provided via the main entry / exit doors of the tenancy; and

28. The main shopfront entries (north and south) associated with Tenancy MM-1010 shall remain open during normal trading hours to provide make-up air for the operation of the smoke exhaust; and

29. Any security shutters provided across the shopfront openings which are required for make-up air shall maintain the required free area such that the make-up-air velocity does not exceed 2.5m/s under maximum design smoke exhaust operation; and

30. A smoke baffle shall be provided at all shopfront openings associated with Tenancy MM-1010. Except where specifically required otherwise by this report, the smoke baffle shall extend down a maximum distance of 2800mm AFFL. In this regard, perimeter walls (including the shopfront) shall be suitably smoke sealed to prevent entry of air at a height above the smoke baffle depth (including doorways providing access / egress from the

tenancy, where a non-combustible bulkhead shall be provided to help contain the smoke within the compartment of fire origin and prevent smoke migration to adjacent areas); and

31. The depth of the baffle shall be measured as follows:

    a. For open ceiling configurations – The depth of the smoke baffle shall be measured from the services zone or the lowest intake point of the smoke exhaust grille, whichever is the lesser; and

    b. For suspended / false ceiling configurations – The depth of the smoke baffle shall be measured from the from the ceiling or the lowest intake point of the smoke exhaust grille, whichever is the lesser.

32. The material of construction for the smoke baffles identified in **Item 30** of this Trial Concept Design must be able to resist a smoke temperature of 200ºC for a minimum duration of 30 minutes and must be of non-combustible construction and resistant to shatter. The baffle shall be fully sealed to prevent any entry of air into the tenancy above the nominated baffle depth during fire mode operation of the smoke management system within the tenancy; and

33. The smoke baffle(s) installed at the shopfront associated with Tenancy MM1010 may be installed as permanent features (such as fixed toughened glass baffle) or in the form of a drop down imperforate metal roller shutter.

    a. Should a drop down imperforate metal roller shutter be utilised as the smoke baffle for the tenancy, then the shutter shall be supplied by the emergency power supply serving the building or provided with a battery back-up that is inspected at regular intervals (minimum frequency of every six (6) months); and

34. The minimum smoke exhaust capacity through the smoke exhaust grilles within Tenancy MM-1010 shall be 20.0m^3/s designed on the basis of five (5) extraction locations as conceptually illustrated in **Figure 11-3** below. Each extraction location shall exhaust smoke at a minimum capacity of 4.0m^3/s, distributed evenly across the exhaust grilles with dimensions 9.6m by 0.6m each, extracting at a maximum average velocity of 1.0 m/s at each exhaust grille.

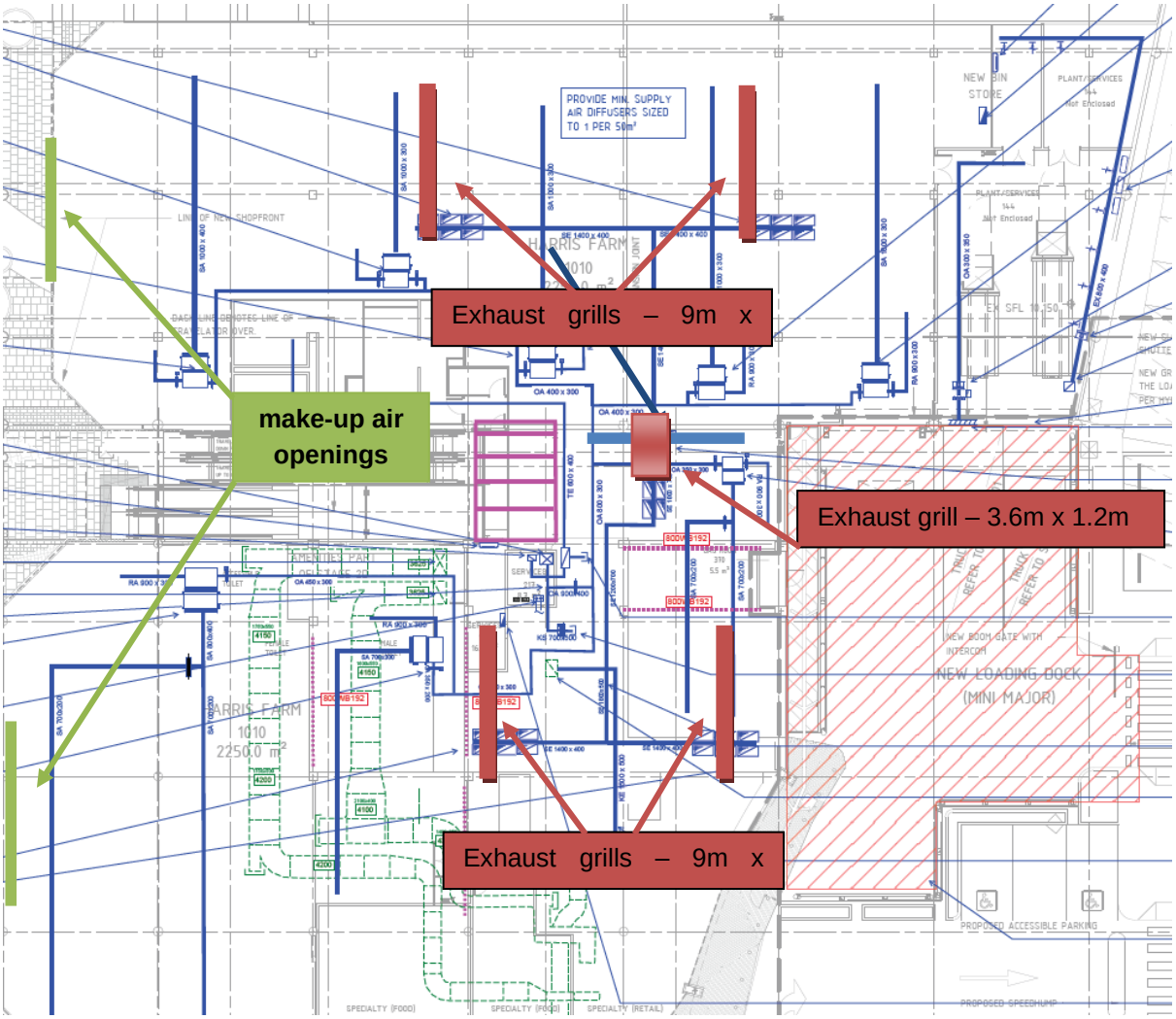

Figure 11-3: Exhaust grille and make-up air locations modelled for the Tenancy MM-1010

35. Natural ventilation openings shall be provided along the mall forming part of the proposed modifications in locations and configuration as conceptually illustrated in **Figure 11-4 and Figure 11-5** respectively.

Figure 11-4: Layout of proposed canopy – Ground floor Warringah mall

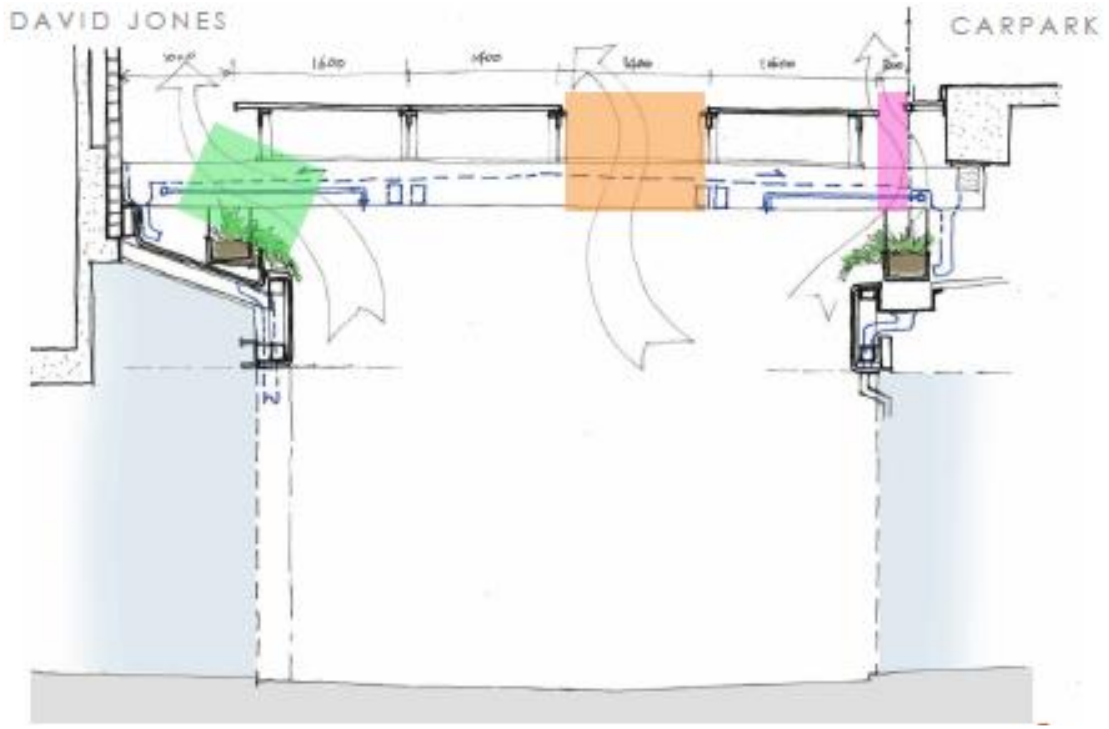

Figure 11-5 Retail Mall Section showing the typical roof configuration showing the ventilation openings on each side of the roof (between roof and the external building wall on east and west)

11.3 MANAGEMENT PROCEDURES

36. An 'Emergency Management Plan' for the Warringah Mall building shall comply with the requirements of AS 3745-2010 and shall incorporate the modifications due to the construction of the MM-1010 tenancy and Fresh Food Market mall areas. This plan shall be implemented and audited on a regular basis to maximise the effectiveness of the fire safety systems provided in the retail and carpark/loading dock areas and the rest of the building. The plan should minimise the potential for shut-down of fire safety systems during trading hours and should detail the exact location of all fire safety measures in and around the buildings. As a minimum, the plan is to include:

    a. Procedures to minimise the extent and duration of shut-down of any part of the sprinkler system when the shopping centre is trading. An approved Red Tag system shall be instigated for each shut down, which requires written permission from management before isolation can take place and a statement as to the length of isolation; and

    b. Procedures shall be implemented to ensure that the areas (within 6m) adjoining the location of fire and smoke curtains forming part of the required fire separation between the retail and carpark areas remain free of combustible items; and

    c. Documented procedures which ensure that prior to sprinkler isolation for tenancy fit out, all merchandise is removed from the tenancy subject to fit out; and

    d. Documented procedures which ensure that prior to any authorised isolation of the ASE the Grade 1 Monitoring Company is notified of the extent and duration of any proposed isolation and is advised as soon as the shut-down has been completed; and

e. Procedures shall be implemented to minimise any potential for the simultaneous isolation of the sprinkler and smoke detection systems; and

f. A3 size plans with stickers showing the exact location of fire hydrants, fire hose reels and portable fire extinguishers. Copies of the plan to be located in strategically locations, including at the fire hydrant system booster assembly, Fire Control Centre, and be available to all security and centre management staff; and

g. Scentre Group shall require that Tenancy MM-1010 shall be responsible for developing suitable emergency evacuation procedures for the tenancy and for training fire wardens within their tenancy to initiate and assist with the effective evacuation of their tenancy in the event of a fire emergency in the building. These training and evacuation procedures shall take into account the evacuation procedures for the tenancy and the building, its fire safety systems and available exits serving those areas. These procedures shall ensure that in the event that a fire occurs outside of the Tenancy MM-1010, occupants are encouraged to evacuate via available exits located within the tenancy (where safe to do so) rather than exiting into the mall, which may become fire/smoke affected; and

h. All full time staff within Tenancy MM-1010 shall be inducted in the tenancy's emergency evacuation procedures; and

i. Westfield Centre Management shall be responsible for ensuring that adequate safety measures are implemented to assist persons with disabilities to evacuate in the event of an emergency, including fire emergency.

12. PERFORMANCE SOLUTION 1 – NON-COMPLIANT FIREWALL BETWEEN CARPARK AND RETAIL AREAS

12.1 INTRODUCTION

In accordance with Clause C1.1 of the BCA, the fire-resisting construction of a building of 'Type A' construction must be in accordance with Clause 3 and Table 3 of Specification C1.1 of BCA 2019. As per the requirements of Clause 3 and Table 3 of Specification C1.1 a Class 6 building shall contain structural elements that achieve an FRL of 180/180/180 (loadbearing elements and firewalls). Clause 3.9 and Table 3.9 of Specification C1.1 permits a concession for the FRLs required to be achieved by the structural elements in an 'open deck' carpark.

Furthermore, in accordance with Clause C2.7(a)(i), parts of a building requiring different FRLs must be separated from each other by a fire wall. Clause C2.7(a)(ii) requires any openings in a fire wall to not reduce the FRL of the firewall required by Specification C1.1 of BCA.

It has been identified to Fire Engineering Professionals Pty Ltd by the Principal Certifying Authority (Steve Watson & Partners) that the existing adjacent carpark has been constructed to the lesser FRLs prescribed by Table 3.9 of Specification C1.1. Therefore, the retail portion of the building is required to be separated from the carpark by a firewall.

The retail entries adjacent to the existing carpark on Level 1, Level 1M and Level 2 which forms the interface between the retail portions of the building and the carpark (i.e. the firewall) are to be protected by way of a fire and smoke curtain on Level 1 and Level 1M while no protection is proposed on Level 2 which is an open to sky carpark. This performance-based protection to elements incorporated in the firewall does not comply with Specification C1.1 and Clause C2.7 of BCA DTS provisions.

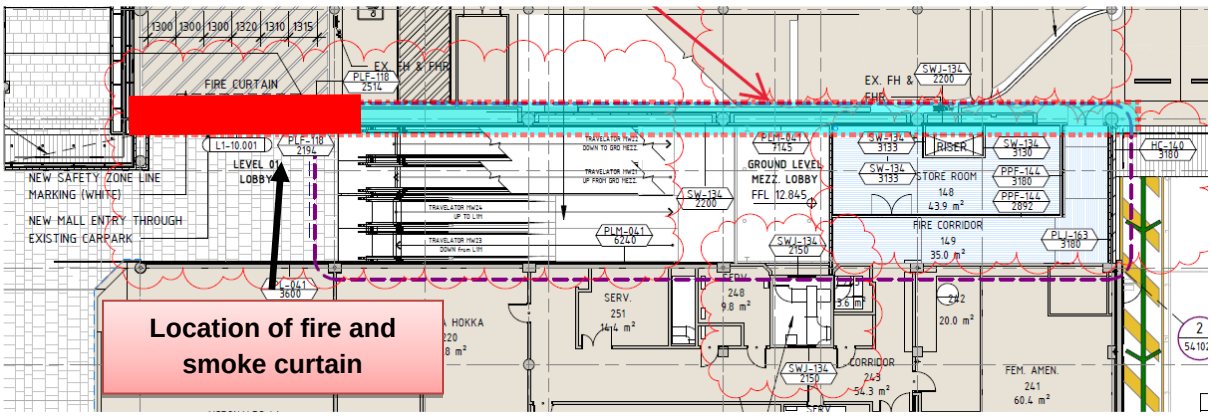

Figure 12-1 Travelator entry on Level 1 showing the location of fire and smoke curtain (shown in 'RED') proposed to provide separation between retail and carparking areas

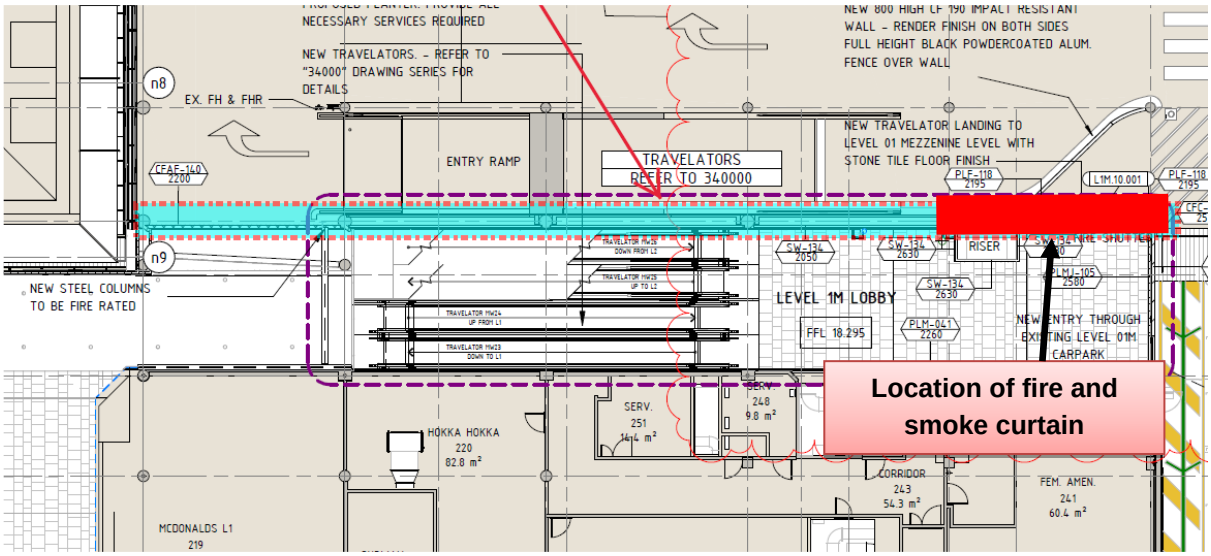

Figure 12-2 Travelator entry on Level 1M showing the location of fire and smoke curtain (shown in 'RED') proposed to provide separation between retail and carparking areas

The Performance Requirements of BCA 2019 A1 associated with this issue of non-compliance with the DTS provisions have been identified as CP1 and CP2.

A fire safety engineering assessment has been undertaken to analyse these issues of non-compliance to determine whether the proposed design of the carpark entry which forms part of the firewall between the retail and carpark portions and incorporates openings with performance based protection in the form of fire and smoke curtains provides a level of life safety required to achieve compliance with Performance Requirements CP1 and CP2 of the BCA 2019 using qualitative deterministic absolute analysis, in accordance with BCA Assessment Method A2.2(b)(ii).

12.2 INTENT OF THE BCA

To make an assessment of whether the proposed performance-based protection (by way of the installation of fire and smoke curtains) of openings in a fire wall achieves compliance with Performance Requirements CP1 and CP2 of BCA, the intent of the BCA must first be understood.

The intent of Performance Requirement CP1 is to ensure that the building has a structure that, "*to the degree necessary*", will withstand the impact of a fire and will not have localised or catastrophic collapse as a result of it.

The Guide to the BCA, which provides an explanation and interpretation of the DTS provisions listed in the BCA, states that the use of words "*to the degree necessary*" means that the "*BCA recognises that different building elements require differing degrees of structural stability during a fire. The expression is intended to allow the appropriate authority to determine the degree of compliance necessary in each particular case*".

The above notwithstanding, the Guide to the BCA states that "*while assessment of a building proposal must have regard to the differing needs of each building element, the proposal must make sure that the elements have an appropriate structural stability during a fire so that:*

- "*the fire does not endanger the occupants by entering escape routes; and*

- "*the fire does not endanger fire fighters while they are undertaking search and rescue operations*".

The intent of Performance Requirement CP2 is to prevent fire spread through the building. The Guide to the BCA again indicates that "*the BCA recognises that different building elements require differing degrees of protection to avoid the spread of fire*". The Guide also highlights that compliance with the DTS provisions in regards to fire separation "*is not compulsory if alternative means can be found to satisfy the appropriate authority that the Performance Requirements will be achieved*". This provision is intended "*to allow the appropriate authority to determine the degree of compliance necessary in each particular case after considering each building scenario*".

From the above it is evident that the main intent of Performance Requirements CP1 and CP2 is to limit the potential of fire and smoke spread through the building as a result of the failure of fire separating elements to allow safe evacuation of the building occupants and to facilitate fire brigade intervention.

12.3 METHODOLOGY

The approach used to meet Performance Requirements CP1 and CP2 of the BCA is in accordance with Clause A2.2(1)(a) of BCA 2019, which requires an "Performance Solution" to demonstrate that the subject design complies with the Performance Requirements of the BCA. The method of meeting these performance requirements is a qualitative deterministic assessment in accordance with BCA Assessment Method A2.2(2)(b)(ii). The documentary evidence used to support this "Performance Solution" is based on an absolute approach, where a quantitative deterministic fire safety engineering assessment was conducted generally in accordance with the procedures outlined in the *International Fire Engineering Guidelines*.

Therefore, the adequacy of the proposed performance-based design has been assessed undertaking a qualitative deterministic analysis to establish whether a potential fire within the non-sprinkler protected open deck carpark could spread to the sprinkler protected retail portions facilitates occupant evacuation and fire brigade intervention and whether a the proposed fire safety measures are capable of limiting the spread of fire originating within the retail portions of the building to the carpark to facilitate occupant evacuation and fire brigade intervention.

12.4 ACCEPTANCE CRITERIA

Based on the discussion in **Section 12.2** above it is evident that structural stability and integrity of the firewall must be maintained to prevent fire and smoke spread throughout the building as it could endanger the evacuation of building occupants and the attending fire brigade's intervention activities.

It is recognised that the fire engineering methodology to be followed in the production of this assessment results in an idealisation of possible real fire scenarios and likely outcomes; however, it is believed that if it can be demonstrated that the structural stability, integrity and insulation of the firewall is capable of withstanding the impact from a reasonable worst credible fire scenario to allow safe occupant evacuation and fire brigade intervention, compliance with Performance Requirements CP1 and CP2 of BCA 2019 is achieved.

Therefore, the acceptance criterion for this assessment is:

- ***Structural stability, integrity and insulation characteristics of the firewall must be maintained to facilitate safe occupant evacuation and fire brigade intervention***.

12.1 FIRE SCENARIO SELECTION

To evaluate the performance of the (protected) openings incorporated in the firewall separating the retail portions from the carpark portions in the proposed design it is first necessary to consider the reasonable worst credible fire scenarios requiring assessment. These scenarios are identified by considering fire hazards present and their potential consequences. The process of fire scenario selection is based around identifying those fire scenarios which might be considered "worst credible" that is having the following aspects:

a) The most likely; and

b) Having the worst impact or consequence; and/or

c) Highlighting the performance of the identified areas of non-compliance during a fire emergency.

Considering the criteria described in a), b) and c), the following fire scenarios are considered to be relevant:

- **Fire originating in the carpark in close proximity to the carpark entry incorporated in the travelator lobby protected on a performance basis; and**
- **Fire originating in the mall areas in close proximity to the carpark opening incorporated in the travelator lobby which is protected on a performance basis.**

12.2 ASSESSMENT OF FIRE SPREAD

As stated in the **Section 12.2**, the provision requiring a firewall between portions of building which require different FRLs for structural elements is to limit the potential of fire and smoke spread through the building as a result of the failure of the structural adequacy, integrity or insulation of the fire separating elements (firewall) to allow safe evacuation of the building occupants and to facilitate fire brigade intervention.

As part of the proposed carpark entry design, it is proposed to separate the 'open deck' carpark which is understood to be constructed in accordance with concession provided in Table 3.9 of Specification C1.1 of BCA DTS provisions from retail portions via a firewall with the carpark entry and travelator lobby on Level 1, Level 1M and Level 2 protected on a performance basis; by way of the provision of fire rated walls and fire and smoke curtains.

To determine the performance of the proposed protection of carpark entry opening in the firewall afforded between the retail portions on Level 1, Level 1M and Level 2 and the adjacent carpark by way of the installation of fire and smoke curtains which do not meet the insulation criterion of the FRL, the effect of a worst credible fire scenario originating in each respective functional area must first be established.

12.2.1 FIRE ORIGINATING IN THE CARPARK

In order to assess the potential for a fire to originate within the non-sprinkler protected carpark and spread to the abutting sprinkler protected retail portions on Level 1, Level 1M and Level 2 of the building the level of combustibles inherent within the carpark must first be established.

The combustibles throughout the carpark area throughout the day-to-day operation of Warringah Mall are understood to comprise primarily of motor vehicles (cars). Other combustible associated with building services and pedestrians are considered to be of a minor nature and would not be expected to create a significant fire unless they involved motor vehicles or were the result of arson.

Level 2 carpark is an open to sky carpark with the openings created by travelator and the retail entries not proposed to be protected. The retail portions of the building adjacent to the

open to sky carpark are characterised by relatively large natural ventilation openings which are expected to provide venting of heat and smoke in the event of a fire on Level 2. The Level 2 carpark itself is open to sky and therefore a fire spread between the retail portions of the building is unlikely. In the unlikely event that the fire from the retail portions of the building spreads to a car parked on the rooftop carpark, an adverse impact on the structure located below the fire is not expected.

Figure 12-3: Photograph of retail mall on Level 2 showing the natural ventilation openings from the mall

The carpark area adjacent to the proposed location of fire and smoke curtain is primarily circulation space (refer to **Figure 12-4**), with designated spaces for parked motor vehicles situated a distance from the protected entry. The spatial distance is unlikely to lead to a direct flame impingement on to the fire and smoke curtain for a fire located within the carpark.

Considering that direct flame impingement from a fire within the carpark on the fire and smoke curtain is unlikely to occur, it is expected that the potential rise in temperature of any exposed part of the fire and smoke curtain would result from excessive levels of radiant heat flux from the seat of the fire or via the smoke plume and the resulting hot gases. The inherent fire rating provided by the fire curtains is therefore considered to be able to assist in preventing fire spread from the carpark to retail portions of the building.

It should also be noted that the area on the retail side of the fire and smoke curtains on Level 1 and Level 1M is generally a circulation area or the travelator lobby with the exception of a storeroom and a fire corridor on Level 1 which are both understood to be separated from the carpark by way of BCA DTS compliant fire rated construction. Therefore, whilst the protection

to the entry opening is performance based, it is considered extremely unlikely that a fire would propagate from carpark to the retail portions as a result of excessive temperatures on the non-fire side of the fire and smoke curtains due to combustible materials not being present in close proximity to the smoke curtains on the retail side.

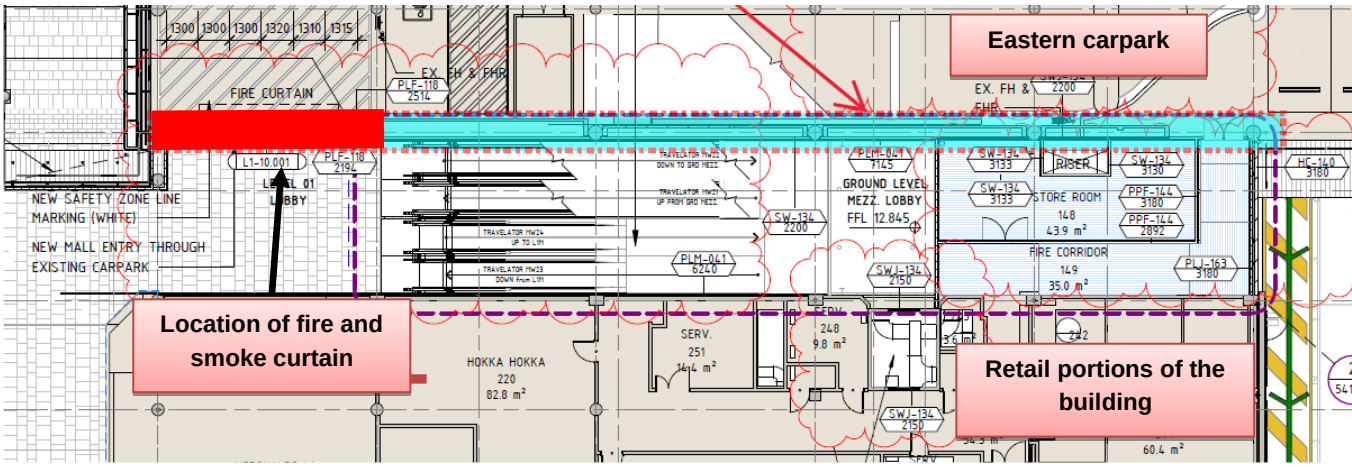

Figure 12-4: Part Level 1 Floor Plan showing the location and configuration of openings within the firewall to be protected with a fire and smoke curtain

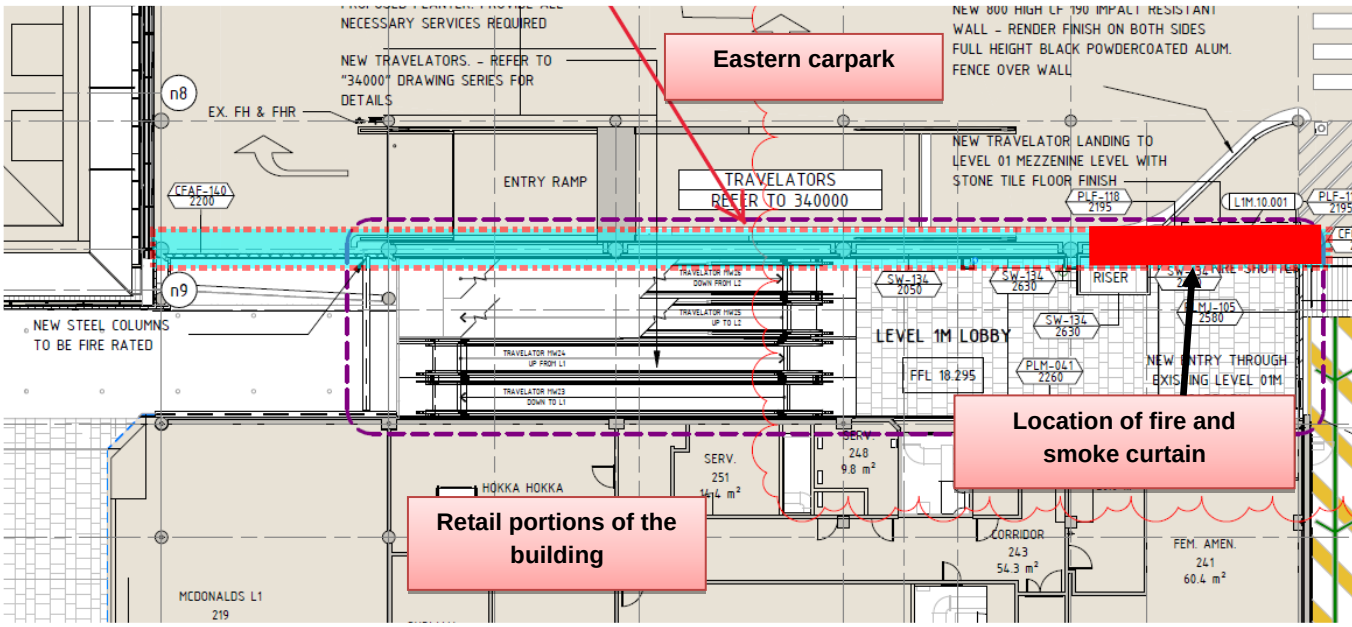

Figure 12-5: Part Level 1M Floor Plan showing the location and configuration of openings within the firewall to be protected with a fire and smoke curtain

12.2.2 FIRE ORIGINATING IN THE RETAIL PORTIONS

The retail portions of Warringah Mall are understood to be protected throughout with an automatic sprinkler system installed in accordance with the base building fire safety strategy. The areas adjoining the carpark entry are generally sterile in nature comprising of pedestrian mall and travelator void.

In the event that a fire originates within the retail mall in proximity of the fire and smoke curtain, it is therefore expected that the provision of the automatic sprinkler system would control and / or extinguish the fire in its incipient stages. In research conducted by H. Marryatt

(1988), upon sprinkler activation, control of the fire via the automatic sprinkler system is achieved in over 99% of fires in sprinkler protected retail buildings. Upon sprinkler activation it is considered unlikely that the temperature of the fire would exceed 200^{o}C [BCC, 2000], with the exception of the areas in the immediate vicinity of the flame, which is understood to be less than the limiting radiant heat intensity required for the failure of the fire and smoke curtain which is understood to have been tested for an integrity rating of 120 minutes.

Considering the above, a fire originating within the retail portions on Level 1 and Level 2 of the building is unlikely to cause the failure of the fire and smoke curtains separating the retail and carparking portions of the building. Therefore, fire spread between the different functional areas of the building with differing FRL requirements for the fire scenario assessed is not expected to occur, which is considered to satisfy Performance Requirements CP1 and CP2 of the BCA.

12.3 CONCLUSION

The assessment found that the proposed design with a performance based protection in the form of fire and smoke curtains forming part of a required firewall between the retail and eastern carpark on Level 1 and Level 2 of Warringah Mall building, is considered to be capable of providing a level of fire safety that achieves compliance with Performance Requirements CP1 and CP2 of the BCA, subject to strict compliance with all the recommendations provided within **Section 11**.

13. PERFORMANCE SOLUTION 2 – TRAVELATORS CONNECT FOUR STOREYS IN LIEU OF THREE STOREYS

13.1 INTRODUCTION

In accordance with the DTS provisions of Clause D1.12(b)(iv) in a Class 5 or 6 building that is sprinkler protected throughout, a travelator that complies with Specification D1.12 can connect any number of storeys. However, in accordance with Clause D1.12(c)(i) a travelator cannot connect more than three (3) storeys if the building is fully sprinkler protected on each storey in accordance with Specification E1.5 and the travelator does not comply with the provisions of Specification D1.12. It should be noted that a travelator is permitted to connect any number of storeys within a carpark.

As part of the proposed modifications to the vertical transportation serving the eastern carpark, a new travelator is proposed to be installed which provides access from all carpark levels to the retail levels on Ground Level, Level 1 and Level 2. The proposed travelator forms part of the carpark fire compartment and is fire separated from retail portions of the building on Level 1 and Level 2. However, owning to the architectural design of the retail portions and travelator entry on Ground Level, a fire separation is not proposed to be provided between the retail portions and the travelator on Ground Level. The non-provision of fire separation between the travelator and the retail portions of the building on Ground Level does not comply with the DTS provisions of Clause D1.12(b)(iv) of BCA 2019 Amdt 1. The location of the travelator in relation to the retail areas of the building is shown in below. A section through the travelator void showing connections to the building carpark and retail levels is shown in **Figure 13-2**.

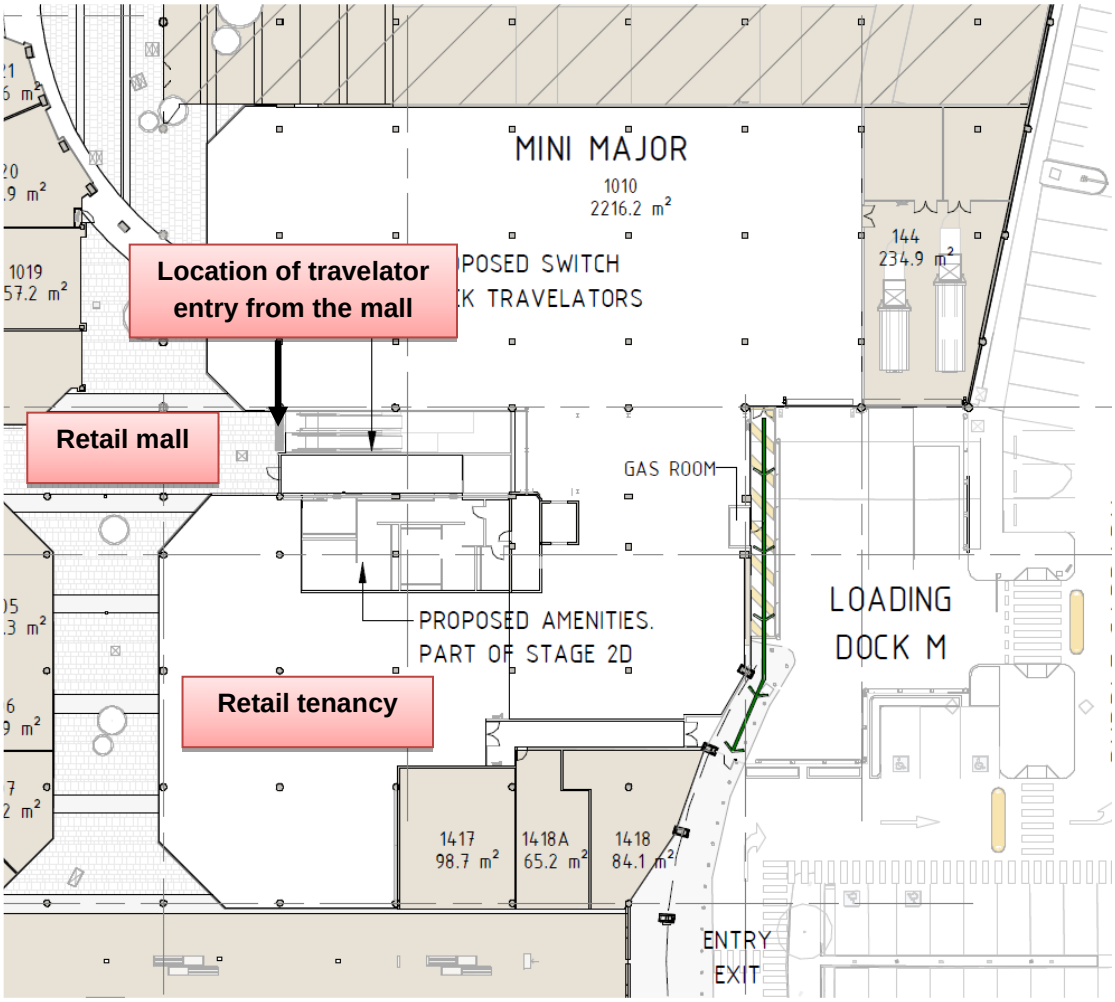

Figure 13-1 Travelator entry on Ground Level where a fire separation between retail portions and the travelator is not provided

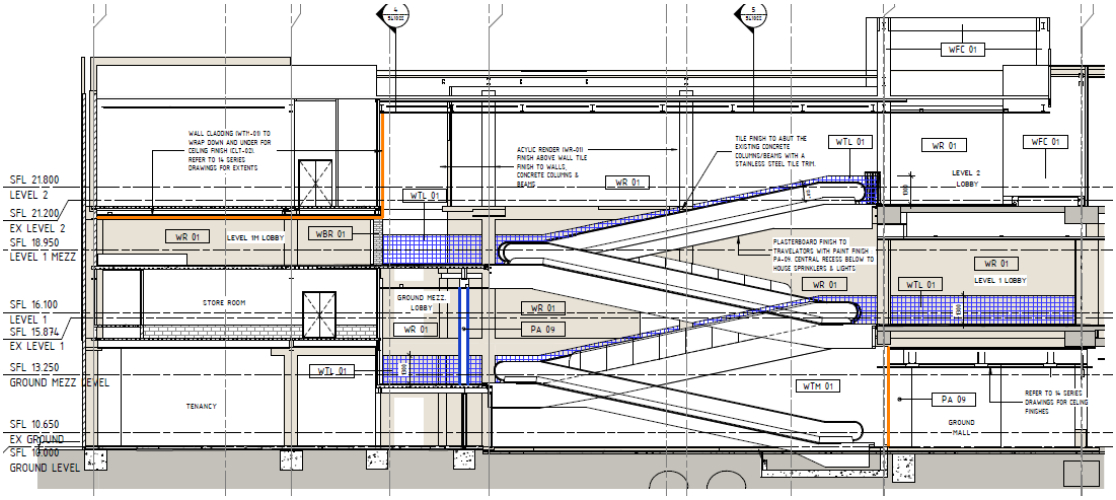

Figure 13-2 Section drawing showing the travelator connection to the building levels

The Performance Requirements of BCA 2019 associated with this issue of non-compliance with the DTS provisions have been identified as CP2 and EP2.2. BCA report to be updated to confirm

A fire safety engineering assessment has been undertaken to analyse the identified issue of non-compliance to determine whether the proposed design of the travelator with connection to the Ground Level retail provides a level of life safety required to achieve compliance with Performance Requirements CP2 and EP2.2 of the BCA 2019 using qualitative comparative analysis, in accordance with BCA Assessment Method A2.2(2)(d).

13.2 INTENT OF THE BCA

To make an assessment of whether travelators that connect four (4) storeys and are not constructed in accordance with Specification D1.12 achieve compliance with Performance Requirements CP2 and EP2.2 the intent of the BCA must first be understood.

The intent of Performance Requirement CP2 is to prevent fire spread through the building. The Guide to the BCA indicates that "*the BCA recognises that different building elements require differing degrees of protection to avoid the spread of fire*". The Guide also highlights that compliance with the DTS provisions in regards to fire separation "*is not compulsory if alternative means can be found to satisfy the appropriate authority that the Performance Requirements will be achieved*". This provision is intended "*to allow the appropriate authority to determine the degree of compliance necessary in each particular case after considering each building scenario*".

The intent of Performance Requirement EP2.2 is to provide occupants with sufficient "*time to evacuate before the onset of untenable conditions*". The Guide to the BCA identifies the untenable conditions as "*dangerous temperatures, low visibility and dangerous levels of toxicity*".

From the above it is evident that buildings must be provided with elements that will prevent fire and smoke spread throughout the building and provide occupants with safe means of egress from the fire affected areas, as well as facilitating safe access to the fire affected areas by the fire brigade's personnel. However, to understand how travelators that are not built in accordance with Specification D1.12 could impact on safe evacuation of the occupants the intent of Clause D1.12 must be understood.

In accordance with the Guide to the BCA the intent of Clause D1.12 is to restrict "*the number of storeys which can be interconnected by a non-required non-fire-isolated stairway, ramp or the like*. *This recognises that an unprotected opening for a stairway, ramp, travelator or the like can lead to the spread of fire or smoke from one floor to another".*

From the above it is evident that if it can be demonstrated to the appropriate authorities that a particular travelator void will not contribute to fire and smoke spread through the building more than would be the case permitted under a base case DTS compliant design, then the design could be considered to satisfy the relevant Performance Requirements of the BCA on an equivalence basis.

13.3 METHODOLOGY

Clause A2.2(1)(b) of BCA indicates that Compliance with the Performance Requirements of the Building Code can be achieved by formulating an "Performance Solution" that is shown to be at least equivalent to the "Deemed-to-Satisfy" provisions of the BCA.

Therefore, the adequacy of the alternative design is assessed by comparing the level of fire safety inherent within the Proposed Design to that of a Base Case Design complying with the DTS provisions of the BCA. To establish this, a qualitative and quantitative comparative analysis is undertaken generally in accordance with the methodology outlined in the

International Fire Engineering Guidelines. The analysis compares the fire safety performance of the Proposed Design (travelators not constructed in accordance with Specification D1.12 connecting four (4) levels, with Retail portions of Level 1 and Level 2 being fire separated from the travelator/travelator void by fire-rated construction) to a BCA DTS compliant design (travelators not required to be constructed in accordance with Specification D1.12 and connect three (3) retail levels or one which connects more than four (4) non-sprinkler protected carpark levels, none of the levels is fire separated from the travelator void and all levels open within the confines of the building.

It must be noted that the level of fire safety inherent within a BCA DTS compliant Base Case Design is considered to represent an acceptable community standard for new building works throughout Australia.

13.4 ACCEPTANCE CRITERIA

From the discussion provided in **Section 13.2** it is evident that the number of storeys that can be connected by travelators that are not constructed in accordance with Specification D1.12 is limited to three (3). This limitation on the number of levels connected by open travelators is aimed at limiting the number of levels that would be affected by fire and smoke as a result of smoke spread between levels through unprotected travelator voids.

If it can be demonstrated that travelators connecting four (4) levels will not contribute to fire and smoke spread throughout the building to a greater degree than travelators connecting three (3) storeys of sprinkler protected retail use or more than four (4) storeys of a non-sprinkler protected carpark in a BCA DTS complying design, then the identified performance requirements are considered to be satisfied.

Therefore, the acceptance criterion for this assessment is:

- ***The number of levels adversely affected as a result of fire and smoke spread between levels via the travelator void in the Proposed Design must be less than or equivalent to that inherent to the BCA DTS complying design***.

13.5 COMPARATIVE CHARACTERISTICS OF BCA DTS COMPLIANT BASE CASE DESIGN AND THE PROPOSED PERFORMANCE BASED DESIGN

To evaluate the performance of the proposed travelator design which connects up to four (4) storeys of non-sprinkler protected open deck carpark levels with the travelator open to the sprinkler protected retail portions on Ground Level against a BCA DTS compliant design where the travelator is permitted to connect either three (3) levels of retail parts or more than four (4) levels of non-sprinkler protected open deck carparks, the characteristics of each design need to be understood. These characteristics are described below:

13.6 PROPOSED DESIGN

In the Proposed Design, travelators that are not constructed in accordance with the provisions of Specification D1.12 connect four (4) levels. The portions of the building which open directly onto the travelator are understood to be retail portion on Ground Level and carparking on Ground Level Mezzanine (Level GM), Level 1, Level 1M and Level 2. Retail portions on Level 1 and Level 2 are to be fire-separated from the travelator void on a performance basis – fire and smoke curtains incorporated in the fire resisting construction to achieve 2 hours fire separation. The carpark levels, which open to the travelator void, have been classified as ‘open deck with perimeter openings for natural ventilation.

The top level is the rooftop car park which is open to the sky and the only enclosed portion connecting to the void on Level 2 is the entry lobby which is required to be generally sterile.

The retail malls are protected throughout with an automatic fire sprinkler system in accordance with the base building fire safety strategy with additional measures to be implemented to improve system reliability.

13.7 BASE CASE DESIGN

In the Base Case Design travelators that are not constructed in accordance with the provisions of Specification D1.12 connect up to three (3) enclosed retail levels or more than 4 carparking levels. All three retail levels are not fire-separated from the travelator void.

The retail levels in the base case design are protected throughout with an automatic fire sprinkler system. The sprinkler system serving the building is not subject to any specific requirements to improve reliability for successful system operation.

13.8 COMPARATIVE CHARACTERISTICS

The comparative characteristics of the Base Case and Proposed Designs can be summarised as illustrated in **Table 13-1** below:

Item	Base Case Design	Proposed Design
Building classification	Class 6/Class 7a	Class 6/7a
Number of levels connected by the travelators	Three Class 6 levels OR Greater than four Class 7a levels	One Class 6 level and four Class 7a levels connected (one Class 7a levels is open to sky)
Number of levels that are fire separated from the travelator void	None	Travelator void is fire separated from Retail Level 1 and Retail Level 2
Type of fire separation between the levels and the travelator void	None	Fire rated walls and fire and smoke curtains separate Retail Level 1 and Retail Level 2 to achieve 2 hours fire separation
Fire suppression throughout the shopping centre and carparks	Automatic sprinkler system to all retail areas Carpark levels are open deck and therefore do not require sprinkler protection	Automatic sprinkler system to all retail areas Carpark levels are open deck and therefore do not require sprinkler protection
Smoke hazard management	Mechanical smoke hazard management system provided to NSW Table E2.2b and Specification E2.2b; provides smoke exhaust from all three (3) levels Natural ventilation provided on the carpark levels	Natural smoke ventilation to achieve extended tenability. Mall areas adjacent to the travelator void are characterised by relatively large natural openings providing effective smoke ventilation Natural ventilation provided on the carpark levels

Item	Base Case Design	Proposed Design
Fire Load in areas adjoining the travelator	No control of fire load – retail tenancies and/or enclosed malls/tenancies/food court may open directly on to the travelator void	The retail areas on Ground Level which open on to the travelator void are mall and amenities spaces with low fire loading present

Table 13-1: Comparative characteristics of the Base Case and Proposed Designs

13.9 ASSESSMENT

This assessment will analyse whether in the Proposed Design fire spread is likely to occur to a degree that is lesser or at least equivalent to that in a BCA DTS complaint Base Case Design, and whether occupants are afforded with evacuation routes that are untenable to the degree that is greater or at least equivalent to that afforded by a BCA complaint Base Case Design. Therefore, this assessment will compare the performance of the Base Case and Proposed Designs in two categories: the potential for fire and smoke spreading between levels via the travelator void, and the expected impact of fire and smoke spread via the travelator void on occupant evacuation and fire brigade intervention.

13.9.1 POTENTIAL FOR FIRE AND SMOKE SPREAD

An important factor of a fire safety engineering assessment is identifying appropriate fire scenarios. These scenarios are identified by considering fire hazards present and their potential consequences. The process of fire scenario selection is based around identifying those fire scenarios which might be considered “worst credible” that is having the following aspects:

a) The most likely; and

b) Having the worst impact or consequence; and/or

c) Highlighting the performance of the identified areas of non-compliance during a fire emergency.

In the proposed design, it is the connection of Ground Level retail portions to the travelator which result in the identified non-compliance and therefore considering the criteria described in a), b) and c), the following fire scenario is considered to be relevant:

- **Fire originating on Ground Level (retail for the proposed design and carpark in the BCA DTS compliant base case design) in close proximity to the travelator entry; and**

Level	Fire scenario	Performance	
		Base Case Design	**Proposed Design**
Ground Level	Fire in the sprinkler protected retail in proposed	A vehicle fire in proximity to the travelator located within a non-sprinkler protected carpark with natural ventilation openings located remote from the fire location may lead to	The retail portions adjoining the travelator are areas with low fire load mall and amenities areas protected with compliant automatic sprinkler protection and are provided

Level	Fire scenario	Performance	
		Base Case Design	Proposed Design
	design; and Fire in the non-sprinkler protected open deck carpark in the BCA DTS compliant base case design	significant levels of smoke entering the travelator void potentially resulting in smoke spread to all upper levels of the building.	with effective natural smoke ventilation.

Table 13-2: Performance of the Base Case and Proposed Designs under different fire scenarios in terms of fire and smoke spread

From **Table 22.2** it is evident that should a fire originate on the Ground Level in a non-sprinkler protected carpark level in the base case design, significant smoke spread from an uncontrolled fire throughout the travelator void and to all carpark levels is likely.

In the event of a fire in a relatively low hazard sprinkler protected mall or amenities areas which adjoin and open directly into the travelator entry in the proposed design, the fire is expected to either be extinguished or controlled to a relatively minor size due to operation of the sprinkler system and the relatively large natural openings from the mall which are expected to permit ventilation of smoke thereby preventing a significant impact of smoke spread to the travelator void.

In the event of a fire scenario on upper levels, both the Base Case and Proposed Designs are expected to perform similarly; however, in the Proposed Design the number of Levels that can get affected by fire and smoke spread is less than or equivalent to those in the Base Case Design where any number of carparking levels are able to be connected directly via the travelator void.

Therefore, based on the analysis above, a fire within the proposed performance based design with the sprinkler protected and well ventilated low fire load retail area opening to the travelator void is likely to result in a reduced potential for smoke spread to the travelator and the upper carpark levels than in the BCA DTS compliant base case design considered.

13.9.2 IMPACT OF FIRE AND SMOKE SPREAD ON OCCUPANT EVACUATION AND FIRE BRIGADE INTERVENTION

In **Section 13.9.1** it was determined that the potential for fire and smoke spread into and via the travelator void in the Proposed Design is either equivalent or less severe than in the BCA DTS complaint Base Case design.

A fire within the Ground Level retail portions is expected to be either extinguished or controlled from the activation of the sprinkler system. The smoke from a sprinkler-controlled fire provided with natural ventilation is unlikely to cause untenable conditions during occupant evacuation from the Ground Level and prevent extensive smoke spread to the upper building levels via the travelator void.

A control of fire due to the operation of the installed sprinkler system on Ground Level in the proposed design is expected to assist fire brigade in their intervention activities. The extended tenability provided by the naturally ventilated retail portions of the building and reduced potential for fire and smoke spread as discussed above are expected to result in improved conditions during fire brigade intervention. The proposed design also provides a number of access points for fire brigade to enter the building and reach the fire affected area which is also expected to facilitate brigade intervention.

Therefore, the proposed design is capable of resulting in improved occupant tenability in a fire situation than in a BCA DTS compliant design where the fire may remain uncontrolled until fire brigade intervention and this scenario could cause extensive smoke spread throughout all connected spaces.

13.9.3 DISCUSSION

The analysis presented in **Section 13.9.1** and **Section 13.9.2** provides supporting evidence demonstrating that the performance of the Proposed Design is better than or equivalent to the performance of a BCA DTS complaint Base Case Design with respect to fire and smoke spread through the travelator void and into the evacuation routes. Generally the improved performance achieved by the Proposed Design in respect to the travelator connecting four (4) levels, is attributed to the following:

- The Ground Level mall areas which open to the travelator void are generally associated with low levels of fire load being predominantly used for pedestrian movement and amenities; and
- The mall and associated retail and amenities areas are to be protected with automatic sprinkler system with measures required to be implemented to improve its reliability; and
- The mall areas opening on to the travelator void are naturally ventilated and are expected to provide extended occupant tenability from smoke; and
- The Retail Levels 1 & 2 are fire separated from the travelator void which limits the areas opening to the travelator void.

Therefore, the potential for fire and smoke spread between levels through the travelator void and to the evacuation routes in the Proposed Design is either lesser or at least equivalent to that afforded by a BCA DTS compliant Base Case Design, which is considered to satisfy Performance Requirements CP2 and EP2.2 of BCA.

13.10 CONCLUSION

The assessment found that the proposed design with Ground Level retail mall opening directly into the travelator void and the travelator void connecting more than three (3) building levels, is considered to be capable of providing a level of fire safety that achieves compliance with Performance Requirements CP2 and EP2.2 of the BCA when compared to a BCA DTS compliant base case design considered, subject to strict compliance with all the recommendations provided within **Section 11.**

14. PERFORMANCE SOLUTION 3 – EXTENDED TRAVEL DISTANCES AND PERFORMANCE BASED SMOKE MANAGEMENT SERVING TENANCY MM-1010 AND ADJOINING MALL AREAS

14.1 INTRODUCTION

BCA 2019 Amdt 1 sets out the following "Deemed-to-Satisfy" parameters in regards to travel distances and smoke hazard management that would satisfy Performance Requirements DP4 and EP2.2:

- In accordance with Clause D1.4(c)(i) the maximum distance to an exit via a point of choice must not exceed 40m; and
- In accordance with Clause D1.5(c)(iii) the maximum distance between the alternative exits must not exceed 60m; and
- In accordance with NSW Table E2.2b and Specification E2.2b the smoke exhaust rates must be determined in accordance with the provisions of "Figure 2 – Smoke Exhaust Rate" in Specification E2.2b; any smoke compartment greater than 2,000m^2 in floor area must be divided into smoke reservoirs by smoke baffles; and
- In accordance with DTS provisions of BCA 2019 Amdt 1, the natural smoke ventilation must be designed in accordance with Specification E2.2c and AS2665-2001.

As a result of the proposed works associated with the modifications to the Fresh Food Market at Warringah Mall, the following non-compliances have been identified:

- The maximum travel distance to an exit in the areas forming part of Tenancy MM-1010 and the mall areas is up to a maximum of 60m, in lieu of 40m, which does not comply with Clause D1.4(c)(i) of the DTS provisions of BCA 2019 Amdt 1; and
- The maximum travel distance between alternative exits in the areas forming part of Tenancy MM-1010 and the mall areas is up to a maximum of 90m, in lieu of 60m, which does not comply with Clause D1.5(c)(iii) of the DTS provisions of BCA 2019 Amdt 1; and
- The smoke hazard management system serving the mini-major tenancy which is greater than 1000m^2 in floor area is to be designed on a performance basis with respect to the smoke exhaust rates and smoke baffle depths, which does not comply with the requirements of Table E2.2b and Specification E2.2b of the DTS provisions of BCA 2019 Amdt 1; and
- The permanent natural openings are provided in the awning/roof of the mall for smoke ventilation, however, these openings have been designed on a performance basis which does not comply with Specification E2.2c and AS2665-2001.

The Performance Requirements of the BCA 2019 Amdt 1 associated with these issues of non-compliance with the DTS provisions have been identified as DP4 and EP2.2.

A fire safety engineering assessment has been undertaken to analyse these issues of non-compliance and determine whether the proposed design provides a level of life safety required to achieve compliance with Performance Requirements DP4 and EP2.2 of BCA 2019 Amdt 1 using an absolute approach supported by a qualitative, deterministic analysis, in accordance with BCA Assessment Method A2.2(2)(b)(ii).

14.2 METHODOLOGY

The approach used to meet Performance Requirements DP4 and EP2.2 of the BCA is in accordance with Clause A2.2(1)(a) of BCA 2019 Amdt 1, which requires a "Performance Solution" to demonstrate that the subject design complies with the Performance Requirements of the BCA. The documentary evidence used to support this "Performance Solution" is based on an absolute approach, where a quantitative, deterministic fire safety engineering assessment was conducted in accordance with the procedures outlined in the *International Fire Engineering Guidelines*.

The methodology adopted is a comparison of the Available Safe Egress Time (ASET) versus the Required Safe Egress Time (RSET) to determine whether there is an adequate safety margin for the occupants to evacuate the tenancy, taking into account the proposed extended travel distances to an exit and between alternative exits, and the performance based smoke hazard management system with respect to the exhaust capacity and smoke baffle depth serving the new mini-major tenancy (MM-1010) and permanent natural smoke ventilation openings in the awning/roof over the mall at Warringah Mall. The assessment also takes into account whether non-hazardous conditions for internal fire-fighting are maintained.

14.3 ACCEPTANCE CRITERIA

It is recognised that the fire engineering methodology to be followed in the production of this assessment results in an idealisation of possible real fire scenarios and likely outcomes. An output arising from the methodology is the margin between the Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET) values. This can be considered as a measure of the level of life safety inherent in a particular building design. The level of risk increases as the margin decreases, particularly when the design results in a negative margin, as shown by **Figure 14-1** which illustrates the typical relationship between risk and ASET versus RSET margin.

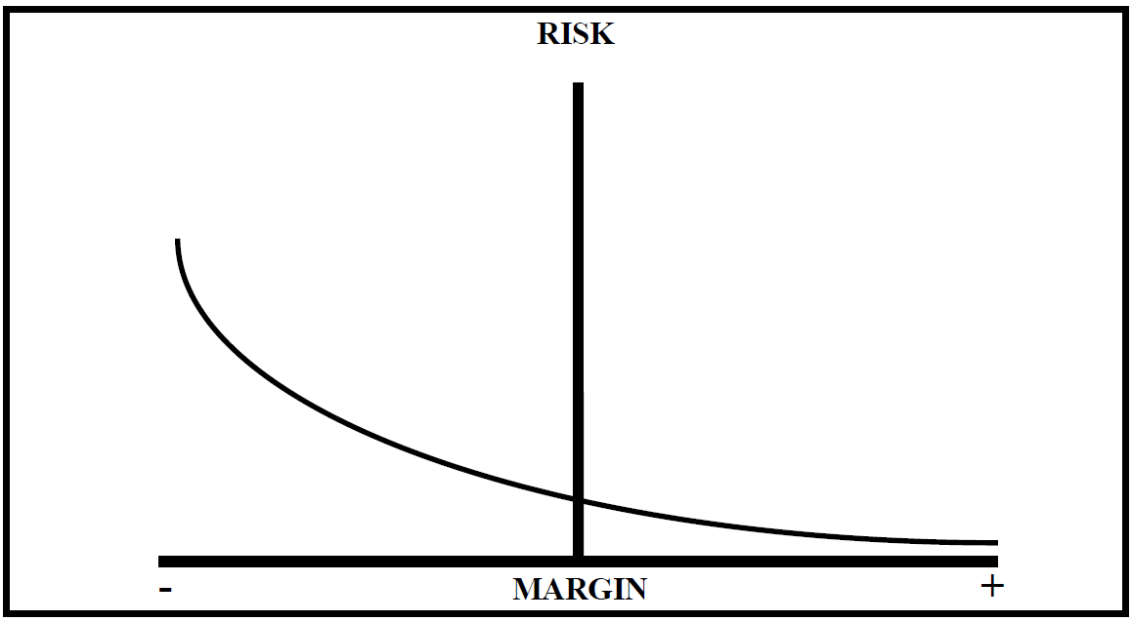

Figure 14-1: Typical relationship between risk and ASET versus RSET margin

Therefore, the acceptance criterion for this assessment is:

- ***ASET calculated for the reasonable worst credible redundancy fire scenario must be better or at least equivalent to the RSET for the reasonable worst credible redundancy fire scenario:***

$$ASET_{rfs} \geq RSET_{rfs}$$

- ***ASET calculated for the design fire scenario must be better than or at least equivalent to the RSET for the design fire scenario incorporating a safety factor of 1.5:***

$$ASET_{dfs} \geq 1.5 \times RSET_{dfs}$$

14.4 ENGINEERING TOOLS USED

This assessment uses a computational fluid dynamics (CFD) computer model FDS6 to predict the time during which tenable conditions are likely to be maintained in the escape routes within the proposed Tenancy MM-1010 and mall areas associated with the Fresh Food Market which are subject of the proposed modifications, and to assess the performance based smoke hazard management system with respect to the exhaust capacity, natural air openings and smoke baffle depth serving the tenancy in the event of a worst credible fire scenario.

The time to activation of automatic fire sprinklers and smoke detectors was established using the detector activation module "*Sprinkler*" from the computer fire modelling package *"FireWind 3.5"* [FMC, 2003].

The movement time component of the Required Safe Egress Time (RSET) was determined using people movement simulator Pathfinder and time for passage calculations.

14.5 GENERAL PARAMETERS FOR THE ASSESSMENT

The following assessments determine whether the proposed building design is capable of satisfying the following nominated fire safety objectives:

- **Safe evacuation of building occupants in the event of fire; and**
- **Internal Fire & Rescue NSW intervention in the event of fire.**

14.5.1 AVAILABLE SAFE EGRESS TIME (ASET)

The Available Safe Egress Time (ASET) for the proposed MM-1010 Tenancy and Fresh Food Market mall area is determined through smoke movement modelling of the design fire scenarios using the field model Fire Dynamics Simulator (FDS).

The input parameters implemented into the FDS program are specified in **Section 14.5.1.1**, provided below, with the output data from smoke modelling presented in **Section 19**–**Appendix "C"** of this report.

14.5.1.1 FIRE & SMOKE MODELLING INPUT PARAMETERS

In CFD modelling where the smoke layer is not expected to remain stratified as opposed to zone modelling, it is paramount to establish parameters (input data) that would correctly reflect the amount of toxic volatiles and the soot yield of smoke produced during the combustion process, as these will determine the tenability of the environment through which occupants might have to evacuate.

Fire Engineering Professionals Pty Ltd had undertaken surveys of different retail outlets to establish the mix of combustible materials typical of particular tenancies. Based on the outcomes of the survey the percentage by weight of different combustible materials was established and a mixed chemical composition, heat of combustion and soot yields were derived for a variety of tenancies. These results have been combined with the "*Practice Note for Design Fires*" prepared for the Society of Fire Safety, Engineers Australia [SFS, 2011].

Information from this document and discussions with Fire & Rescue NSW considered a high soot yield shall be used as part of the CFD input parameters for fire scenarios.

CFD modelling does not account for any deposition of soot on the ceiling and walls. A recent study has shown that up to 37% of soot maybe deposited on the ceiling which is not accounted for in CFD modelling using Fire Dynamics Simulator. A 25% proposed reduction in soot yield input for the CFD modelling to account of deposition on ceilings and walls is used in this fire engineering study.

Based on the outcomes of the survey and the Practice Note for Design Fires, the CFD input parameters for the fire scenarios are reflected in **Figure 14-2**, below.

	Cellulosic	**Polyethylene / Polypropylene**	**Polyester / Nylon**	**Polystyrene**	**Polyurethane**	
% by weight	25.0%	25.0%	25.0%	15.0%	10.0%	
Applications	Desks, shelving, cartons, natural fibres, paper, etc.	Plastic wrapping, hard plastic items (toys etc), plastic bottles/cuttlery and containers, stationary items, etc.	Synthetic fibre, clothes, cushion fillings, etc.	Foam packaging (generally low weight), styrofoam cups, etc.	Spandex (minor quantities in clothes), some foam, etc.	**Average Value**
Chemical composition	$CH_{1.7}O_{0.72}N_{0.001}$	$CH_{1.5}$	$CH_{1.6}O_{0.20}N_{0.1}$	CH	$CH_{1.8}O_{0.3}N_{0.06}$	**$CH_{1.53}O_{0.26}N_{0.03125}$**
Heat of combustion (MJ/kg)	17.0	43.5	32.5	39.0	27.0	**31.8**
Soot yeild (g/g)	1.50%	6.00%	8.00%	16.00%	15.00%	**7.78%**
					Less 25% soot deposition =	**5.83%**
					Used for CFD modelling	

Figure 14-2: Input parameters for CFD modelling for the Tenancy MM-1010 and Fresh Food Market mall areas at Warringah Mall

14.5.2 REQUIRED SAFE EGRESS TIME (RSET)

To establish the Required Safe Egress Time (RSET) the methodology based on **Equation 14-1** can be used. The egress analysis evaluates the time necessary to initiate occupant response to an alarm or cue of a fire and the required time for occupants to reach a safe place in a controlled evacuation.

The RSET is measured from the same point of origin as the fire, that is, from the time of effective ignition. The calculated RSET is the sum of times incurred during the following three stages of the evacuation process:

- ***Cue time*** – time taken from effective ignition to the receipt of a cue by the occupants regarding the presence of a fire. In open plan areas occupants can also receive a cue upon development of a visible smoke layer under the ceiling.
- ***Response (pre-movement) time*** – time which extends from the alarm or cue to the time when occupants decide to evacuate. The degree of training and familiarity with the surroundings, as well as the general nature of the population, has an impact on the response time, together with the type of cue received. This period covers the time for occupants to assimilate the cue, resolve any ambiguity, undertake pre-evacuation actions and commence evacuation.
- ***Egress time*** – occupant evacuation time, which can be calculated on the basis of human walking speeds affected by crowding.

The above can be expressed through **Equation 14-1**, provided on the following page.

$$T_R = t_d + t_{pm} + t_e$$

where:

T_R is the total time of evacuation to a place of safety; and

t_d is the time of occurrence for an automatic or intrinsic fire cue; and

t_{pm} is the pre-movement time; and

t_e is the time necessary for occupants to move to a safe place.

Equation 14-1: Total time to complete evacuation to a place of safety

14.5.2.1 POPULATIONS NOMINATED

Egress calculations were based on the following occupant numbers:

- **Redundancy fire scenarios** – occupant numbers are based on a statistical analysis of population count within Westfield Shopping Centres throughout Australia. This analysis and the population derived therefrom have been used on a number of recent Westfield projects throughout Australia. The statistical analysis provides the worst case population which is expected to be present during the trading-hours in accordance with BCA DTS provisions (i.e. use of other means of calculating population as permitted by Clause D1.13 of BCA) – For the purpose of this assessment, a population density based upon 7.5m^2/person has been adopted. Based upon the trading floor area of the Tenancy MM-1010 and Fresh Food Market mall area at Warringah Mall, the population numbers are as follows:
    - Mini-major tenancy MM-1010 (2216.2m^2) is calculated to contain a total of **296 occupants**.
    - Fresh Food Market Malls – a density of 7.5m^2/person is used in evacuation modelling to calculate overall occupant numbers

For the purpose of this assessment all occupants are considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. These occupants were considered to be awake and conscious at all times when inside the building.

14.5.2.2 CUE TIMES

The cue times were based either on the activation of the fire detection and alarm system comprised of smoke detectors, or the automatic fire sprinkler system, whichever occurred first.

The module "*Sprinkler*" [FMC, 2003a] from the *"FireWind"* suite of programs was used to predict the time of both smoke detector and sprinkler activations.

Smoke Detector Activation – Tenancy MM-1010

The fire detection and alarm system in the new mini-major tenancy (MM-1010) shall be provided with smoke detectors located in accordance with Section 5 of AS1670.1-2018 i.e. 10m spacing between detectors and 5m from walls (based on open ceiling in the tenancy).

The detection time for a given smoke detector, installed on a 10m x 10m grid, is based on the time it takes smoke of sufficient optical density to cover the distance between the axis of the fire plume and the nearest detector. This concept is illustrated in **Figure 14-3**, provided below.

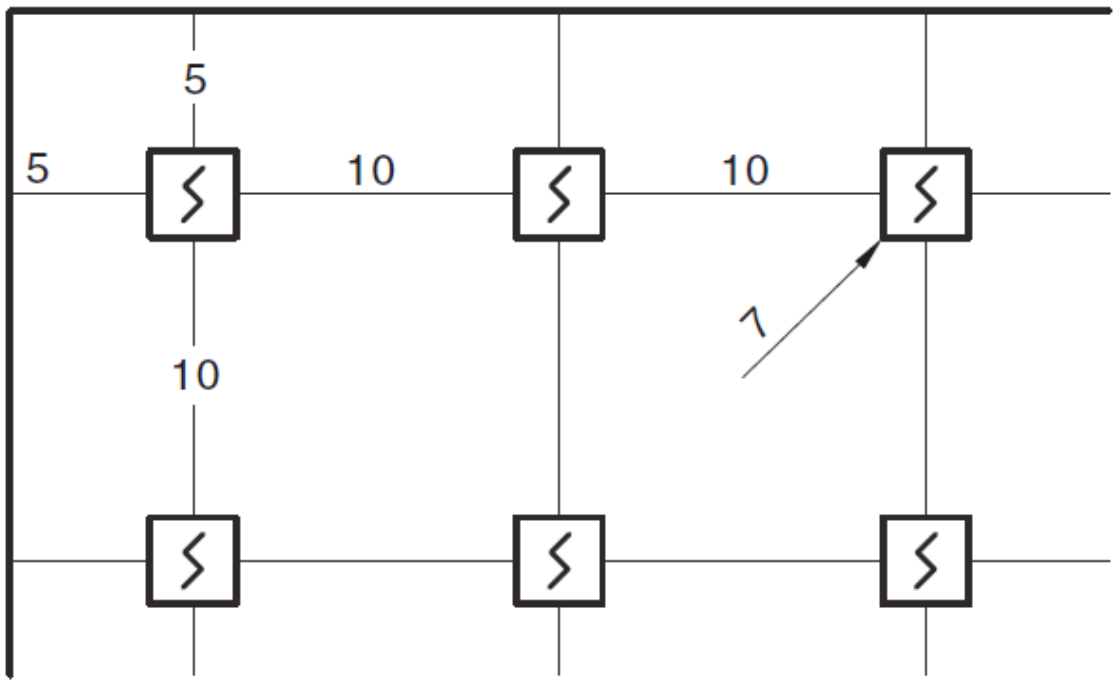

Figure 14-3: Distance from the centre of a fire plume to the nearest smoke detector installed on a 10m x 10m grid

Smoke Detector Activation Fresh Food Market mall areas

The fire detection and alarm system in the Fresh food market mall areas is required to be provided in accordance with Clause 6 of Specification E2.2a of the DTS provisions of BCA 2019 Amdt 1, i.e. the detectors are installed on a 15m x 15m grid.

The detection time for a given smoke detector, installed on a 15m x 15m grid, is based on the time it takes smoke of sufficient optical density to cover the distance between the axis of the fire plume and the nearest detector. This concept is illustrated in **Figure 14-4**, provided on the following page.

The fire detection and alarm system in the Fresh Food Market mall areas is provided in accordance with Clause 6 of Specification E2.2a of the DTS provisions of BCA 2019 Amdt 1, i.e. the detectors are installed on a 15m x 15m grid.

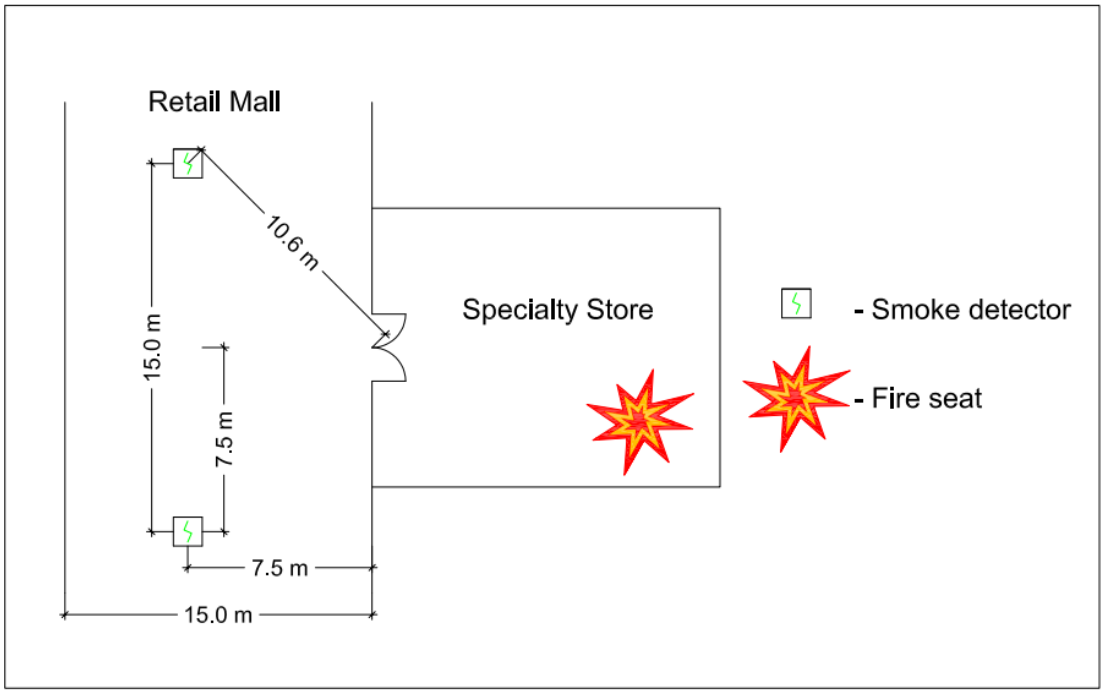

Figure 14-4: Distance from the centre of a fire plume to the nearest smoke detector installed on a 15m x 15m grid

One relatively simple method of predicting smoke detector activation times at different spacing and heights is identified in the International Fire Engineering Guidelines [ABCB, 2005]. This method was developed by Heskestad [1981] and is based on a temperature equivalence model. It suggests that once the temperature at the detector has reached approximately 13^{o}C above ambient the detector is likely to have activated.

Sprinkler Activation

The automatic fire sprinkler system throughout the new or modified areas (including mini-major tenancy) is required to have be provided in accordance with AS2118.1-2017 with sprinkler heads installed on a 3.0m x 4.0m grid.

Sprinkler activation times are based on the distance between the axis of the fire plume and the sprinkler head. In order to incorporate a level of safety into the assessment of the fire controlled fire scenario, the activation time of sprinkler heads closest to the location of fire is considered to be when the “second row” of sprinkler heads activate (i.e. activation of up to five [5] sprinkler heads). This concept is illustrated in **Figure 14-5**, provided on the following page.

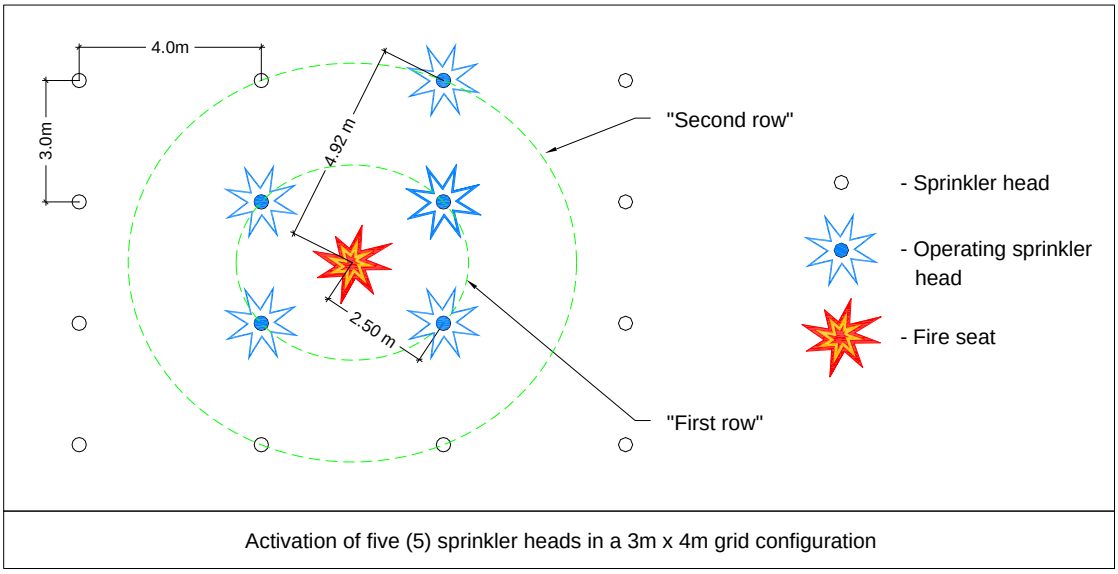

Figure 14-5: Schematic drawing showing the location of the fire and the distances between sprinkler heads

It shall be noted that the depressurisation time – the time lapse between the moment a sprinkler operates and the moment the fire sprinkler system goes into alarm – can be considerable. It is hard to predict the depressurisation time for a large sprinkler system; therefore, all cue times for this assessment will be based on smoke detector system activation.

14.5.2.3 RESPONSE TIME

The response time is the time taken between the moment when the cue is first received and the moment when movement to a place of safety begins. The occupant response time involves the process of interpreting automatic and/or intrinsic cues and identifying them as a cause for evacuation. The response time is dependent upon the type of a cue. For the primary fire/smoke zone the cues may be in the form of:

- Alarm from the detection of smoke from a fire; and
- Sight of smell of smoke (based on a smoke depth which is 10% of the ceiling height); and
- The occupant warning system for the building; and
- Notification and evacuation assistance by shopping centre staff; and
- Movement of a substantial number of occupants from the primary fire affected zone to an adjacent zone during evacuation.

Occupants close to the location of the fire (occupants in the tenancy of fire origin) are expected to respond quicker due to the sight of fire and the strong smell of smoke than occupants remote from the fire (occupants in a tenancy areas away from the seat of fire).

Previous investigations in the occupant behaviour reveal that all occupants do not respond to a fire emergency at the same time. However, it has been observed in all emergency evacuations in shopping centres that the staff assistance plays a critical role in the evacuation of occupants, which results in a reduction of the response time and a more efficient evacuation.

Table 3-13.1 of the SFPE Handbook [Proulx, 2002], reproduced below, provides suggested response times for various occupancies based on the type of warning system within the occupancies, where:

> ***W1***: live directives using a voice communication system from a control room with closed circuit television facility, or live directives in conjunction with well trained, uniformed staff that can be seen and heard by all occupants.
>
> ***W2***: nondirective voice message (pre-recorded) and/or informative warning visual displays with trained staff.
>
> ***W3***: warning system using fire alarm signal with no relevant training.

Table 14-1: Response times as function of occupancy type and warning system

Occupancy type	W1	W2	W3
Offices, commercial, schools, universities	<1	3	>4
Shops, museums, sport and assembly buildings	<2	3	>6
Dormitories, residential mid and high rise	<2	4	>5
Hotels and boarding houses	<2	4	>6
Hospitals, nursing homes	<3	5	>8

The proposed mini-major tenancy and mall areas (including specialty shops) at Warringah Mall is protected with an automatic fire sprinkler, and fire detection and alarm system that are linked to the occupant warning system. The occupant warning system is required to be capable of providing pre-recorded evacuation messaging and allowing for live directives to be broadcast throughout the tenancy and mall areas. The mini-major tenancy is to be provided with staff who are to be trained in emergency procedures and mall areas are understood to be provided with uniformed Westfield security staff and centre management personnel as fire wardens and those inducted in emergency procedures to assist occupant evacuation. Therefore based on the information provided in **Table 14-1**, it is reasonable to assume that pre-movement time throughout the modified shopping centre portions is not exceed 2 minutes, or 120 seconds.

14.5.2.4 OCCUPANT EVACUATION TIME

Fresh Food Market Mall Areas

Occupant travel time is the time taken for the occupants to walk to the exits and eventually to a place of ultimate safety such as an open road. Egress calculations are carried out using program Pathfinder, a well-recognised people evacuation simulation package. The results are considered to be conservative because the modelling process assumes that the first person starts to move towards an exit after the cue and response times have elapsed, whereas in fact some people may commence moving towards the nearest available exit earlier due to direct visual contact with the fire and smoke.

Tenancy MM-1010

The egress analysis has been undertaken to assess both the efficiency of the performance-based smoke hazard management provided within the proposed MM-1010 tenancy,

The travel time during emergency egress in the case of the Tenancy MM-1010 has been calculated on the basis of queuing time, travel distance and the walking speed to reach the exit from the tenancy, which is considered to represent a place of relative safety for the occupants.

The calculation of queuing time has been conducted using **Equation 14-2** [Proulx, 2002] to assess the time for a group of persons to pass a point in an exit route (final egress doors from the various areas).

$$t_p = \frac{P}{(1 - aD)kDW_e}$$

where:
t_p = the time for passage
P = Population
a = 0.266 a constant
D = 2 density in persons per unit area
k = 1.20 a constant
W_e = effective width (Clear Width minus 300mm boundary)
Equation 14-2: Occupant travel time equation

14.5.3 FIRE SCENARIO SELECTION

An important factor of a fire safety engineering assessment is identifying appropriate fire scenarios. These scenarios are identified by considering fire hazards present and their potential consequences. The process of fire scenario selection is based around identifying those fire scenarios which might be considered “worst credible” that is having the following aspects:

a) The most likely; and

b) Having the worst impact or consequence; and/or

c) Highlighting the performance of the identified areas of non-compliance during a fire emergency

Considering the criteria described in a), b) and c) and the specific details of this building, the following fire scenarios have been identified as requiring assessment for the Fresh Food Mall areas and MM-1010 at Warringah Mall:

Table 14-2: Schedule of the design and redundancy fire scenarios

Fire ID	Fire Scenario	Location
DFS-MM-1010-01	Design fire scenario 1 for the Tenancy MM-1010	Fires located in the centre of the tenancy, at the lower ceiling height and remote from the make-up air location (refer to **Figure 14-6**).
RFS-MM-1010-01	Redundancy fire scenario 1 for the Tenancy MM-1010	
RFS-FFM-01	Redundancy fire scenario located in one of the speciality tenancies in the mall area	Tenancy located adjacent to Kmart entry (refer to **Figure 14-7**).
RFS-FFM-02	Redundancy fire scenario located in one of the speciality tenancies in the mall area	Tenancy located adjacent to proposed canopy (refer to **Figure 14-7**).

The location of the fire scenarios identified in **Table 14-2** are shown in **Figure 14-6** and to **Figure 14-7**, provided below.

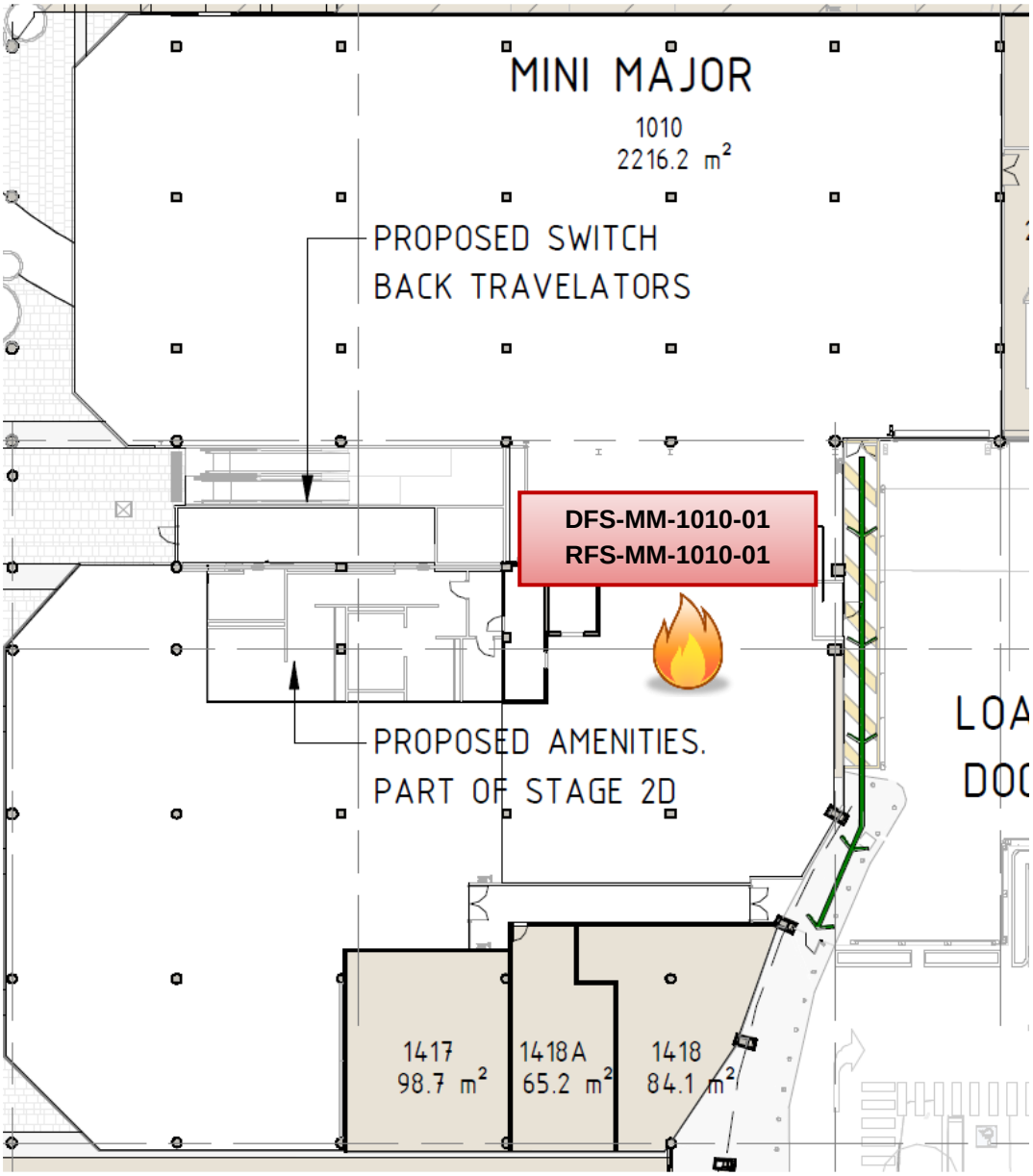

Figure 14-6: Tenancy MM-1010 floor plan – Location of the identified design and redundancy fire scenarios

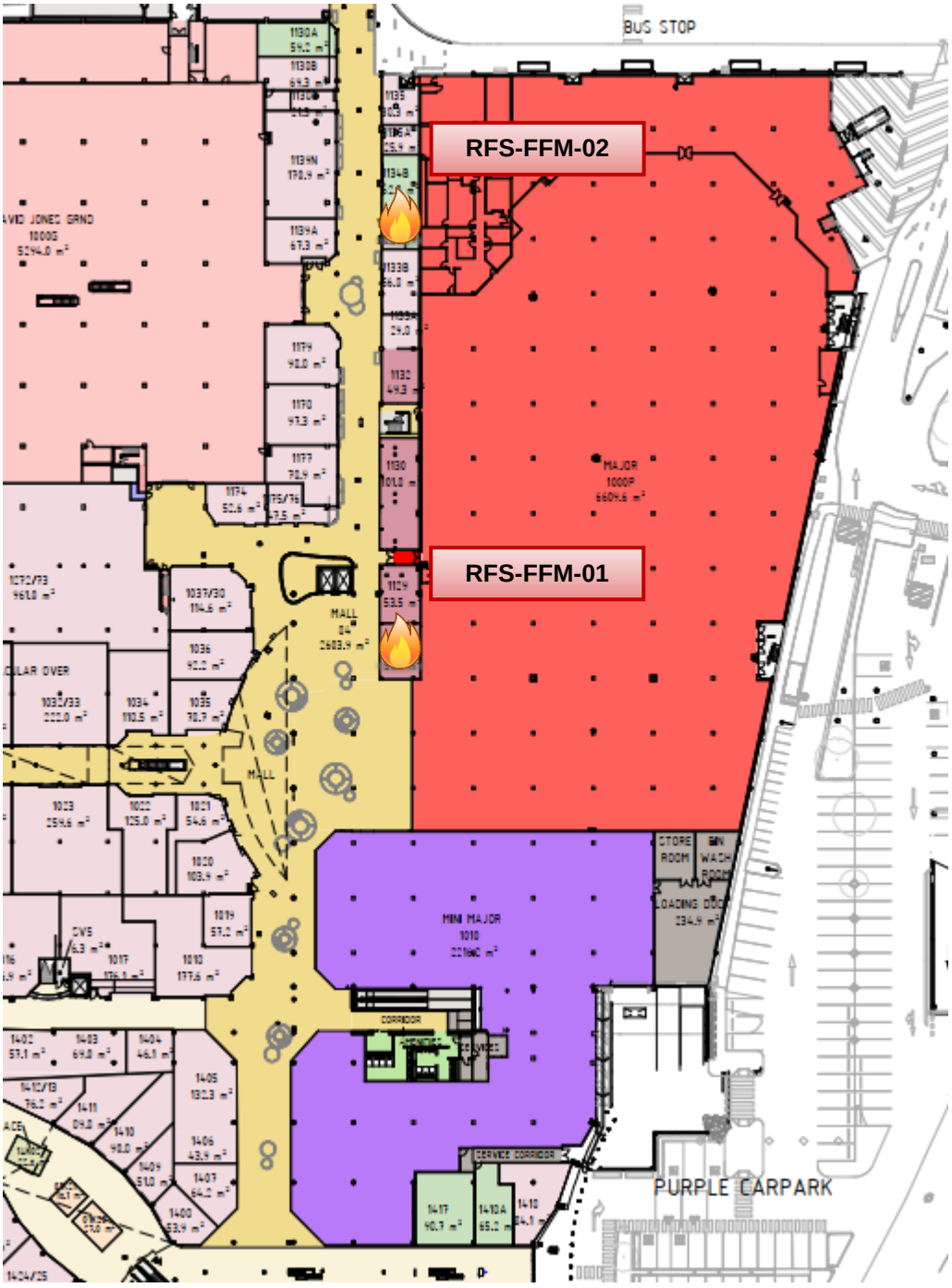

Figure 14-7: Fresh Food Market mall areas – Location of the identified redundancy fire scenario

14.5.4 DESIGN FIRES

There is a large amount of data concerning the burning rates of items and materials; however, rarely this information is sufficiently generic to be universally adopted. Also, what can be representative of current fuel loading for an enclosure may not be the case in the future. Therefore, it would be a rare assessment in which the specific items forming the fuel load had been tested to provide the fire heat release data.

Much experimental work has been carried out on the burning rates. These have been closely examined and translated into a simplified mathematical expression relating heat release to time after commencement of the flaming stage of the fire growth [Buchanan, 2001]. The unpredictable incubation phase of fire development is not included. The basis of the mathematical simplification arises from the fact that the fire growth during the flaming stage can be approximated by a smooth curve that can be expressed mathematically.

Studies of actual fires have led to the adoption of five (5) standard fire growth rates covering a wide range of potential fire scenarios and fuel loads. As noted, the times of fire incubation are not included in the t-squared growth fire models. **Figure 14-8** illustrates the five typical fire growth rates. The design fire curve represents the initial stage of the fire. For nominated fire scenario the design fire is modified to take into the account either the action of the fire suppression measures, or the reduction of the available fuel load, or lack of ventilation. These design fires are used in computer models to determine the smoke spread between the enclosures. It should be noted that there is no or very little reliable data for fires where the rate of heat released exceeds 10 MW. This fire size represents the approximate limit for current test facilities.

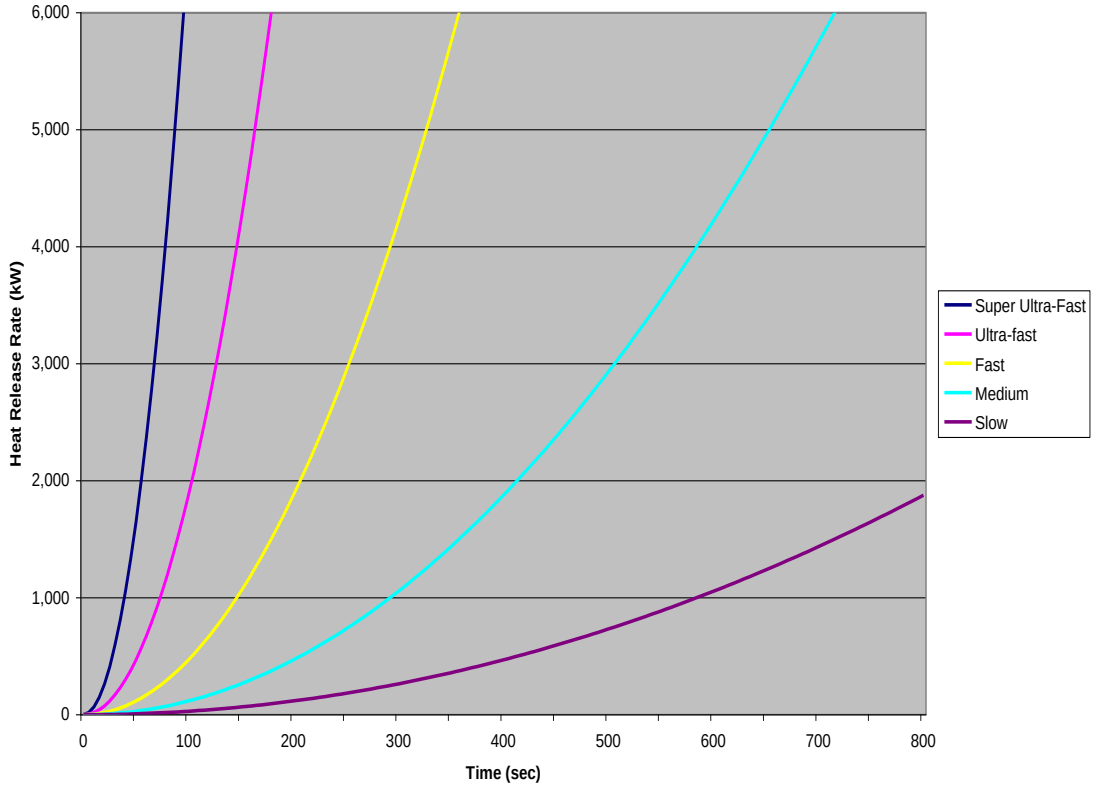

Figure 14-8: t-squared growth rate fires based on test data

In establishing fire scenarios, “fast” t-squared fire growth rates have been generally assumed to be appropriate, as described in the Fire Safety Engineering Guidelines [FCRC, 1996] and FCRC Research Report Project 6 “Fire Safety in Shopping Centres” [FCRRP, 1998].

In all modelled fire scenarios, the height of the fire bed above the floor has been taken as 0.5m, which is considered to represent a realistic fire scenario in a shopping centre environment.

14.5.4.1 SPRINKLER CONTROLLED FIRE SCENARIOS

Sprinkler controlled fire scenarios have been modelled to assess the requirements for smoke hazard management that would enable safe occupant evacuation during an emergency. The assessment aims to demonstrate that tenable conditions (hot smoke layer height and its temperature) are maintained at or above head height within the main escape paths via the mall to the degree necessary to facilitate safe occupant evacuation.

For the design fire scenarios (sprinkler controlled fires) a “fast” t-squared fire growth rate has been selected to represent the initial stage of the fire development before sprinklers activate to control the fire spread and heat release rate production.

For the purpose of the fire engineering calculations the fire is assumed to grow unrestricted until at least five (5) sprinklers are activated, and thereafter it is assumed to remain at a constant heat release rate. This concept is illustrated in **Figure 14-9** below. This is considered to be a conservative estimate, because experiments conducted by Factory Mutual and National Institute of Standards and Technology (NIST) in the past have shown a reduction in heat release rates upon activation of the first sprinklers, and a sound concept, as the following values for sprinkler reliability can be adopted for a soundly managed sprinkler system in accordance with recommendations set out in Fire Code Reform Project 6 [FCRRP, 1998].

- Sprinkler zones associated with specialty shops 98.50%
- Sprinkler zones associated with major stores 99.50%

Sprinkler activation times have been modelled using the “Sprinkler” module within the software package *FireWind 3.5*, and are shown in **Section 18** - **Appendix “B”**.

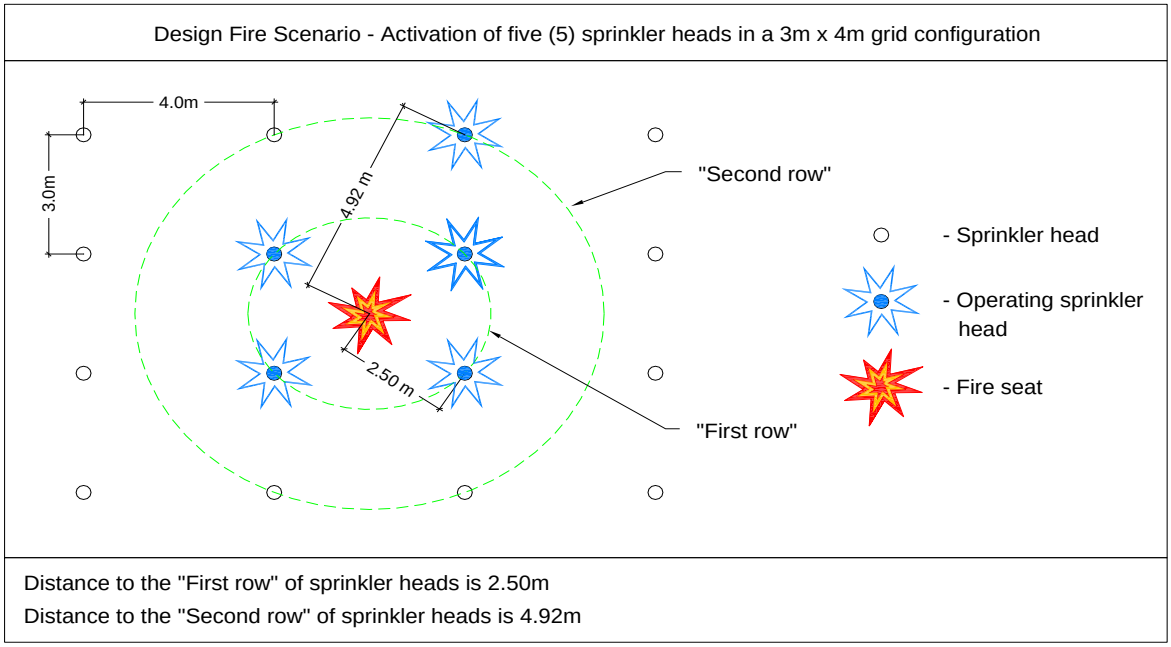

Figure 14-9: Schematic drawing showing the location of the fire and the distances to the sprinkler heads – design fire scenarios

14.5.4.2 REDUNDANCY (SPRINKLERS FAIL TO OPERATE AS DESIGNED) FIRE SCENARIOS

Redundancy fire scenarios have been modelled to assess the requirements for smoke hazard management that would enable safe occupant evacuation during an emergency even if the sprinkler system failed to operate as designed. The assessment aims to demonstrate that

tenable conditions (hot smoke layer height and its temperature) are maintained at or above head height within escape paths to the degree necessary to facilitate occupant evacuation.

For the redundancy fire scenarios (sprinklers fail to operate as designed) a “fast” t-squared fire growth rate has been selected to represent the vertical stage of the fire development. Once the fire reaches a size of 5MW, its growth rate is modified to remain constant. A 5MW fire has been assessed as being the worst credible fire scenario for the Fresh Food Market mall areas and Tenancy MM-1010 areas forming part of the new works, as these areas are generally understood to be designed to BCA provisions, therefore taking into consideration the provisions listed in Figure 2 of Specification E2.2b a sprinkler protected building is permitted to contain smoke hazard management systems to be designed using a maximum fire size of 5MW.

14.5.4.3 FIRE SCENARIOS ASSESSED IN THIS REPORT

Design Fire Scenarios

The Heat Release Rate (HRR) vs. time relationship of the identified design fire scenarios for the Tenancy MM-1010 at Warringah Mall (RFS-MM-1010-01, RFS-MM-1010-01) is based on a “fast” t-squared growth rate fire until the “second row” of sprinklers operates. Thereafter the growth rate of the fire is assumed to remain constant. As detailed in **Section 18** - **Appendix “B”**, the “second row” of sprinklers are expected to activate at 239 seconds (refer to **Table 14-3** and **Figure 14-10**).

Table 14-3: Time vs. Heat Release Rate for the identified design fire scenarios

Time (sec)	Heat Release Rate (kW)
0	0
25	28
50	111
75	250
100	444
150	1,000
200	1,778
203	1,830
900	1,830

The heat release rate over time curve for the identified design fire scenarios is based on **Table 14-3** and is shown graphically in **Figure 14-10**, provided on the following page.

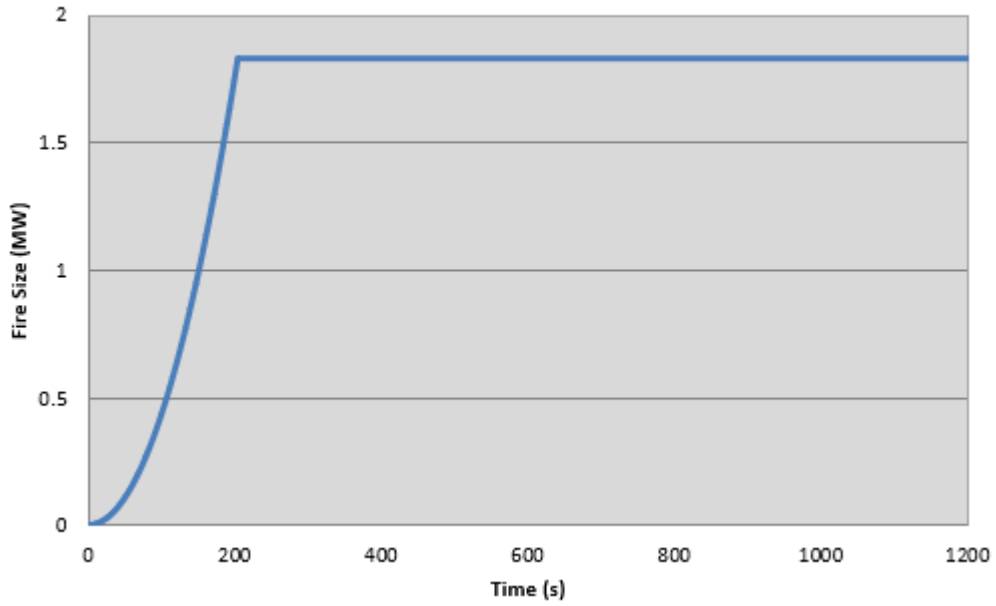

Figure 14-10: Heat Release Rate over time curve of the identified design fire scenarios for the Tenancy MM-1010 at Warringah Mall

Redundancy Fire Scenarios (MM-1010 & Fresh Food Market mall areas)

The Heat Release Rate (HRR) vs. time relationship of the redundancy fire scenario for the Tenancy MM-1010 and the Fresh Food Market mall areas at Warringah Mall (RFS-MM-1010-01, RFS-MM-1010-01, RFS-FFM-01 & RFS-FFM-02 is based on a "fast" t-squared growth rate fire until the fire reaches a maximum of 5MW and thereafter is assumed to remain constant (refer to **Table 14-4** and **Figure 14-11**).

Table 14-4: Time vs. Heat Release Rate for the redundancy fire scenarios

Time (sec)	Heat Release Rate (kW)
25	28
50	111
75	250
100	444
150	1,000
200	1,778
250	2,778
300	4,000
336	5,018
900	5,018

The heat release rate over time curve for the Tenancy MM-1010 and Fresh Food Market Mall areas redundancy fire scenarios is based on **Table 14-4** and is shown graphically in **Figure 14-11**, provided below.

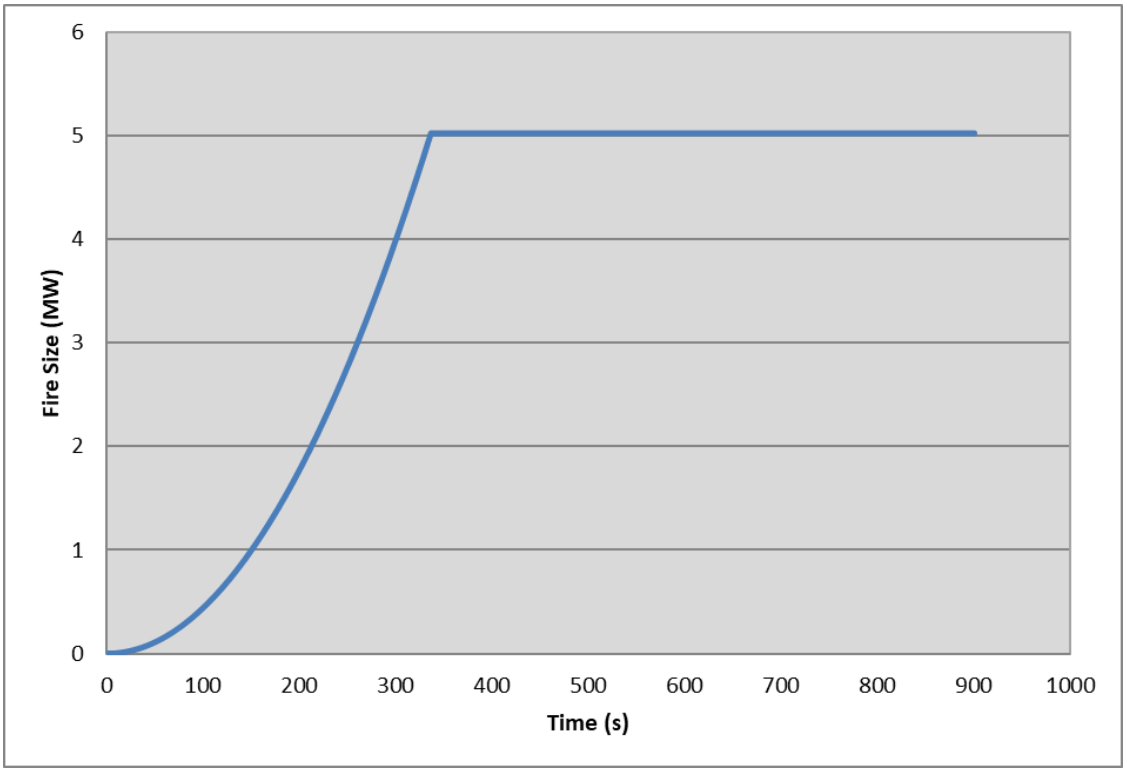

Figure 14-11: Heat Release Rate over time curve of the redundancy fire scenarios for the Tenancy MM-1010 and Fresh Food Market mall area at Warringah Mall

14.5.5 FIRE SCENARIOS SUMMARY

The information regarding the redundancy fire scenarios that will be modelled for the Tenancy MM-1010 and the Fresh Food Market mall area at Warringah Mall are summarised in **Table 14-5**.

Table 14-5: Summary of the redundancy fire scenario

Fire Scenario	Location of Fire	Fire Description
DFS-MM-1010-01	Upper portion of the tenancy	"Fast" t-squared growth rate fire capped off at 239 seconds (2.539MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation with a safety factor of 1.5. FDS modelling. Heat release rate at 900 seconds: 2,539kW Smoke exhaust activation time: 109 seconds (refer to **Appendix "B"**) Limiting criteria: Visibility and temperature (refer to **Section 14.5.6**)

Fire Scenario	Location of Fire	Fire Description
RFS-MM-1010-01	upper portion of the tenancy	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat release rate at 900 seconds: 5,018kW Smoke exhaust activation time: 109 seconds (refer to **Appendix "B"**) Limiting criteria: Visibility and temperature (refer to **Section 14.5.6**)
RFS-FFM-01	Redundancy fire scenario located in one of the speciality tenancies in the mall area (adjacent to Kmart tenancy entry)	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat release rate at 900 seconds: 5,018kW Smoke exhaust activation time: 109 seconds (refer to **Appendix "B"**) Limiting criteria: Visibility and temperature (refer to **Section 14.5.6**)
RFS-FFM-02	Redundancy fire scenario located in one of the speciality tenancies in the mall area (close proximity to new canopy area)	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat release rate at 900 seconds: 5,018kW Smoke exhaust activation time: 109 seconds (refer to **Appendix "B"**) Limiting criteria: Visibility and temperature (refer to **Section 14.5.6**)

14.5.6 LIMITING CRITERIA

To establish the point in time at which the Available Safe Egress Time (ASET) is exhausted the following limiting criteria has been adopted to evaluate the performance of the smoke management systems serving the proposed Tenancy MM-1010 and Fresh Food Market mall area at Warringah Mall.

14.5.6.1 OCCUPANT EVACUATION LIMITING CRITERIA

It is widely accepted that occupants can evacuate safely if the visibility through the smoke stays at above 10m in large spaces and above 5m in smaller spaces and the smoke temperature does not exceed 60^{o}C. Familiarity with the environment plays an important role as well [Purser, 2002].

The above notwithstanding, in experiments conducted by Jin it was determined that people would still walk through non-irritant smoke if the visibility was reduced down to 5m [Purser,

2002]. However, in other experiments [Proulx, 2002] it was established that people would generally turn back if the visibility was around 3m.

The main difficulty with researching this subject is that in many fires in buildings there is a choice between passing through smoke to an exit and turning back to a refuge in a place of relative safety such as a closed room. In some situations people have moved through very dense smoke when the fire was behind them, while in other cases people have failed to move at all. Behaviour may also depend on whether layering permits occupants to crouch down to levels where the smoke density is lower and if low-level lighting is used to improve the visibility. However, it is likely that some people will not move through dense smoke [Purser, 2002].

CFD Models

For the purpose of this assessment, it was assumed that it is acceptable that smoke during a fire simulation descends below the 2.1m benchmark above the finished floor level. However, smoke below this benchmark must satisfy the following limiting criteria:

- Visibility does not reduce to less than 10m and the temperature does not exceed the 60^{o}C benchmark at 2.0m above the finished floor level [Purser, 2002]
    - The minimum acceptable visibility for a small enclosure is 5m (0.2 optical density/m), which for irritant smoke, is that at which people behave as if in darkness. In large enclosures, occupants require much greater visibility to orient themselves and therefore a minimum visibility is required to be 10m (0.1 optical density/m). This visibility relates to an optical density of 1.3dB/m for light reflecting signs and 3.4dB/m for light emitting signs
- Exposure to toxic gases produced as a result of the combustion process
    - It has been observed in several studies that CO concentration is critical in determining the tenability in a smoky environment such as that obtained in a fire scenario. Fire Safety Engineering Guidelines recommends the use of CO concentration as one of the acceptance criteria. However, it has been observed that the mixture of asphyxiant gases (CO, CO_2, low O_2 and HCN) is approximately additive and the tenability for total inhalation of asphyxiant gases can be related to optical density of smoke. It has been recommended that the level of toxic products (asphyxiants and irritants), are unlikely to reach limiting levels for up to 30 mins in situations where the smoke optical density does not exceed 0.1/m (or 10m visibility)
- If travel paths to alternative exits are available from a point of choice, one travel path and/or exit may be completely obstructed by smoke, only if an alternative travel path to an exit is visible, and the temperature in this travel path does not exceed the 60^{o}C benchmark at 2.1m above the finished floor level; or
- If there is no alternative travel path to an exit from a point within the building where occupants are likely to remain in the building, and the visibility in this travel path reduces to less than 10m at 2.0m above the finished floor level, conditions are considered to be tenable provided visibility is not reduced to less than 5m over an area of up to 25m^2.

14.5.6.2 FIRE BRIGADES INTERVENTION LIMITING CRITERIA

The limiting criteria for the internal Fire Brigade's intervention during the worst credible design fire scenarios are outlined in **Table 14-6**. The values indicated in **Table 14-6** are described in

the Australasian Fire Authorities Councils Fire Brigade Intervention Model (FBIM) as the limiting conditions for fire-fighters in full turnout gear [AFAC, 1997].

Table 14-6: Maximum critical radiant heat flux allowed for fire brigades personnel in their protective clothing

Tenability Criteria	Limiting Value for Fire-fighters
Heat Radiation @ 1.5m AFFL	1 kW/m^2 for 25 minutes exposure
	3 kW/m^2 for 10 minutes exposure
	4.4 kW/m^2 for <1 minute exposure

It shall be noted that the limiting criteria for fire brigade intervention applies to the design fire scenarios considered in this assessment. It does not apply to uncontrolled fire scenarios, as it is unreasonable to expect that Fire & Rescue NSW personnel will be able to undertake internal search and rescue activities inside the store of fire origin when sprinklers fail to operate and the fire develops uncontrolled before the Fire & Rescue NSW arrival. In redundancy fire scenarios it is expected the Fire & Rescue NSW intervention activities will be limited to protection of exposures and prevention of fire spread throughout the building.

14.5.7 SAFETY FACTORS

The *Fire Engineering Guidelines* specify that ASET should be greater than RSET x λ_{esc}, where λ_{esc} is a factor of safety incorporated to ensure conservatism in the analysis of the reasonable worst credible fire scenario. There should be a margin incorporated in this to account for uncertainty and the potential consequence of any deficiencies in the analysis. The safety factor λ_{esc} is usually taken to be between 1 and 2.

Given that considerable conservatism has been built into the quantification of the worst credible fire scenario, it is not considered appropriate to add significantly to this conservatism by requiring a high safety margin. A margin 50% greater than that of the RSET is considered appropriate. Hence the criterion for acceptability of an outcome from a time-line analysis for the credible worst case fire scenarios is:

$$\mathbf{ASET_{dfs} \geq 1.5 \times RSET_{dfs}}$$

For a redundancy fire scenario a safety factor of 1.0 (i.e. no safety factor) is applied. Therefore the criterion for the redundancy fire scenario is:

$$\mathbf{ASET_{rfs} \geq 1.0 \times RSET_{rfs}}$$

14.6 ASSESSMENT FOR TENANCY MM-1010

In the following assessment, the output data from the smoke development and egress modelling undertaken for the proposed Tenancy MM-1010 on Ground Level at Warringah Mall is analysed to establish whether the smoke hazard management system is capable of maintaining tenable conditions during occupant evacuation of the Tenancy MM-1010 in a fire emergency and Fire & Rescue NSW intervention.

To simulate fire scenarios in Tenancy MM-1010 at Warringah Mall, a 3D model of the tenancy was built in FDS6. The model incorporates the major obstructions present in the tenancy (such as walls, baffles and balustrades), as well as make-up air openings and smoke exhaust grilles. The addition of these features within the building aims to improve the accuracy of the FDS6 modelling.

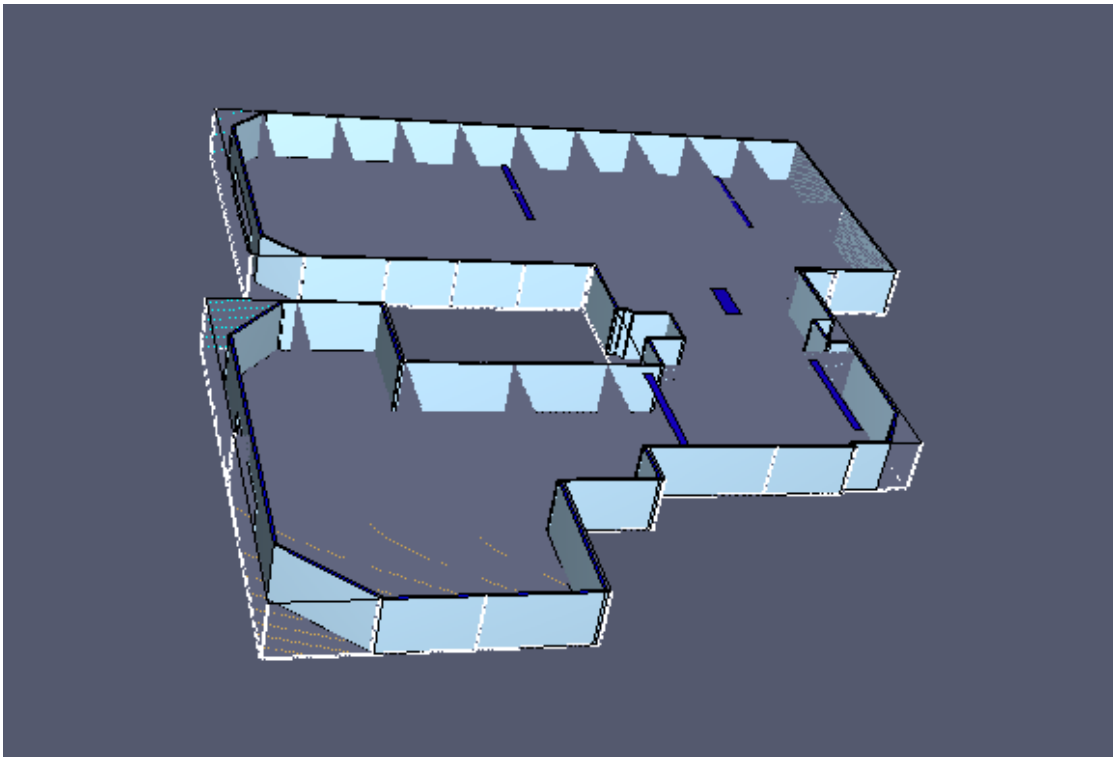

Figure 14-12: 3D model of the **Tenancy MM-1010** used for FDS simulations

14.6.1 REQUIRED SAFE EGRESS TIME

In carrying out the egress analyses for the proposed the Tenancy MM-1010, the total time required for evacuation is calculated by establishing three components of egress, namely cue time, occupant response time and travel time. These components are discussed below.

14.6.1.1 CUE TIME

As outlined in **Section 14.5.2.2**, the cue time for this assessment was based on smoke detector activation. Based on the analysis of the output data from smoke detector activation time (refer to **Section 18 - Appendix "B"**) the detectors installed in the main trading area of Tenancy MM-1010 are expected to activate at **84 seconds** after the fire starts, excluding any delays resulting from alarm verification.

14.6.1.2 RESPONSE TIME

As outlined in **Section 14.5.2.3**, the response time for this assessment is conservatively taken as 120 seconds, which is based on the data provided in **Table 14-1**.

14.6.1.3 TRAVEL AND QUEUING TIME

The total population for the tenancy based on a statistical analysis of population count within Westfield Shopping Centres throughout Australia (i.e. 7.5m^2/person). Considering the Tenancy MM-1010 has a total floor area of approximately 2,210m^2, the total number of occupants was calculated to be 879. It should be noted the entire population has been located within the main trading area.

Based on the output data from the occupant evacuation data, the total egress time for the Tenancy MM-1010 egress model was **45 seconds** (refer to **Section 19** - **Appendix "D"**).

14.6.1.4 EGRESS TIME

The total predicted required safe egress time for the Tenancy MM-1010 is shown in **Table 14-7**, provided below.

Table 14-7: RSET for Tenancy MM-1010 at Warringah Mall

Egress Model	Cue Time	Pre-movement Time	Egress Time	RSET	RSET with 1.5 safety factor
Tenancy MM-1010	84 seconds	120 seconds	45 seconds	249 seconds	374 seconds

14.6.2 FIRE SCENARIOS

The fire growth rate for the design and redundancy fire scenarios for the Tenancy MM-1010 was based on input parameters outlined in **Section 14.5.1.1**.

14.6.2.1 AVAILABLE SAFE EGRESS TIME

Following the analysis of the output data presented in **Section 19 – Appendix "C"** and based on the limiting criteria as outlined in **Section 14.5.6**, the ASET for the fire scenarios are predicted to be as shown in **Table 14-8**.

Table 14-8: ASET for the design and redundancy fire scenario in the Tenancy MM-1010

Fire scenario	Area assessed	Onset of untenable conditions
RFS-MM-1010-01	Tenancy MM-1010 main trading floor	380 seconds
DFS-MM-1010-01	Tenancy MM-1010 main trading floor	>480 seconds

*Note: * Local untenable conditions within close proximity of the fire are observed, however, occupants are expected to have moved away from the immediate location of fire origin prior to the onset of untenable conditions; and*

*It should also be noted that Tenancy 1010 features two (2) mall entries which will likely be able to be utilised in the event of a fire. The CFD modelling in **Section 19 – Appendix "C"** shows that fires in the upper and lower portions of the tenancy quickly result in untenable conditions at one of the two exits; however it is expected that occupants within close proximity to the fire would be alerted to the fire sooner and evacuate before the conditions became untenable.*

** *In accordance with the limiting criteria established in **Section 14.5.6**, it is considered that a reduced visibility of approximately 5m is appropriate for use as the limiting criteria for occupants who are queuing at exits.*

14.6.3 ASET VERSUS RSET COMPARISON

The results from evacuation modelling provided in **Section 14.6.1** show that the evacuation of the Tenancy MM-1010 is completed after the time shown in **Table 14-7**. The CFD modelling conducted shows that tenable conditions exist within the Tenancy MM-1010 in excess of the

required time for evacuation for the identified reasonable worst credible fire scenario assessed, with the addition of the applicable safety factor (where applicable).

Based on the information provided in **Table 14-7** and **Table 14-8** the ASET for the redundancy fire scenario is compared to the RSET in **Table 14-9**, below.

Table 14-9: ASET vs. RSET comparison for the identified fire scenarios in the Tenancy MM-1010

Fire Scenario	ASET	RSET	ASET vs RSET
RFS-MM-1010-01	>480 seconds	249 seconds	>1.5
DFS-MM-1010-01	380 seconds	249 seconds	>1.0

Based on the comparison of the predicted ASET and RSET for the identified reasonable worst credible design and redundancy fire scenarios for the Tenancy MM-1010, presented above, it is considered reasonable to conclude that the dedicated smoke hazard management system adequately facilitates the safe evacuation of the evacuating occupants.

14.7 ASSESSMENT FOR FRESH FOOD MARKET MALL AREAS

In the following assessment, the output data from the smoke development and egress modelling undertaken for the Fresh Food Market mall areas on Ground Level at Warringah Mall is analysed to establish whether the smoke hazard management system is capable of maintaining tenable conditions during occupant evacuation of the mall areas in a fire emergency and Fire & Rescue NSW intervention.

To simulate fire scenarios in the Fresh Food Marker mall areas at Warringah Mall, a 3D model of the Warringah Mall was built in FDS6. The model incorporates the major obstructions present in the tenancy (such as walls, baffles and balustrades), as well as make-up air openings and smoke exhaust grilles. The addition of these features within the building aims to improve the accuracy of the FDS6 modelling.

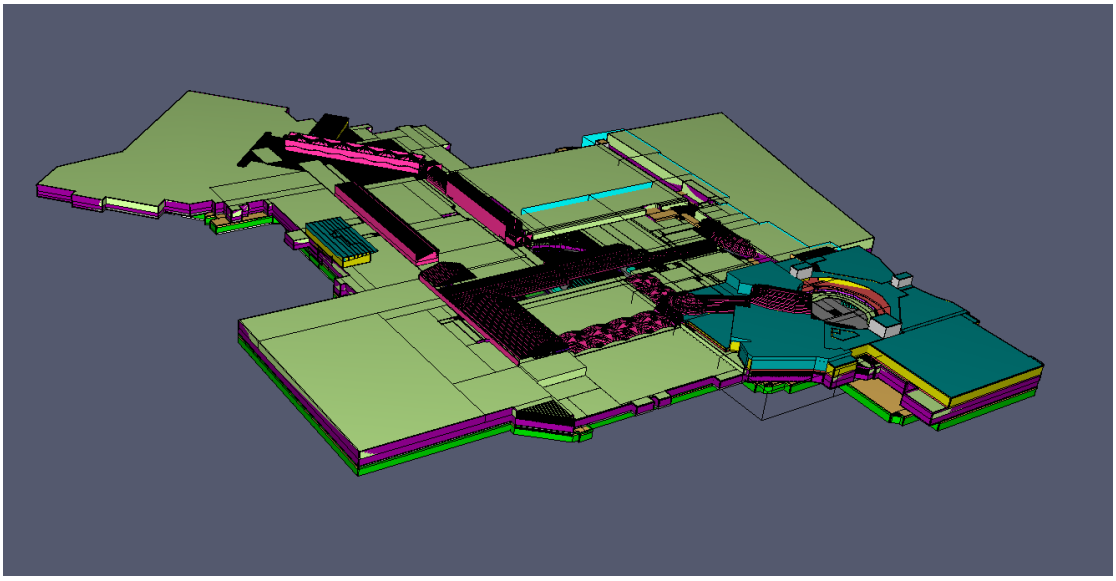

Figure 14-13: 3D model of the Westfield Warringah mall used for FDS simulations

14.7.1 REQUIRED SAFE EGRESS TIME

In carrying out the egress analyses for the proposed the mall areas within close proximity to the proposed fire, the total time required for evacuation is calculated by establishing three components of egress, namely cue time, occupant response time and travel time. These components are discussed below.

14.7.1.1 CUE TIME

As outlined in **Section 14.5.2.2**, the cue time for this assessment was based on smoke detector activation. Based on the analysis of the output data from smoke detector activation time (refer to **Section 18 - Appendix "B"**) the detectors installed in the Fresh Food Market mall area are expected to activate at **109 seconds** after the fire starts, excluding any delays resulting from alarm verification.

14.7.1.2 RESPONSE TIME

As outlined in **Section 14.5.2.3**, the response time for this assessment is conservatively taken as 120 seconds, which is based on the data provided in **Table 14-1**.

14.7.1.3 TRAVEL AND QUEUING TIME

The total population for the tenancy based on a statistical analysis of population count within Westfield Shopping Centres throughout Australia (i.e. 7.5m^2/person). This density was used for the mall areas in the Pathfinder simulation model.

Based on the output data from the occupant evacuation simulator Pathfinder, the total egress time for the Fresh Food Market mall area egress model (worst case occupant location on level 1 in area adjacent to the Fresh Food Market mall area) was **720 seconds** for RFS-FFM-01 and 240 seconds for RFS-FFM-02 (refer to **Section 19** – **Appendix "D"**).

14.7.1.4 EGRESS TIME

The total predicted required safe egress time for the Fresh Food Market mall area is shown in **Table 14-7**, provided below.

Table 14-10: RSET for the Fresh Food Market mall area at Warringah Mall

Egress Model	Cue Time	Pre-movement Time	Egress Time	RSET	RSET with 1.5 safety factor
RFS-FFM-01	109 seconds	120 seconds	720 seconds	949 seconds	1424 seconds
RFS-FFM-02	109 seconds	120 seconds	245 seconds	474 seconds	711 seconds

14.7.2 FIRE SCENARIOS

The fire growth rate for the design and redundancy fire scenarios for the Fresh Food Market mall area was based on input parameters outlined in **Section 14.5.1.1**.

14.7.2.1 AVAILABLE SAFE EGRESS TIME

Following the analysis of the output data presented in **Section 19 – Appendix "C"** and based on the limiting criteria as outlined in **Section 14.5.6**, the ASET for the fire scenarios are predicted to be as shown in **Table 14-8**.

Table 14-11: ASET for the design and redundancy fire scenario in the Tenancy MM-1010

Fire scenario	Area assessed	Onset of untenable conditions
RFS-FFM-01	Fresh food market mall area (adjacent to Kmart entry)	>1450 seconds (>700 seconds steady state conditions)
RFS-FFM-02	Fresh food market mall area (underneath new canopy section)	>700 seconds (>400 seconds steady state conditions)

Note:

* *Local untenable conditions within close proximity of the fire are observed, however, occupants are expected to have moved away from the immediate location of fire origin prior to the onset of untenable conditions; and*

** *In accordance with the limiting criteria established in **Section 14.5.6**, it is considered that a reduced visibility of approximately 5m is appropriate for use as the limiting criteria for occupants who are queuing at exits.*

14.7.3 ASET VERSUS RSET COMPARISON

The results from evacuation modelling provided in **Section 14.6.1** show that the evacuation of the mall areas is completed after the time shown in **Table 14-7**. The CFD modelling conducted shows that tenable conditions exist within the mall areas in excess of the required time for evacuation for the identified reasonable worst credible fire scenario assessed, with the addition of the applicable safety factor (where applicable).

Based on the information provided in **Table 14-7** and **Table 14-8** the ASET for the redundancy fire scenario is compared to the RSET in **Table 14-9**, below.

Table 14-12: ASET vs. RSET comparison for the identified fire scenarios in the Fresh Food Market mall areas

Fire Scenario	ASET	RSET	ASET vs RSET
RFS-FFM-01	>1450 seconds	949 seconds	>1.5
RFS-FFM-02	>700 seconds	474 seconds	>1.5

Based on the comparison of the predicted ASET and RSET for the identified reasonable worst credible design and redundancy fire scenarios for the Fresh Food Marker mall areas, presented above, it is considered reasonable to conclude that fire safety systems serving the Fresh Food Market mall areas adequately facilitates the safe evacuation of the evacuating occupants.

14.8 FIRE BRIGADE INTERVENTION

Warringah Mall Fresh Food Market mall areas and Tenancy MM-1010 is proposed to be protected throughout with an automatic sprinkler system installed to the requirements of AS 2118.1-1982. It is therefore expected that in the event of a fire originating within the Tenancy

MM-1010 or the Fresh Food Market mall areas, the fire will be either extinguished or controlled by the sprinkler system. In research conducted by H. Marryatt (1988), upon sprinkler activation, control of the fire via the automatic sprinkler system is achieved in over 99% of fires in sprinkler protected buildings. In the likely circumstance that the fire is controlled by the fire suppression system the fire would grow until sprinklers activate and thereafter the fire would cease to grow in intensity; i.e. the fire would have a constant heat release rate. Research has found that sprinkler controlled fire temperatures are unlikely to exceed 200^{o}C [BCC, 2000], except in the immediate vicinity of the fire. The conditions in such a scenario are not expected to inhibit fire brigade.

In the unlikely event of a sprinkler failure scenario it is considered reasonable to conclude that the Fire Brigade activities would be limited to exposure protection and fire-fighting from outside the compartment of fire origin.

Based upon the above discussion it is considered that the proposed tenancy design, subject to the provisions listed in the Trial Concept Design of **Section 11** is expected to facilitate fire brigade intervention.

14.9 CONCLUSION

The modelling of heat and smoke development in the proposed Tenancy MM-1010 and Fresh Food Market mall area at Warringah Mall, when compared with the evacuation modelling results, show the following:

- Tenability was observed to be maintained during occupant evacuation with a minimum safety factor of 1.5 for the design fire scenarios (where considered) and 1.0 for redundancy fire scenarios within the Tenancy MM-1010 and 1.5 for redundancy fire scenarios in the Fresh Food Market mall areas; and
- Non-hazardous conditions for Fire & Rescue NSW internal operations within the enclosed retail areas are shown to be maintained in accordance with the acceptance criteria at the commencement of Fire Brigades intervention for the reasonable worst credible fire scenario assessed.

Therefore, this assessment provides supporting evidence demonstrating that the proposed design provides, to the degree necessary, adequate provisions to facilitate the safe evacuation of occupants and Fire & Rescue NSW intervention. Consequently, it is considered that the proposed works associated with the construction of a Tenancy MM-1010 and the Fresh Food Market mall area at Warringah Mall shopping centre is capable of satisfying Performance Requirements DP4 and EP2.2 of the BCA, subject to compliance with the Trial Concept Design in **Section 11** of this report.

15. CONCLUSION

The fire engineering report provides supporting evidence demonstrating that the architectural design for the Fresh Food Market areas including construction of specialty tenancies and a mini-major tenancy; the new travelator as means of vertical transportation and associated works which form part of the Target Backfill project on Ground Level of Warringah Mall is capable of achieving compliance with Performance Requirements CP1, CP2, DP4 and EP2.2 of the BCA 2019 Amdt 1, subject to the following recommendations:

- The requirements listed in **Section 11** are Essential Services and, as all fire safety systems, must be identified as requiring maintenance and certification at appropriate intervals as per AS1851-2012 and the EP&A Regulation 2000; and
- Should a change in use or building alterations and/or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report.

16. REFERENCES

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- Marryatt, H.W., 1988: "*Fire: a century of automatic sprinkler protection in Australia and New Zealand, 1886-1986*", Melbourne, Australia – Section 4, Table 3, p.90;
- Proulx, G., 2002: *"The SFPE Handbook of Fire Protection Engineering – Movement of People: The Evacuation Timing"*, the Society of Fire Protection Engineers, Quincy, Massachusetts, USA.
- Purser, D.A., 2002: "*The SFPE Handbook of Fire Protection Engineering – Toxicity assessment of combustion products*", the Society of Fire Protection Engineers, Quincy, Massachusetts, USA – Chapter 2-6, pp 2-83 to 2-171;
- SFS, 2011: "*Practice note for design fires*", Society of Fire Safety, Engineers Australia, Sydney – Version J, Table 5-2, p.17.

17. APPENDIX A – DOCUMENTATION

The following drawings were examined during the production of this report:

Table 17-1: Assessment Documentation

Drawing Description	Drawing No.	Issue	Drawn/Issued By	Plot Date
Stage 2B Site Location Plan Level GL	SDC-000623	A	Scentre Design & Construction	21/05/2021
GA Plan – Stage 2B Level L1M	SDC-080006	E	Scentre Design & Construction	21/05/2021
Master Lease Plan Stage 2B Ground Floor	SDC-087003	B	Scentre Design & Construction	21/05/2021
Master Lease Plan Stage 2B Level 1	SDC-087005	A	Scentre Design & Construction	21/05/2021
Master Lease Plan Stage 2B Level 2	SDC-087007	A	Scentre Design & Construction	21/05/2021
GA Plan – Stage 2B Zone 6 Level GL	SDC-100623	H	Scentre Design & Construction	28/05/2021
GA Elevations Stage 2B Sone 6 & 10	SDC-200621	B	Scentre Design & Construction	21/05/2021
Travelators – MW19-MW26 Sections	SDC-341022	B	Scentre Design & Construction	28/05/2021
Harris Farm Sketch Tenancy Plan Option 1	SDC-831010-2	B	Scentre Design & Construction	12/05/2021
MM1010-Sections & Elevations	SDC-831010-5	B	Scentre Design & Construction	12/05/2021
SDC-SK-990170-Central Canopy Coordination With FE	-	-	Scentre Design & Construction	-

18. APPENDIX B – OUTPUT RESULTS FROM THE SMOKE DETECTOR AND SPRINKLER ACTIVATION TIME MODELLING

The following is the output data for smoke detector activation times calculated using module "*Sprinkler*" from the *"FireWind"* suite of computer programs.

The simulation of smoke detector activation times was based on the ***"fast"*** t-squared fire growth rate provided in **Table 14-4**.

The fire seat has been assumed to be located at 0.5m above the floor level.

18.1 SMOKE DETECTOR ACTIVATION FOR THE MM-1010 TENANCY

The maximum horizontal radial distance from a smoke detector to the axis of the fire is 7m (based on 10m x 10m smoke detector spacing). Due to program limitations the assumed ambient temperature for the calculations is 27^{o}C.

The activation temperature of a smoke detector is assumed to be 40^{o}C. The smoke detector Response Time Index (RTI) has been assumed as being 10 $(ms)^{1/2}$ or less. The conduction factor (C-factor) has been assumed as being 0 $(m/s)^{1/2}$.

The input parameters used in calculations are summarised in **Table 18-1**, below.

Table 18-1: Input parameters for smoke detector activation modelling

Item	Parameter
Height of the ceiling above fuel	4.2m (assuming a ceiling height of 4.2m which is the maximum ceiling height within the tenancy)
Distance of detector from axis of fire	7m (based on the maximum 10m x 10m smoke detector spacing in accordance with Clause 6 of Specification E2.2a of BCA 2019 Amdt 1)
Ambient temperature	27^{o}C
Detector activation temperature	40^{o}C
RTI for detector	10 $(ms)^{1/2}$
C-factor for detector	0 $(m/s)^{1/2}$
Fire growth rate	***'Fast'*** t-squared growth (as per **Table 14-4**)

Program Sprinkler

Height of ceiling above fuel 4.2 m

Distance of detector from axis of fire 7 m

Ambient temperature 27 oC

Detector Actuation Temperature 40 oC

Detector Response Time Index (RTI) 10 (m.s)$^{1/2}$

Conduction factor C 0 (m/s)$^{1/2}$

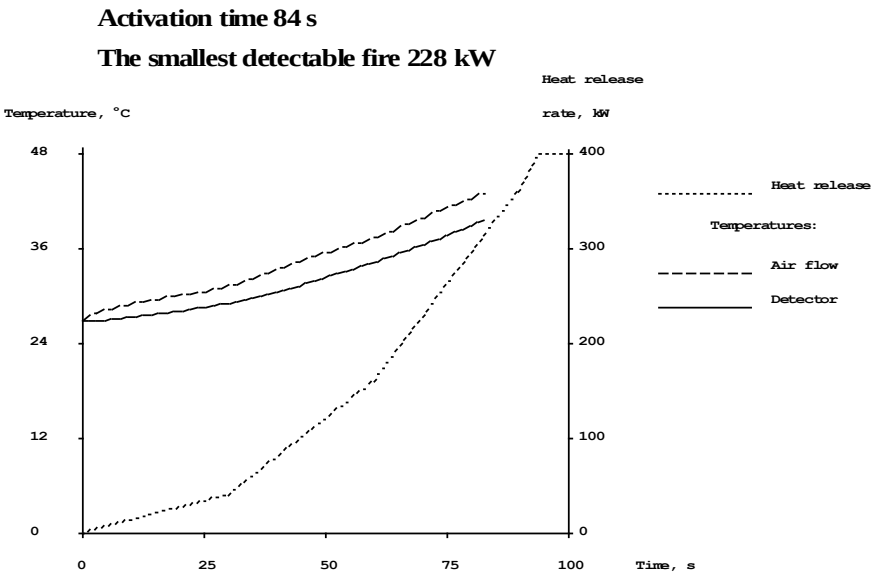

Figure 18-1: Smoke detection activation time

From **Figure 18-1**, it is evident that the smoke detectors installed in the MM-1010 tenancy are expected to activate at ***84 seconds*** (assuming no alarm verification time) after the fire starts.

18.2 SMOKE DETECTOR ACTIVATION FOR THE FRESH FOOD MARKT MALL AREA

The maximum horizontal radial distance from a smoke detector to the axis of the fire is 7m (based on 15m x 15m smoke detector spacing). Due to program limitations the assumed ambient temperature for the calculations is 27^{o}C.

The activation temperature of a smoke detector is assumed to be 40^{o}C. The smoke detector Response Time Index (RTI) has been assumed as being 10 $(ms)^{1/2}$ or less. The conduction factor (C-factor) has been assumed as being 0 $(m/s)^{1/2}$.

The input parameters used in calculations are summarised in **Table 18-1**, below.

Table 18-2: Input parameters for smoke detector activation modelling

Item	Parameter
Height of the ceiling above fuel	4.7m (assuming a ceiling height of 5.2m which is the maximum ceiling height within the mall area)
Distance of detector from axis of fire	10.6m (based on the maximum 15m x 15m smoke detector spacing in accordance with Clause 6 of Specification E2.2a of BCA 2019 Amdt 1)
Ambient temperature	27^{o}C
Detector activation temperature	40^{o}C
RTI for detector	10 $(ms)^{1/2}$
C-factor for detector	0 $(m/s)^{1/2}$
Fire growth rate	***'Fast'*** t-squared growth (as per **Table 14-4**)

Program Sprinkler

Height of ceiling above fuel 4.7 m

Distance of detector from axis of fire 10.6 m

Ambient temperature 27 oC

Detector Actuation Temperature 40 oC

Detector Response Time Index (RTI) 10 $(m.s)^{1/2}$

Conduction factor C 0 $(m/s)^{1/2}$

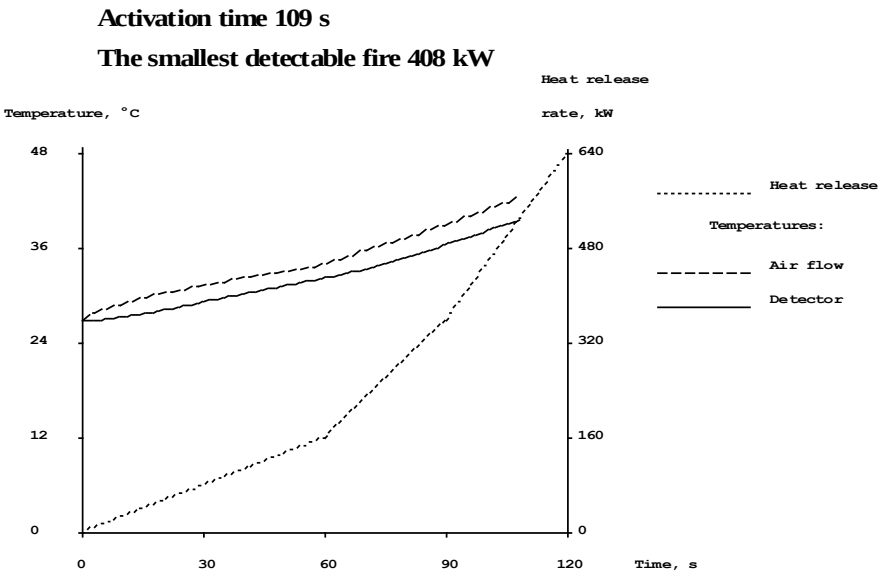

Figure 18-2: Smoke detection activation time

18.3 SPRINKLER ACTIVATION FOR THE MM-1010 TENANCY

The maximum horizontal radial distance from a sprinkler to the axis of the fire is 4.92m (based on second row activation of the maximum 3.0m x 4.0m sprinkler spacing in accordance with AS2118.1), assuming that the fire is located in the centre of the sprinkler array.

The activation temperature of a sprinkler is assumed to be 68^{o}C. The sprinklers installed throughout the tenancy are understood to be “fast response” with an RTI of 50 $(ms)^{1/2}$. The conduction factor (C-factor) has been assumed as being 1 $(m/s)^{-1/2}$.

The input parameters used in calculations are summarised in **Table 18-3**, below.

Table 18-3: Input parameters for smoke detector activation modelling

Item	Parameter
Height of the ceiling above fuel	4.2m for the main trading area; and
Distance of sprinkler from axis of fire	4.92m (based on second row activation of the maximum 3.0m x 4.0m sprinkler spacing in accordance with AS2118.1)
Ambient temperature	23^{o}C
Sprinkler activation temperature	68^{o}C
RTI for sprinkler	50 $(ms)^{1/2}$
C-factor for sprinkler	1 $(m/s)^{-1/2}$
Fire growth rate	***‘Fast’*** t-squared growth (as per **Table 14-4**)

Program Sprinkler

Height of ceiling above fuel 4.2 m

Distance of detector from axis of fire 4.92 m

Ambient temperature 23 oC

Detector Actuation Temperature 68 oC

Detector Response Time Index (RTI) 50 (m.s)$^{1/2}$

Conduction factor C 1 (m/s)$^{1/2}$

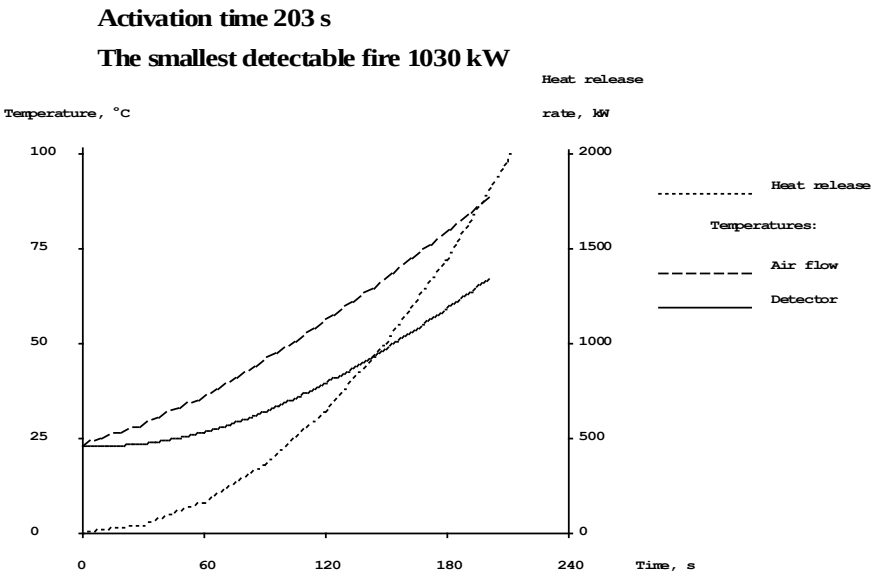

Figure 18-3: Second row sprinkler activation time for the MM-1010 tenancy (main trading floor)

From **Figure 18-3**, it is evident that the sprinklers installed in the main trading areas of the MM-1010 tenancy are expected to activate at ***203 seconds*** after the fire starts.

19. APPENDIX C – OUTPUT RESULTS FROM SMOKE DEVELOPMENT MODELLING USING FDS-6

The following is the summary of the output data from FDS-6 for the fire scenarios within the MM-1010 tenancy and the Fresh Food Market mall areas. All slices are taken at 2.0m AFFL unless specified otherwise.

19.1 DESIGN FIRE SCENARIO – (DFS-MM-1010-01)

Fire Scenario	Fire Description
DFS-MM-1010-01	"Fast" t-squared growth rate fire capped off at 203 seconds (1.830MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation with a safety factor of 1.5. Heat Release Rate at 900 seconds: 1.830MW Heat of Combustion: 31.8 MJ/kg Chemical Composition: $CH_{1.53}O_{0.26}N_{0.03125}$ Soot yield: 6% (after 25% soot deposition) Smoke exhaust activation time: *84 seconds* (refer **Section 18**) Limiting criteria: visibility and temperature (refer **Section 14.5.6**)

19.1.1 VISIBILITY OF THE MM-1010 TENANCY (DFS-MM-1010-01)

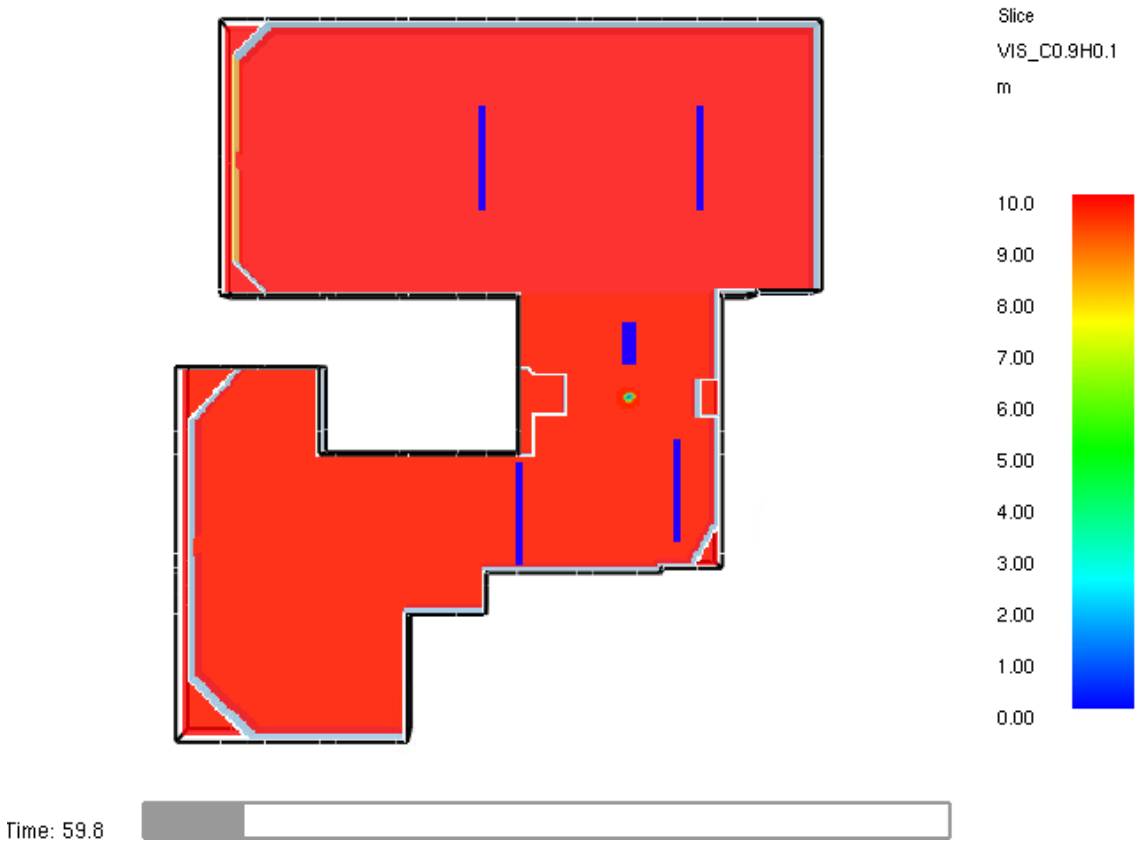

Figure 19-1: MM-1010 – Visibility at **60 Seconds**

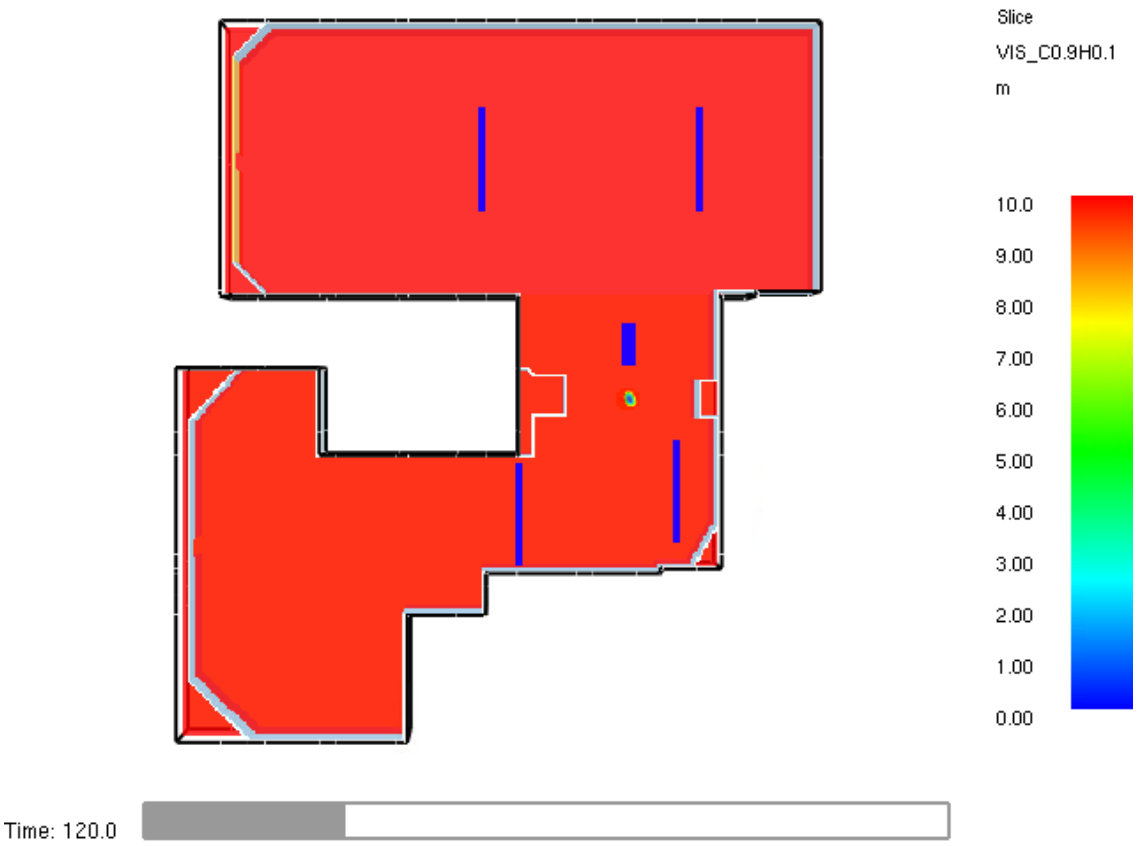

Figure 19-2: MM-1010 – Visibility at **120 Seconds**

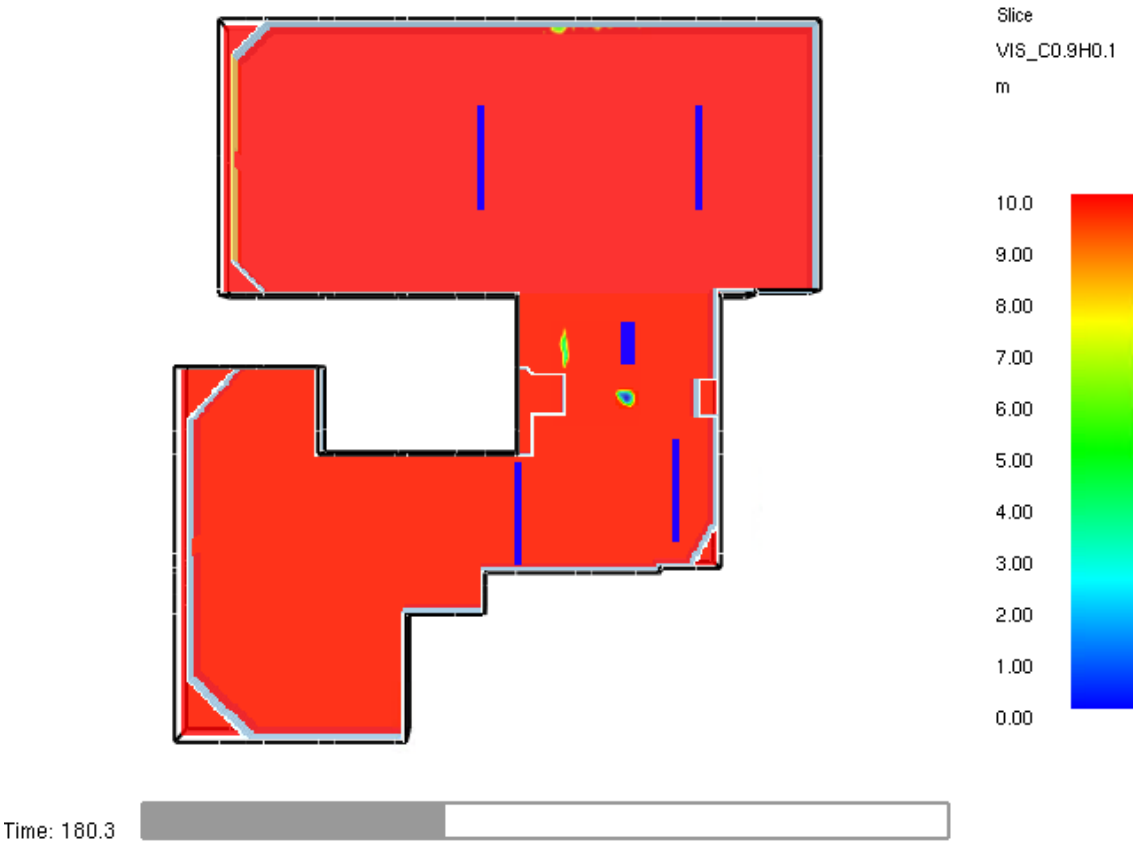

Figure 19-3: MM-1010 – Visibility at **180 Seconds**

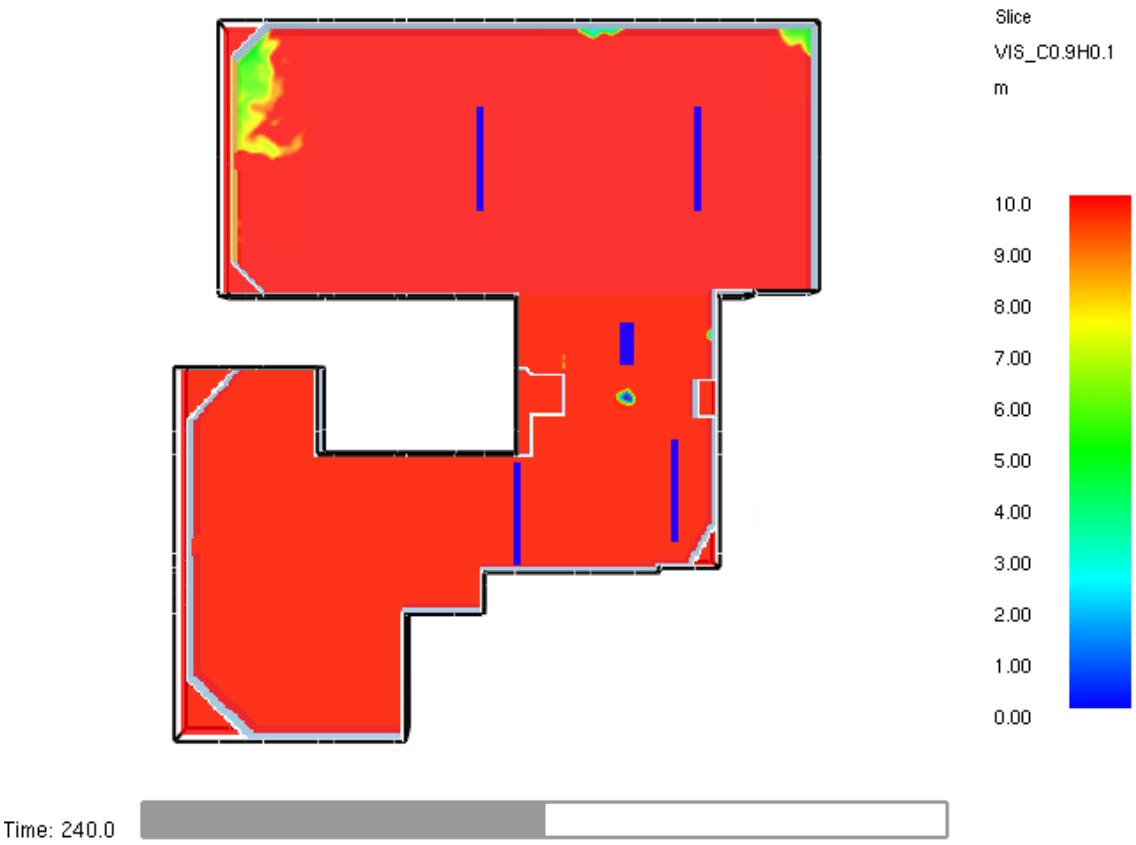

Figure 19-4: MM-1010 – Visibility at **240 Seconds**

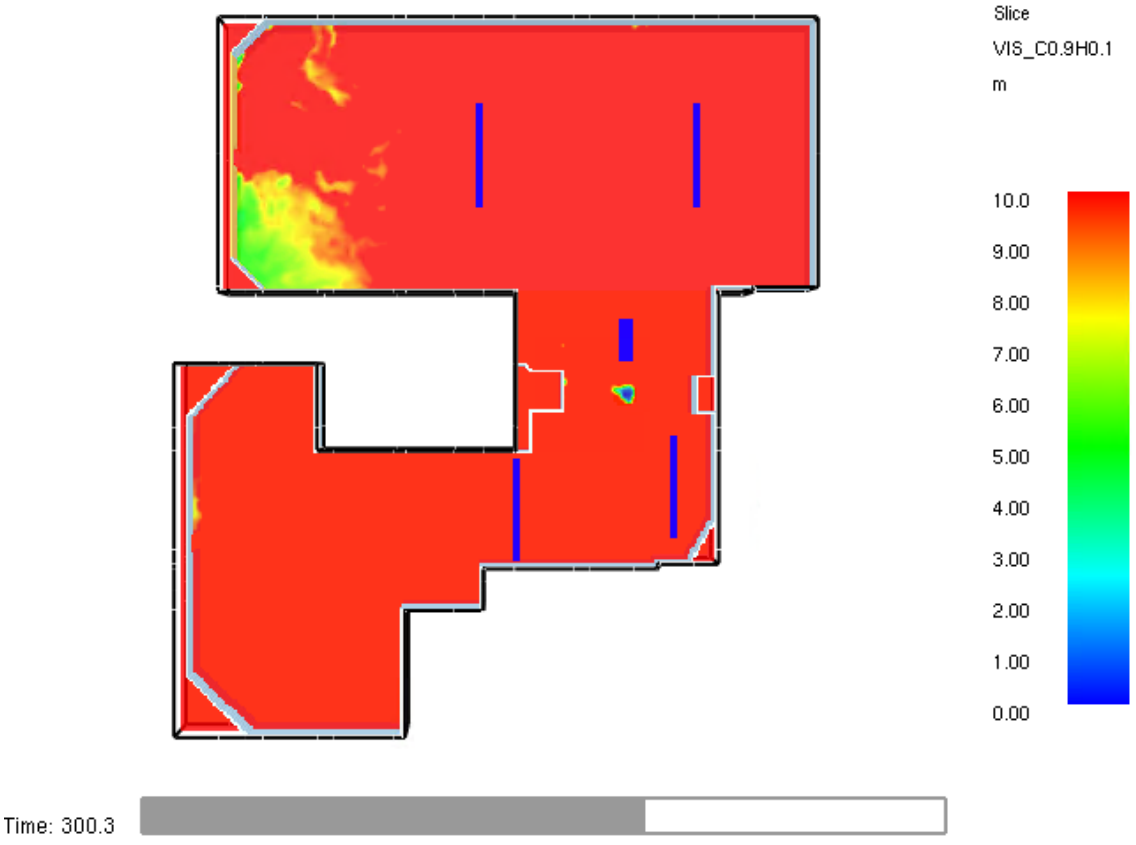

Figure 19-5: MM-1010 – Visibility at **300 Seconds**

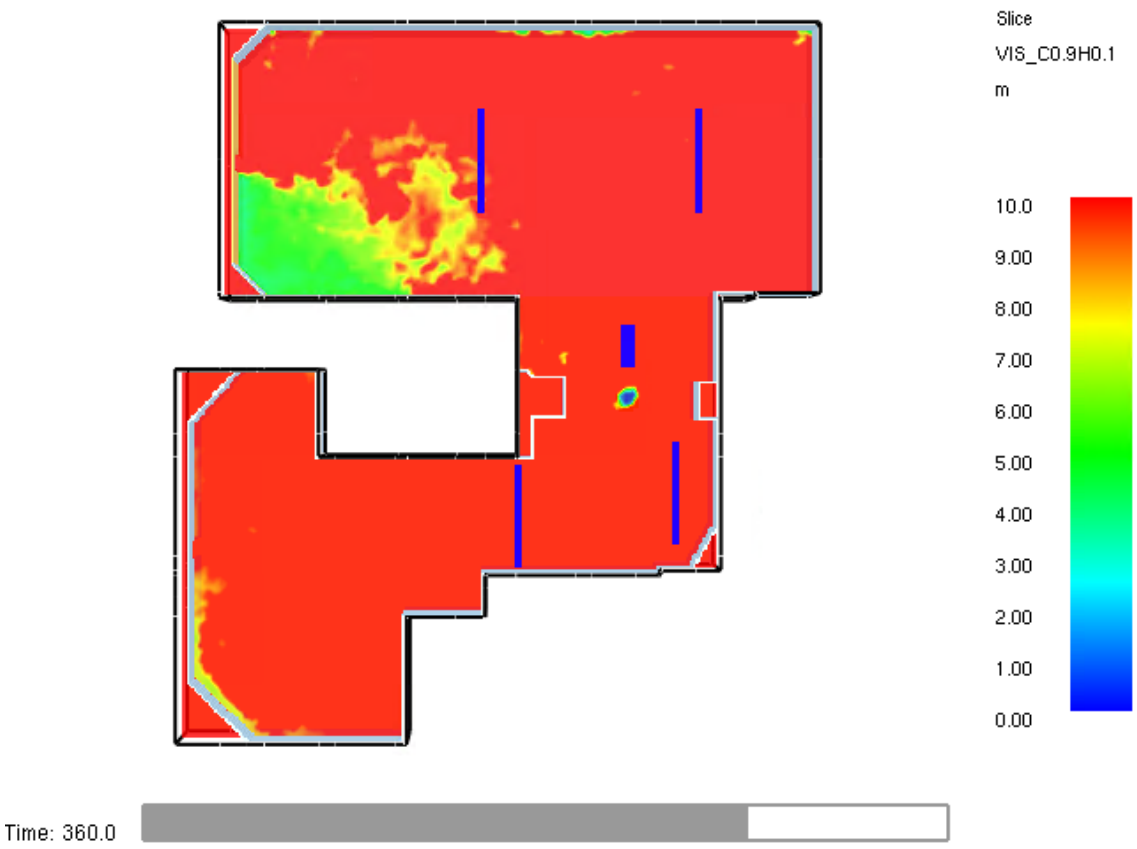

Figure 19-6: MM-1010 – Visibility at **360 Seconds**

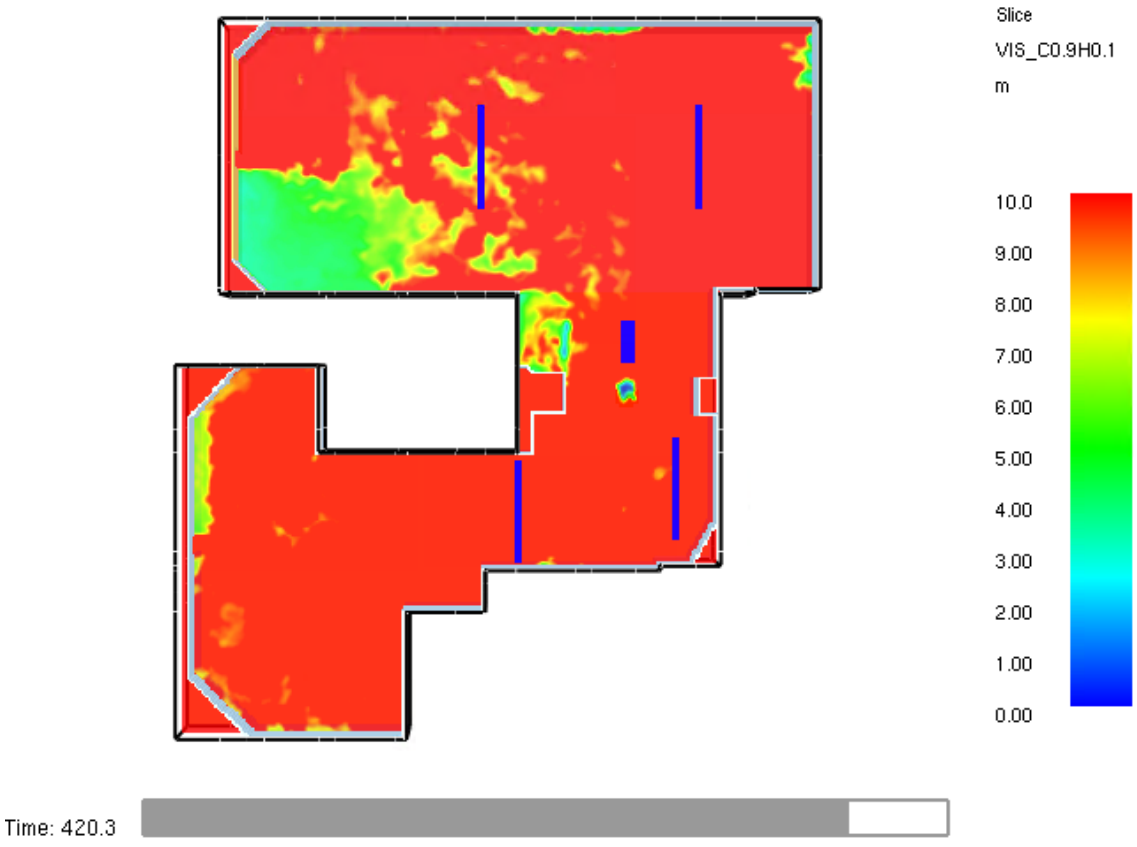

Figure 19-7: MM-1010 – Visibility at **420 Seconds**

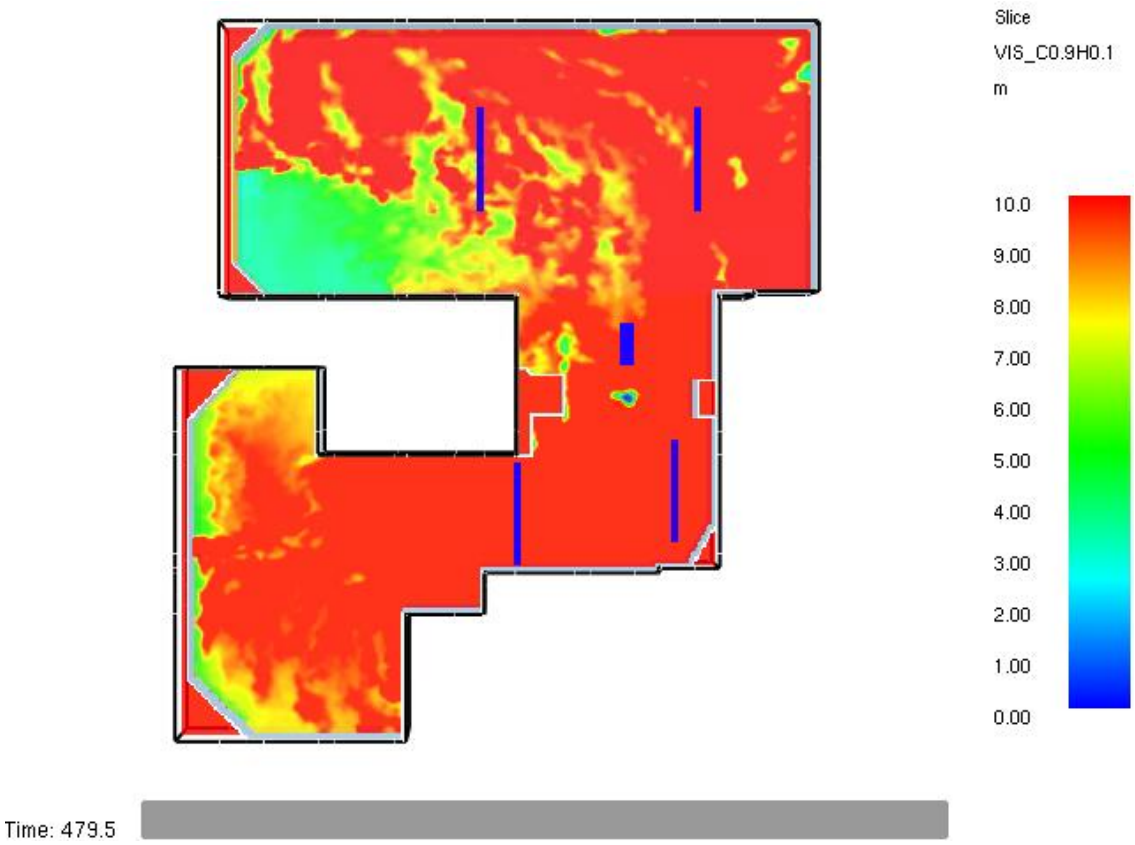

Figure 19-8: MM-1010 – Visibility at **480 Seconds**

19.1.2 TEMPERATURE OF THE MM-1010 TENANCY(DFS-MM-1010-01)

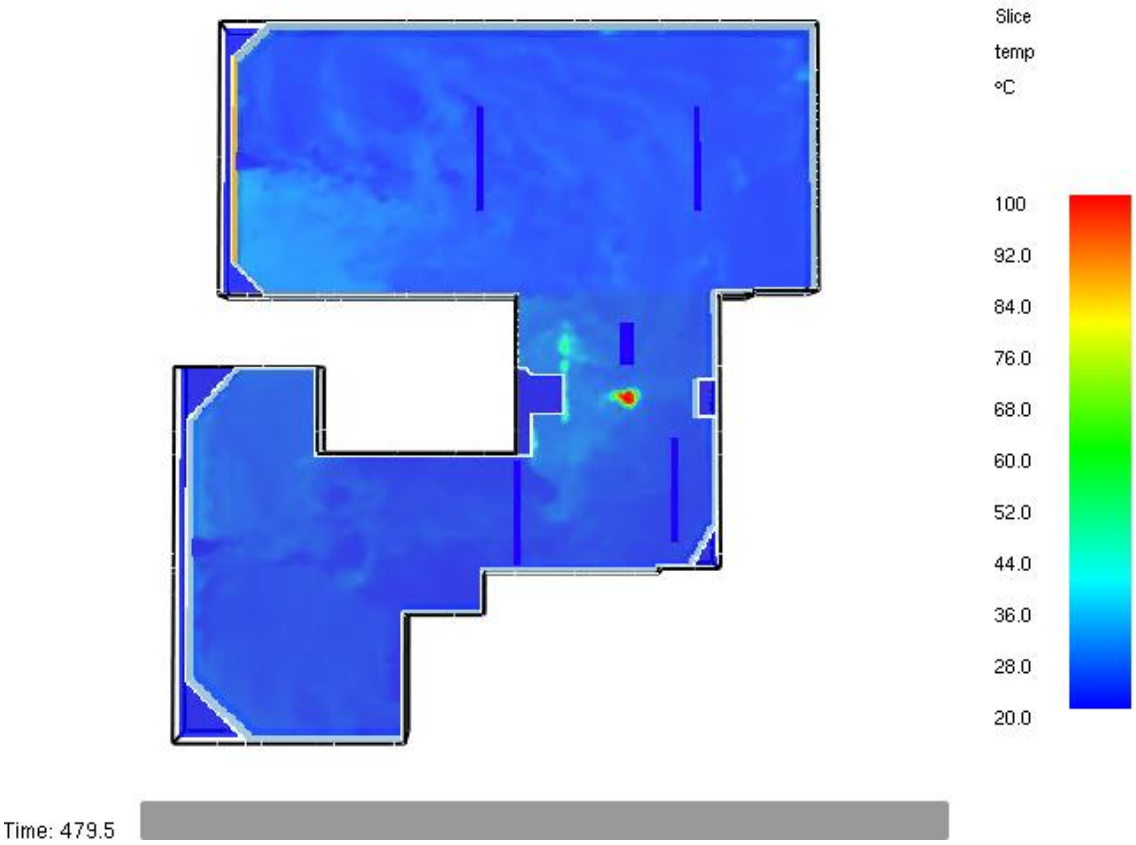

Figure 19-9: MM-1010 Tenancy – Temperature at **480 Seconds**

19.2 REDUNDANCY FIRE SCENARIOS – MM-1010

Fire Scenario	Fire Description
RFS-MM-1010-01	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat Release Rate at 900 seconds: 5,018kW Heat of Combustion: 31.8 MJ/kg Chemical Composition: $CH_{1.53}O_{0.26}N_{0.03125}$ Soot yield: 6% (after 25% soot deposition) Smoke exhaust activation time: *109 seconds* (refer **Section 18**) Limiting criteria: visibility and temperature (refer **Section 14.5.6**)

19.2.1 VISIBILITY OF THE MM-1010 TENANCY(RFS-MM-1010-01)

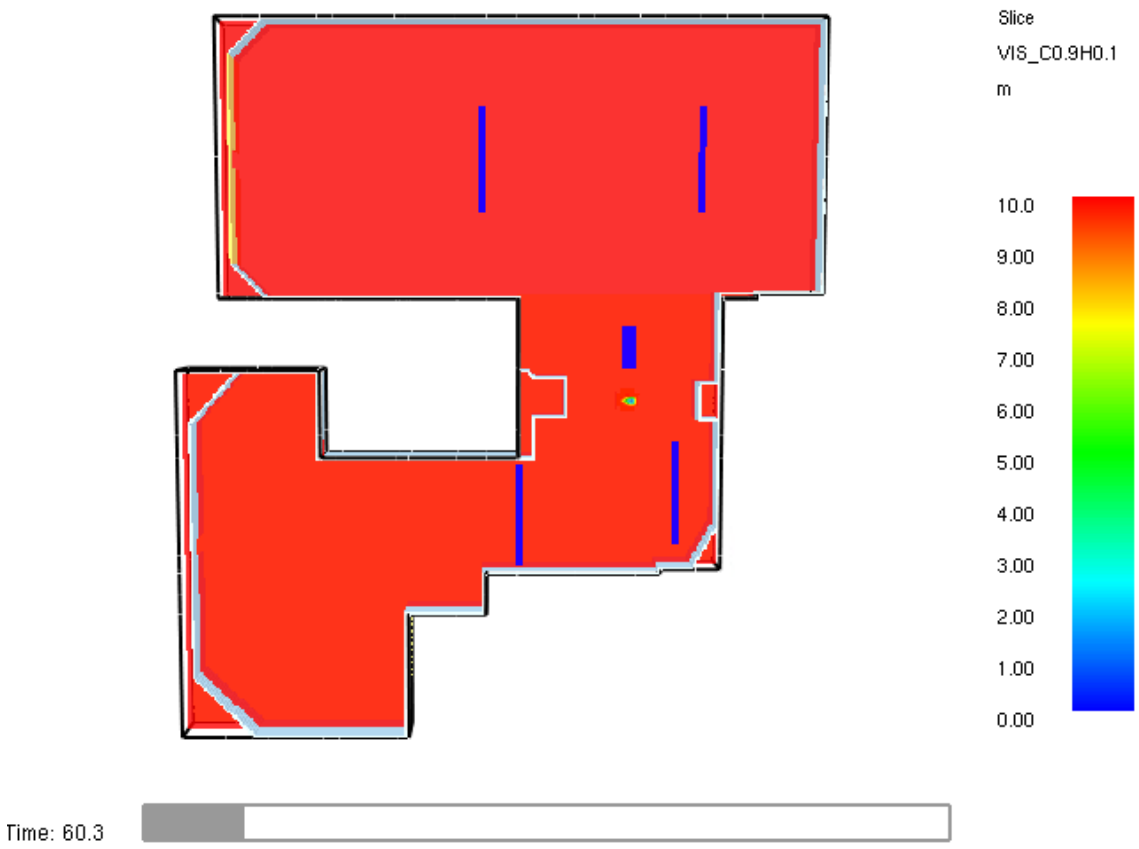

Figure 19-10: MM-1010 – Visibility at **60 Seconds**

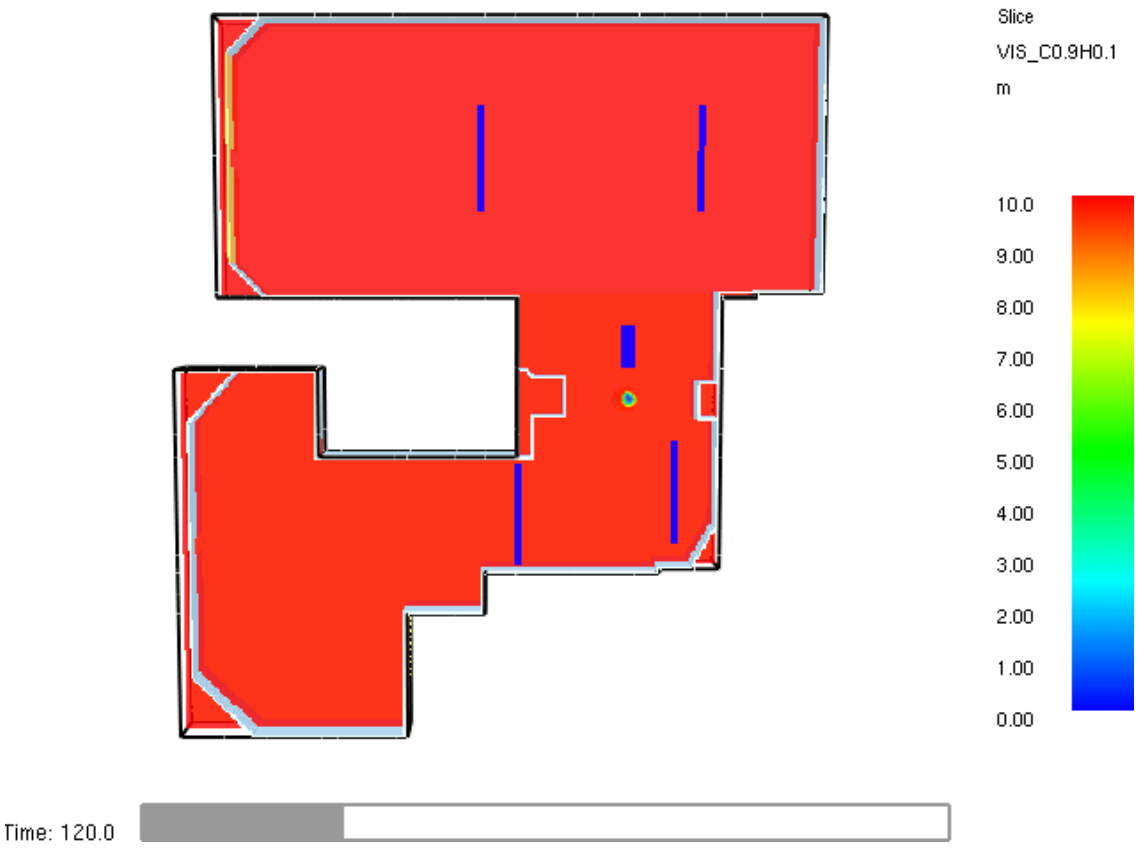

Figure 19-11: MM-1010 – Visibility at **120 Seconds**

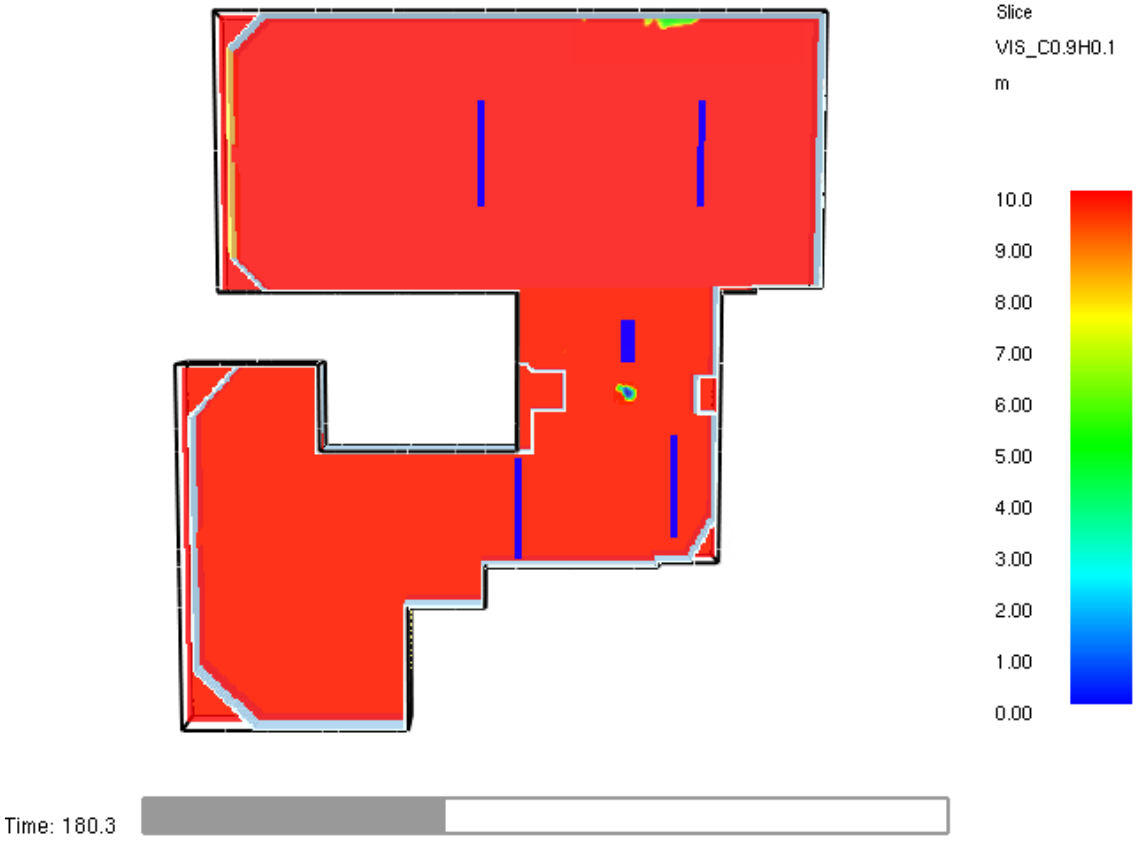

Figure 19-12: MM-1010 – Visibility at **180 Seconds**

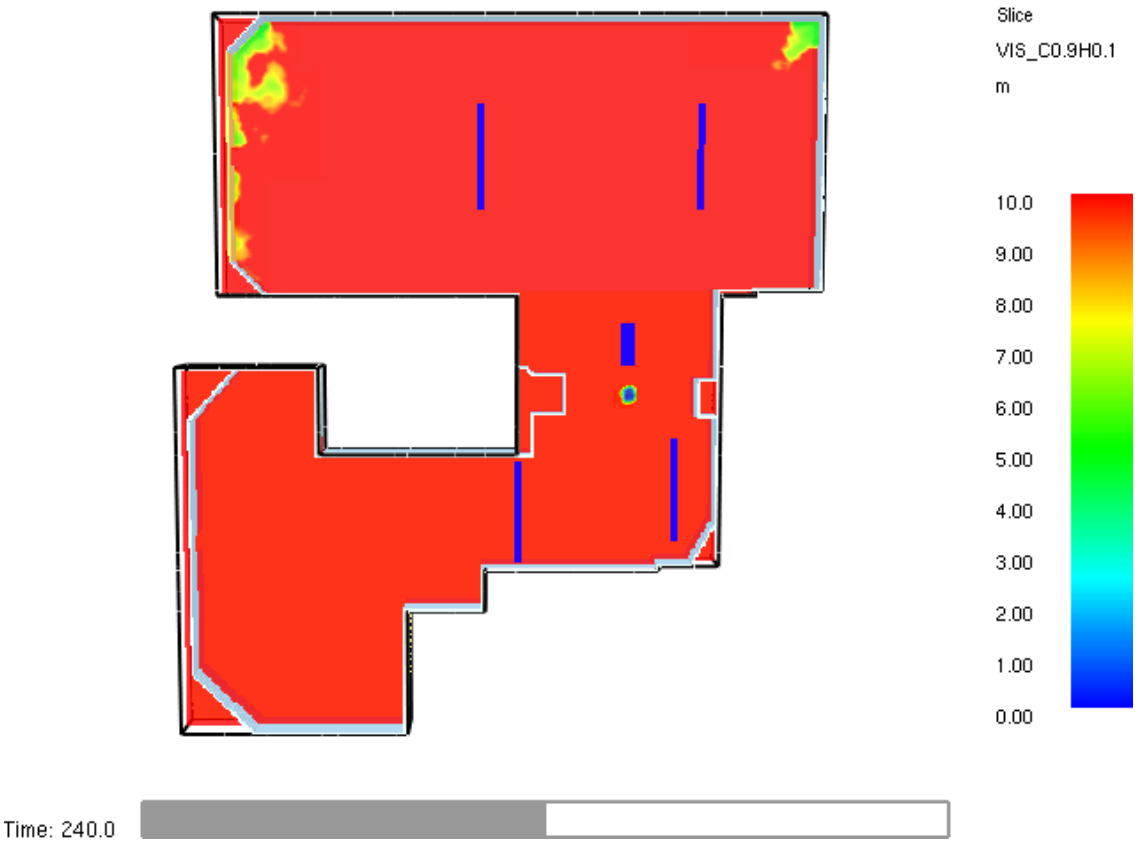

Figure 19-13: MM-1010 – Visibility at **240 Seconds**

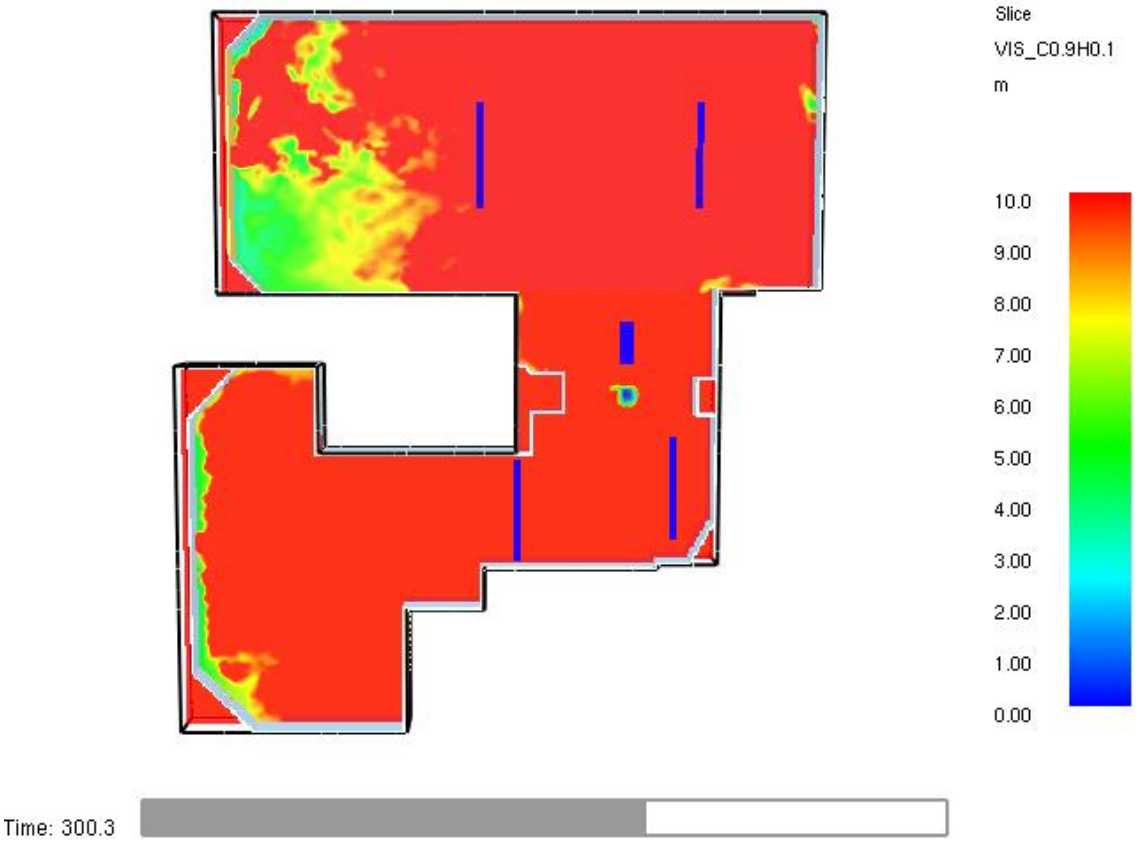

Figure 19-14: MM-1010 – Visibility at **300 Seconds**

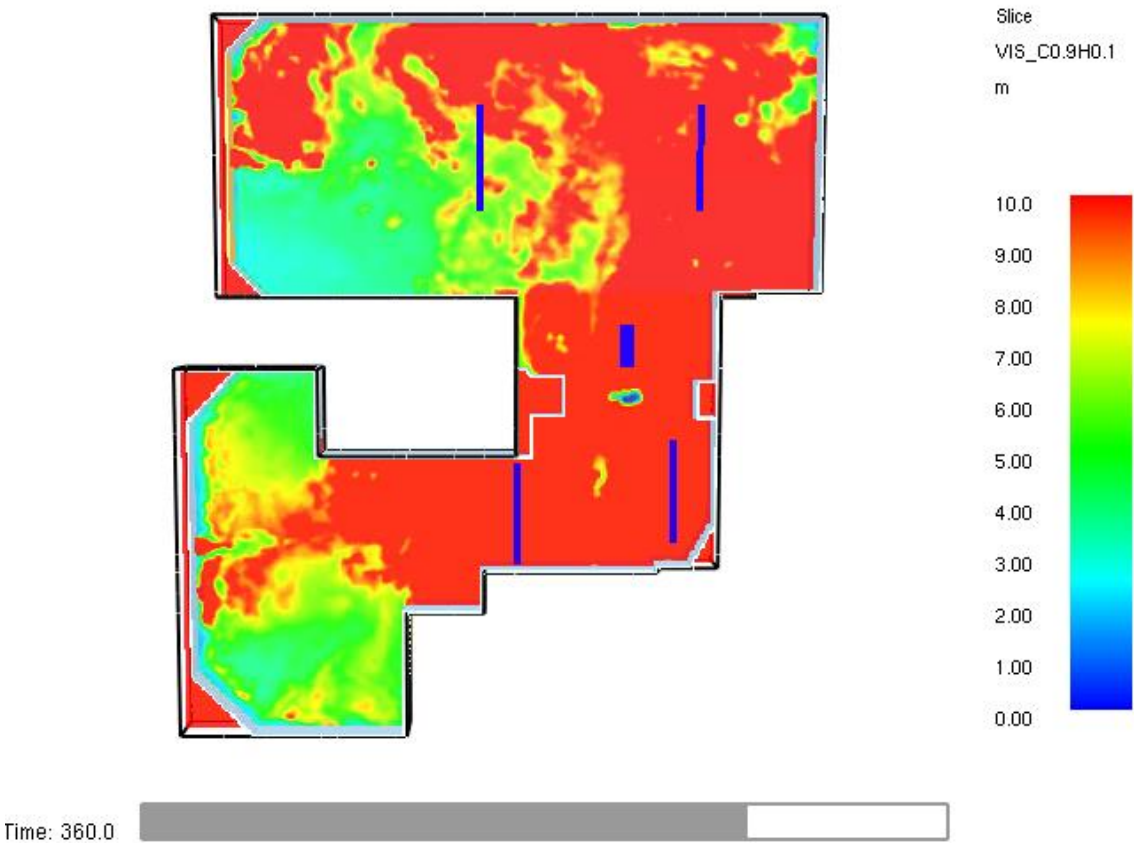

Figure 19-15: MM-1010 – Visibility at **360 Seconds**

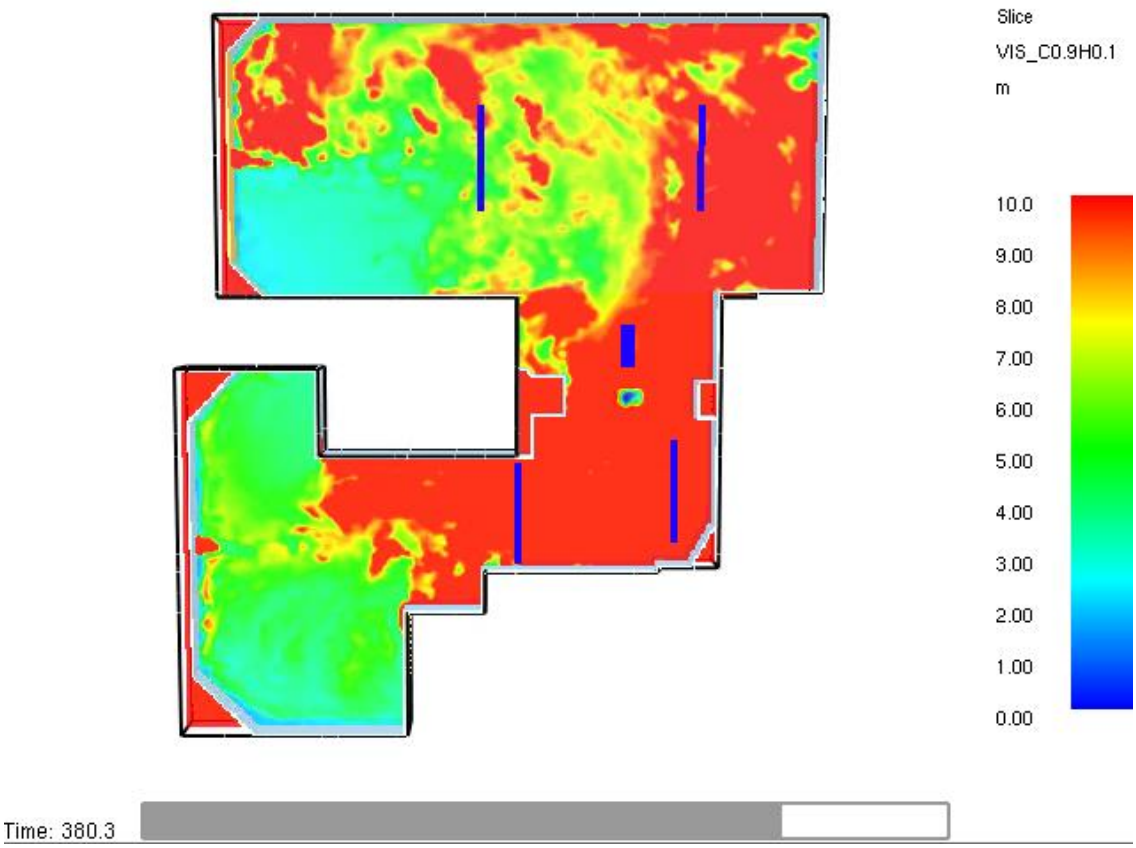

Figure 19-16: MM-1010 – Visibility at **380 Seconds**

19.2.2 TEMPERATURE OF THE MM-1010 TENANCY (RFS-MM-1010-01)

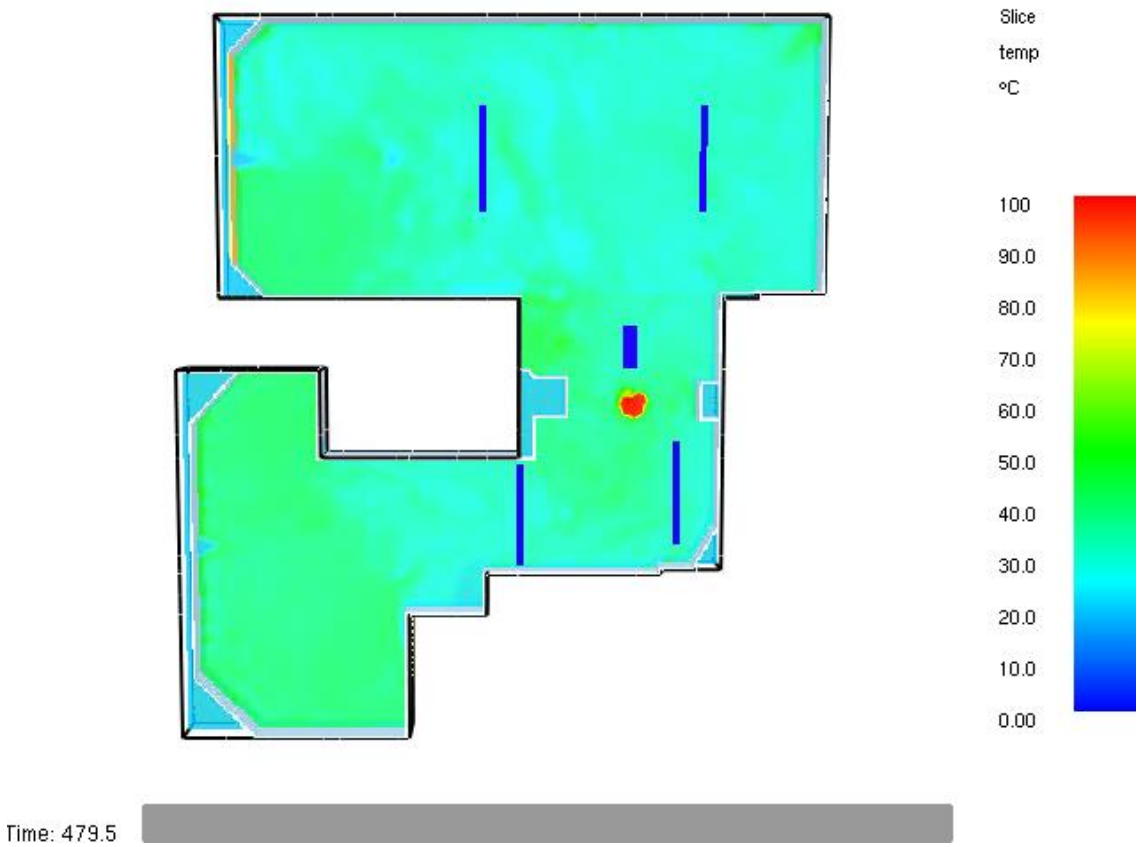

Figure 19-17: MM-1010 Tenancy – Temperature at **700 Seconds**

19.3 REDUNDANCY FIRE SCENARIO – FRESH FOOD MARKET GROUND LEVEL

Fire Scenario	Fire Description
RFS-FFM-01	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat Release Rate at 900 seconds: 5,018kW Heat of Combustion: 31.8 MJ/kg Chemical Composition: $CH_{1.53}O_{0.26}N_{0.03125}$ Soot yield: 6% (after 25% soot deposition) Smoke exhaust activation time: *109 seconds* (refer **Section 18**) Limiting criteria: visibility and temperature (refer **Section 14.5.6**)

19.3.1 VISIBILITY OF THE FRESH FOOD MARKET

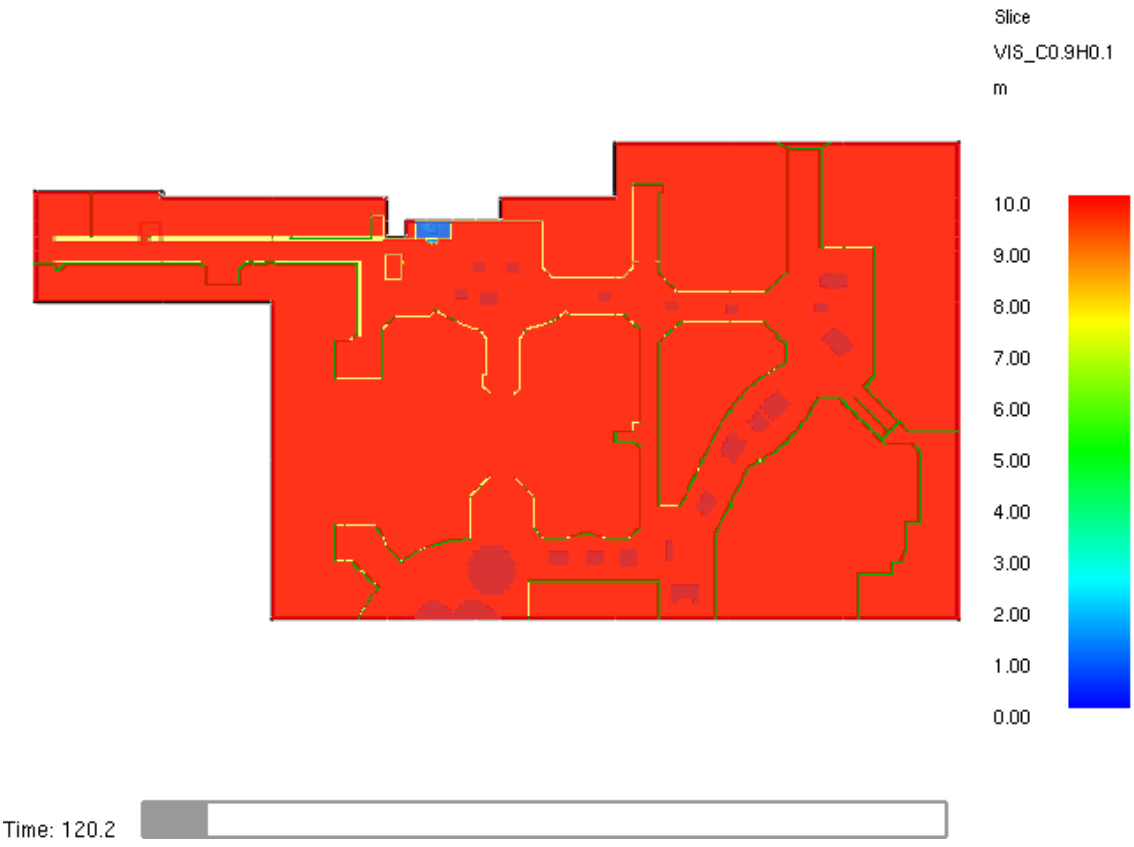

Figure 19-18: Fresh Food Market visibility Ground level – Temperature at **120 Seconds**

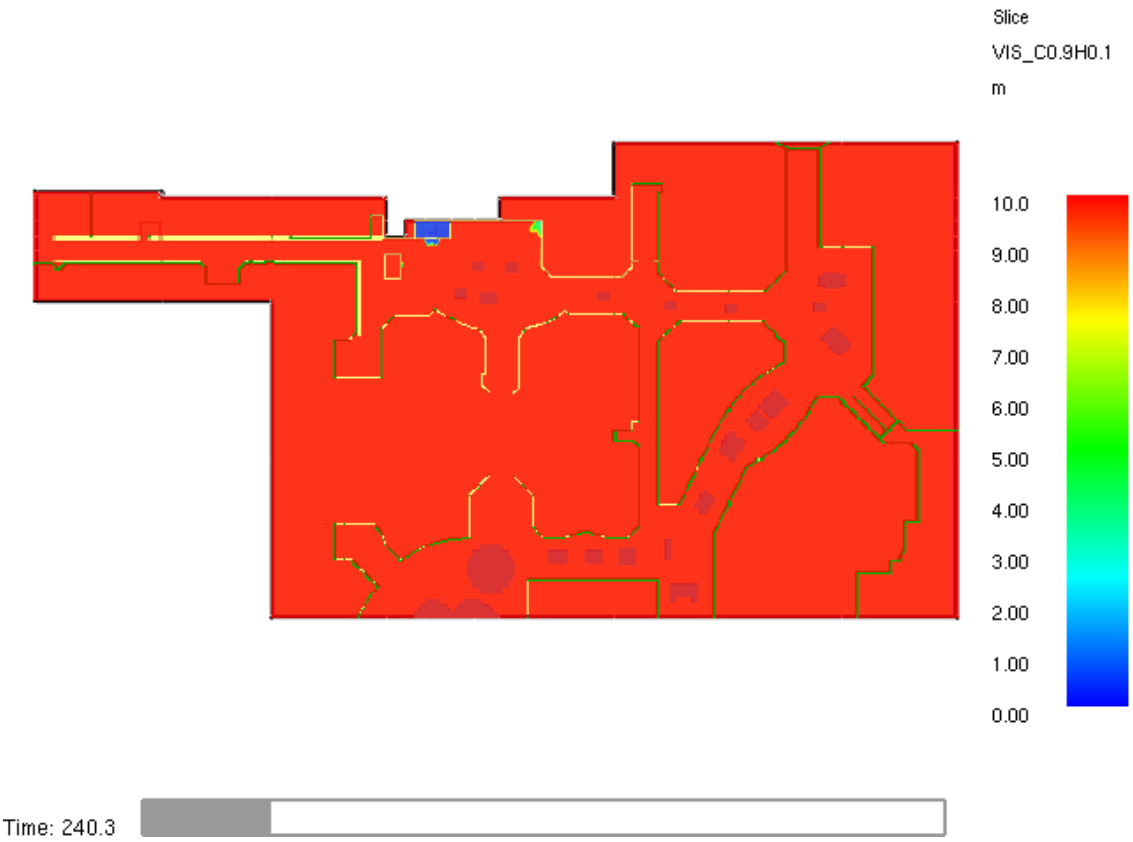

Figure 19-19: Fresh Food Market visibility Ground level – Temperature at **240 Seconds**

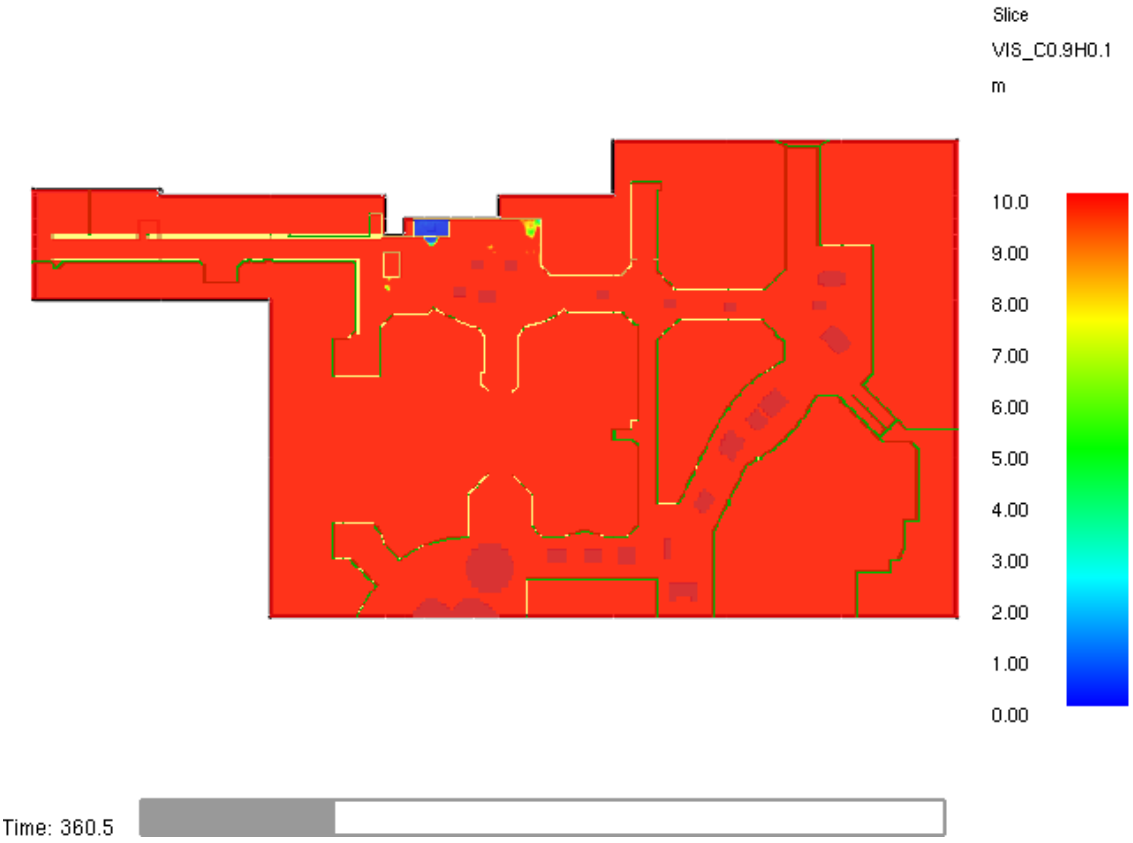

Figure 19-20: Fresh Food Market visibility Ground level – Temperature at **360 Seconds**

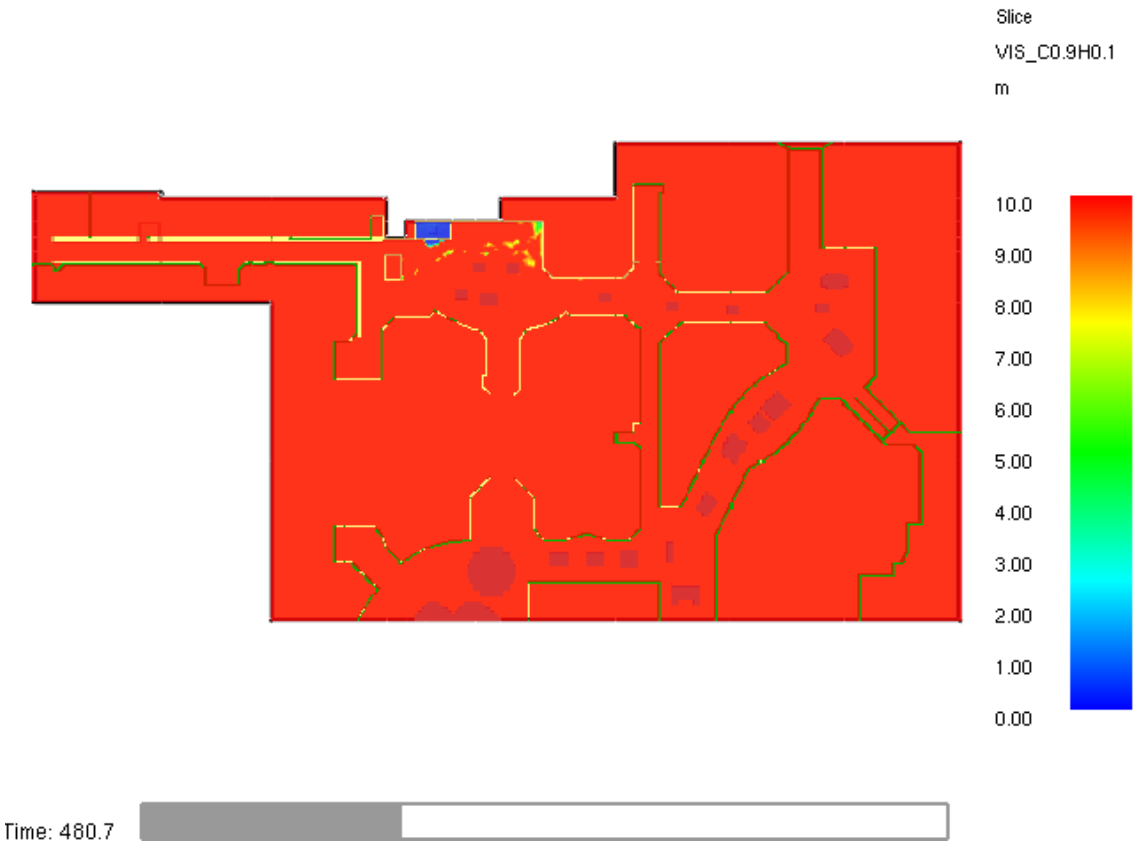

Figure 19-21: Fresh Food Market visibility Ground level – Temperature at **480 Seconds**

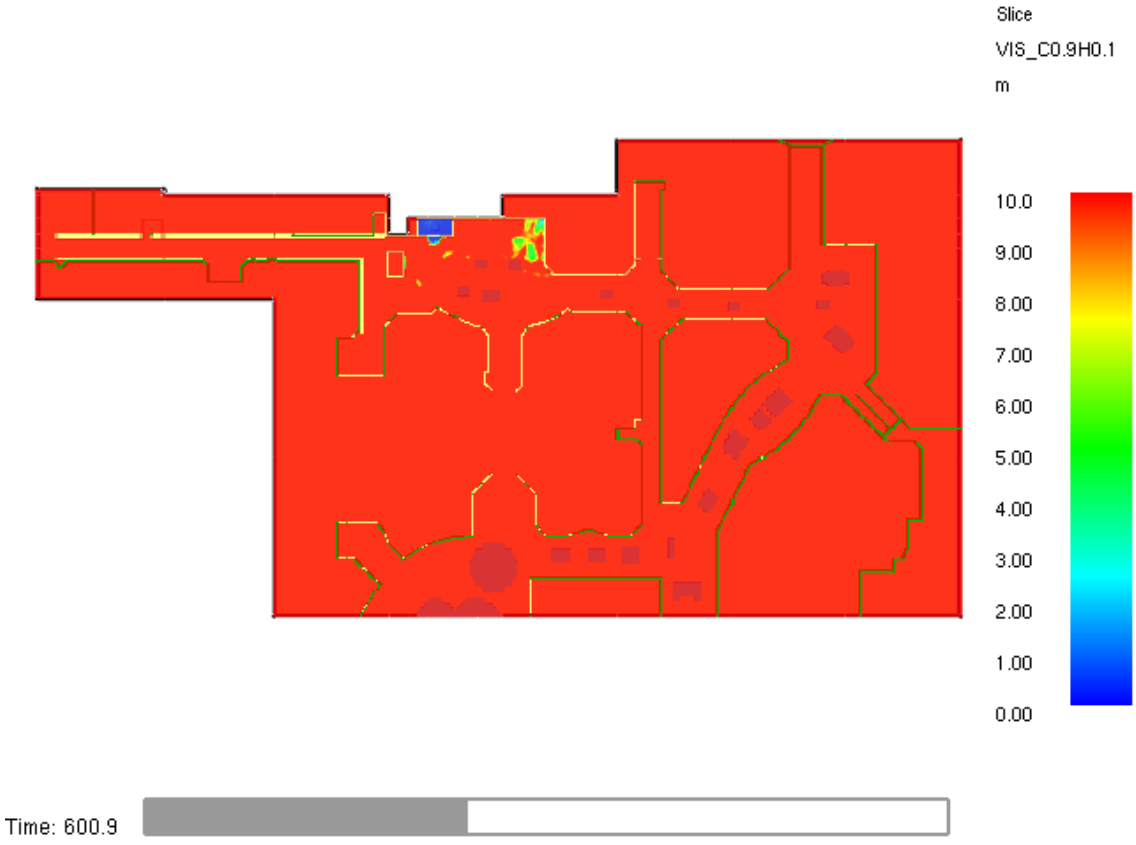

Figure 19-22: Fresh Food Market visibility Ground level – Temperature at **600 Seconds**

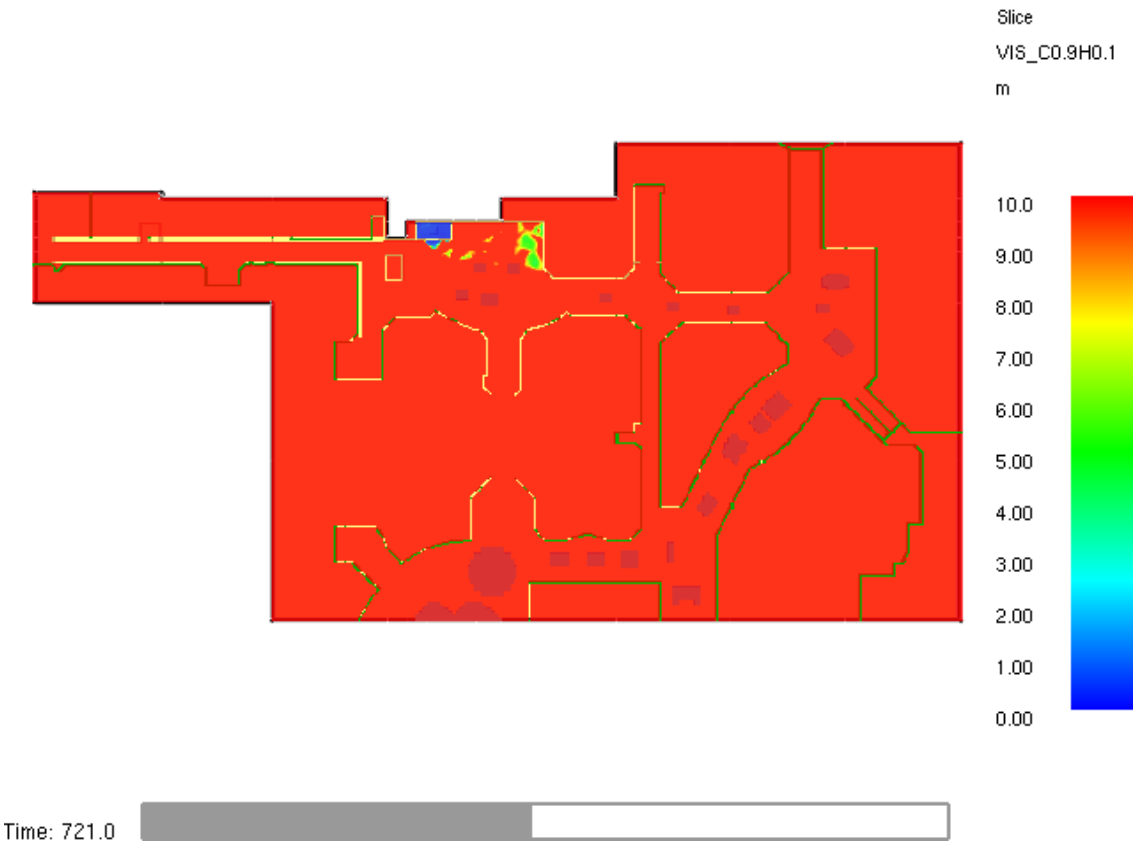

Figure 19-23: Fresh Food Market visibility Ground level – Temperature at **720 Seconds**

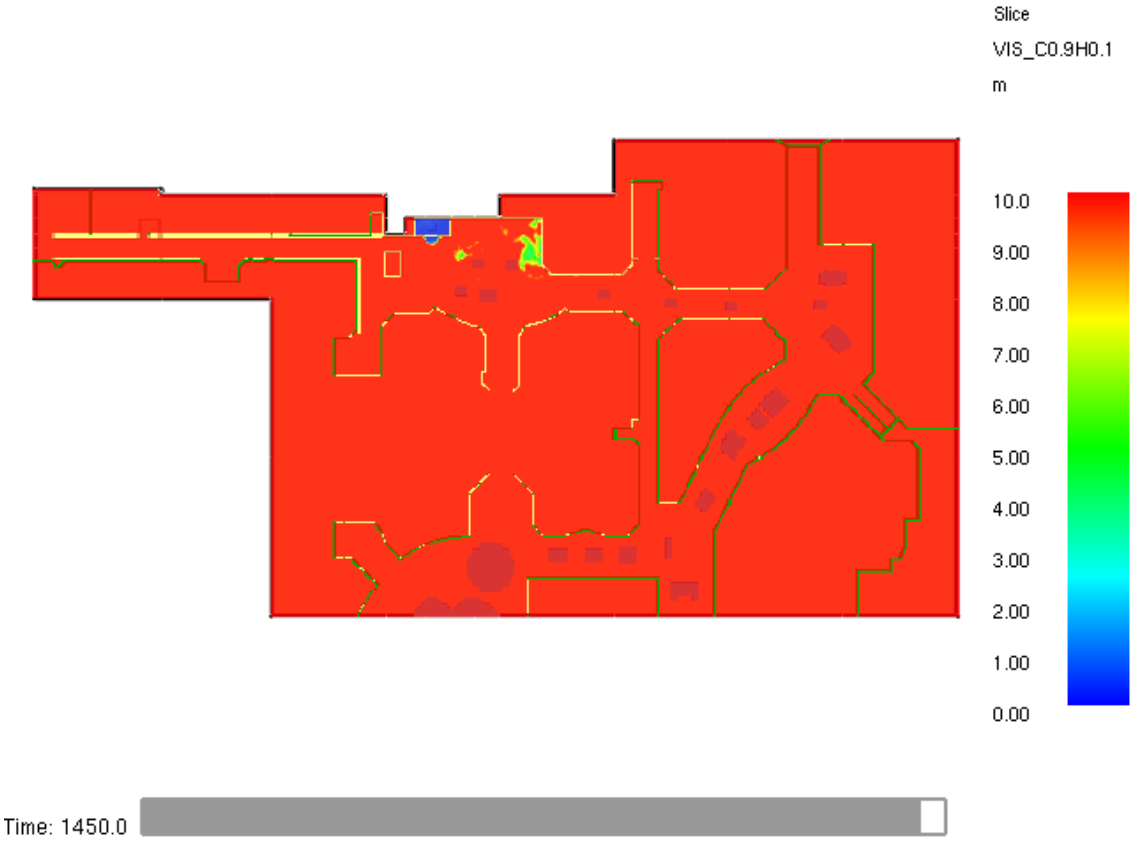

Figure 19-24: Fresh Food Market visibility Ground level – Temperature at **1450 Seconds**

19.3.2 TEMPERATURE OF THE RETAIL MALL (RFS-FFM-01)

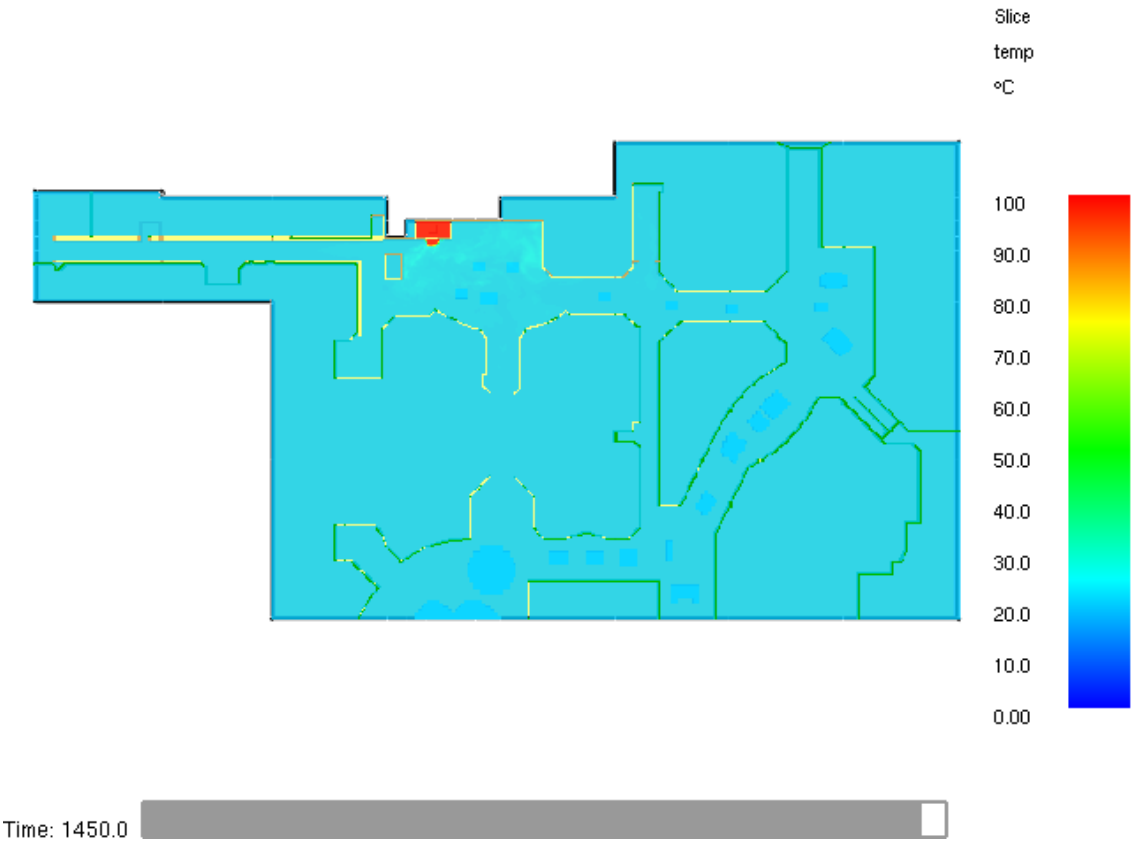

Figure 19-25: Fresh Food Market Mall Area Ground level – Temperature at **1450 Seconds**

19.4 REDUNDANCY FIRE SCENARIO – FRESH FOOD MARKET LEVEL 1

Fire Scenario	Fire Description
RFS-FFM-01	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat Release Rate at 900 seconds: 5,018kW Heat of Combustion: 31.8 MJ/kg Chemical Composition: $CH_{1.53}O_{0.26}N_{0.03125}$ Soot yield: 6% (after 25% soot deposition) Smoke exhaust activation time: *109 seconds* (refer **Section 18**) Limiting criteria: visibility and temperature (refer **Section 14.5.6**)

19.4.1 VISIBILITY OF THE FRESH FOOD MARKET

Figure 19-26: Fresh Food Market visibility level 1– Temperature at **120 Seconds**

Figure 19-27: Fresh Food Market visibility level 1– Temperature at **240 Seconds**

Figure 19-28: Fresh Food Market visibility level 1– Temperature at **360 Seconds**

Figure 19-29: Fresh Food Market visibility level 1– Temperature at **480 Seconds**

Figure 19-30: Fresh Food Market visibility level 1– Temperature at **600 Seconds**

Figure 19-31: Fresh Food Market visibility level 1– Temperature at **720 Seconds**

Figure 19-32: Fresh Food Market visibility level 1– Temperature at **1500 Seconds**

19.4.2 TEMPERATURE OF THE RETAIL MALL (RFS-FFM-01)

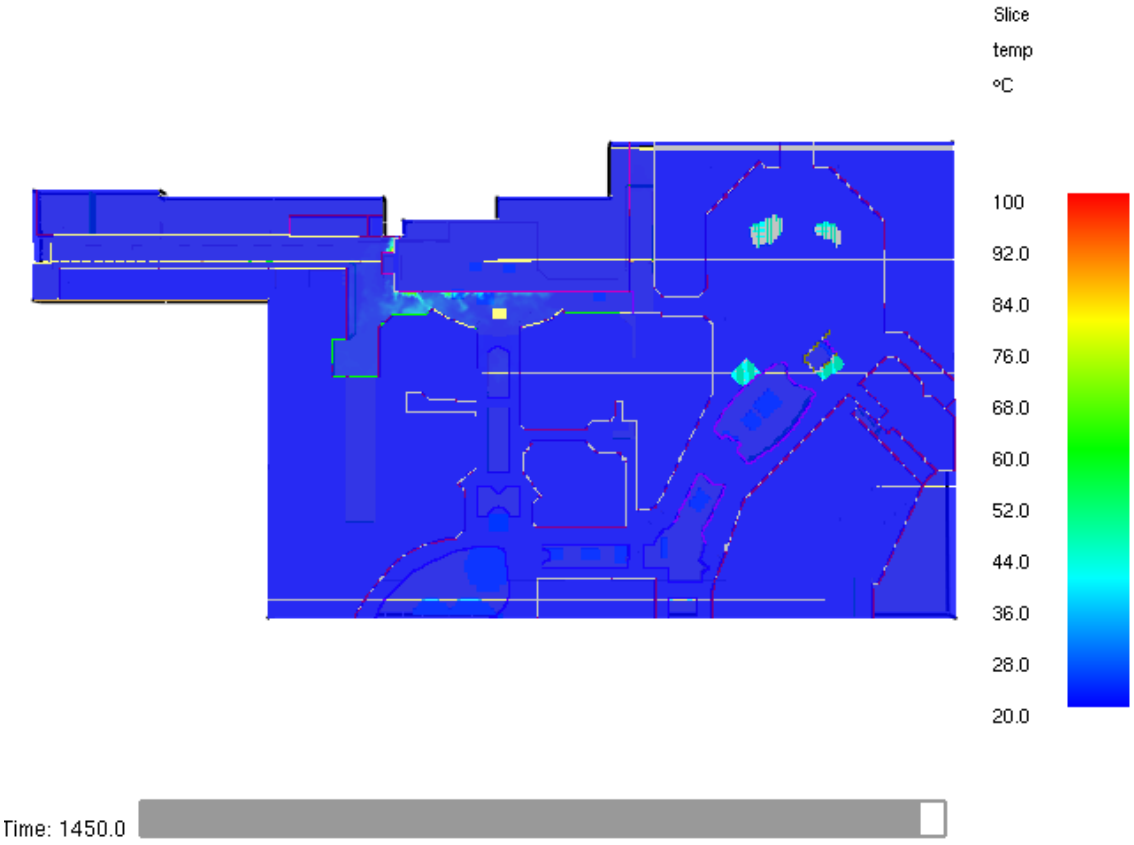

Figure 19-33: Fresh Food Market Mall Area level 1 – Temperature at **1500 Seconds**

19.5 REDUNDANCY FIRE SCENARIO – FRESH FOOD MARKET GROUND LEVEL

Fire Scenario	Fire Description
RFS-FFM-02	"Fast" t-squared growth rate fire capped off at 336 seconds (5MW fire) to assess smoke exhaust requirements to maintain tenability for occupant evacuation. FDS modelling. Heat Release Rate at 900 seconds: 5,018kW Heat of Combustion: 31.8 MJ/kg Chemical Composition: $CH_{1.53}O_{0.26}N_{0.03125}$ Soot yield: 6% (after 25% soot deposition) Smoke exhaust activation time: *109 seconds* (refer **Section 18**) Limiting criteria: visibility and temperature (refer **Section 14.5.6**)

19.5.1 VISIBILITY OF THE FRESH FOOD MARKET (RFS-FFM-02)

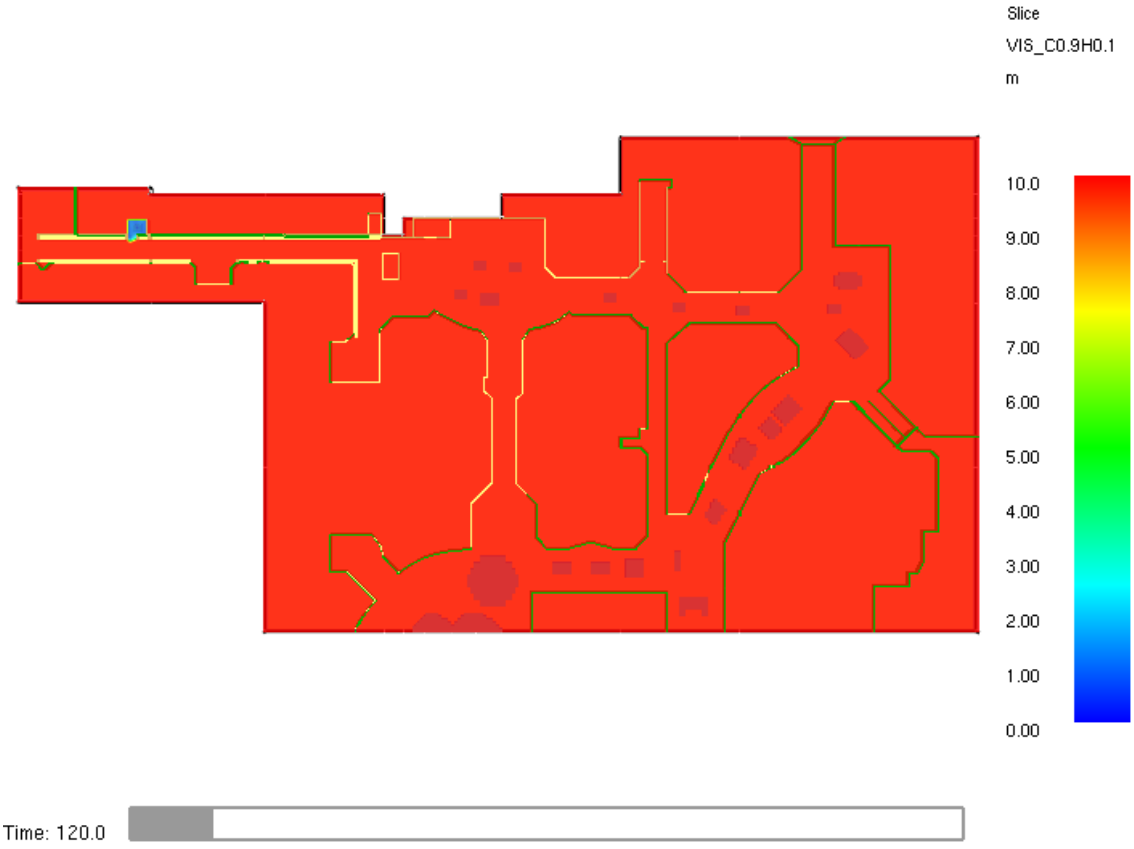

Figure 19-34: Fresh Food Market visibility level 1– Temperature at **120 Seconds**

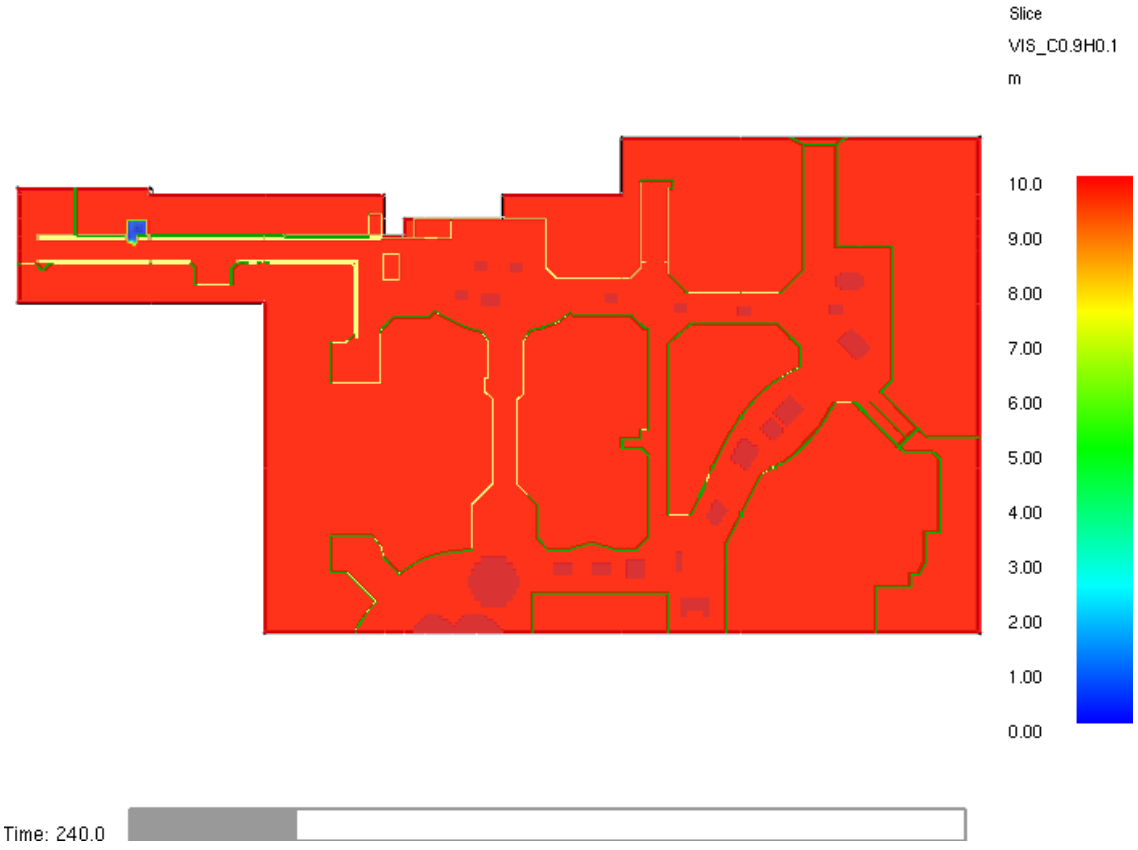

Figure 19-35: Fresh Food Market visibility level 1– Temperature at **240 Seconds**

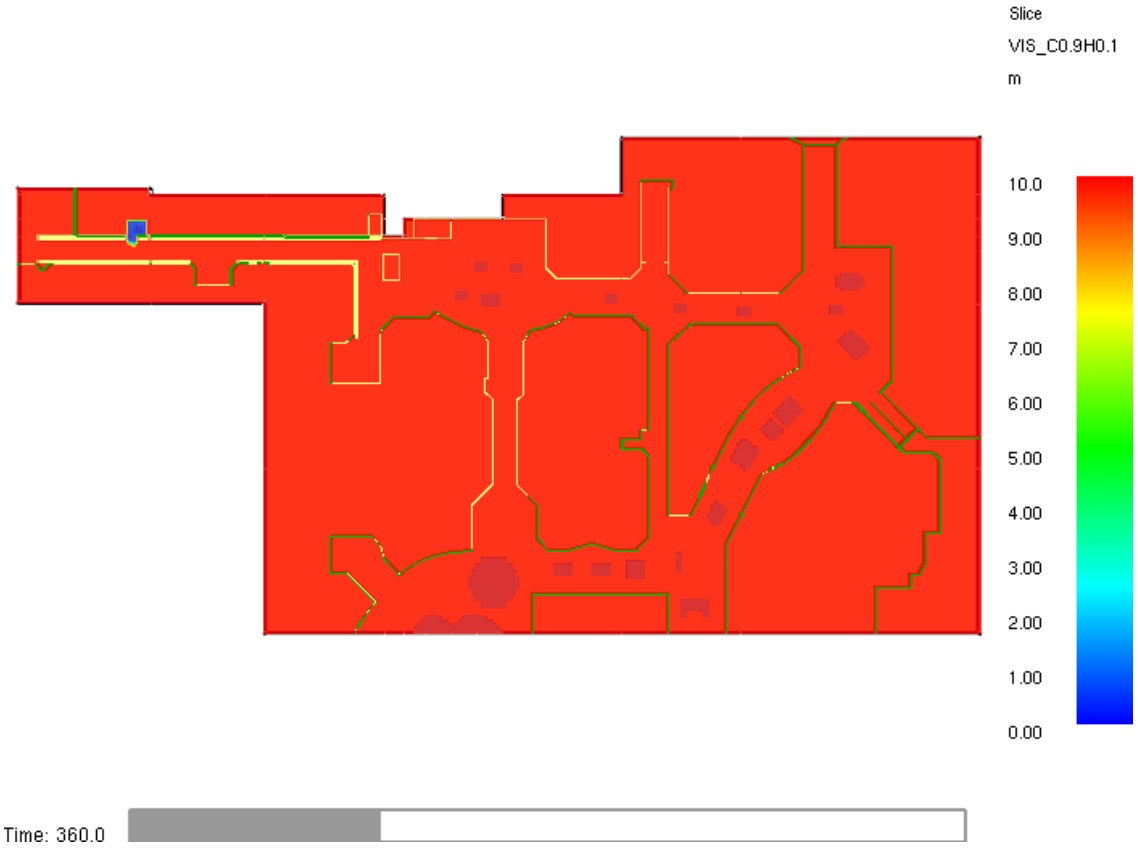

Figure 19-36: Fresh Food Market visibility level 1– Temperature at **360 Seconds**

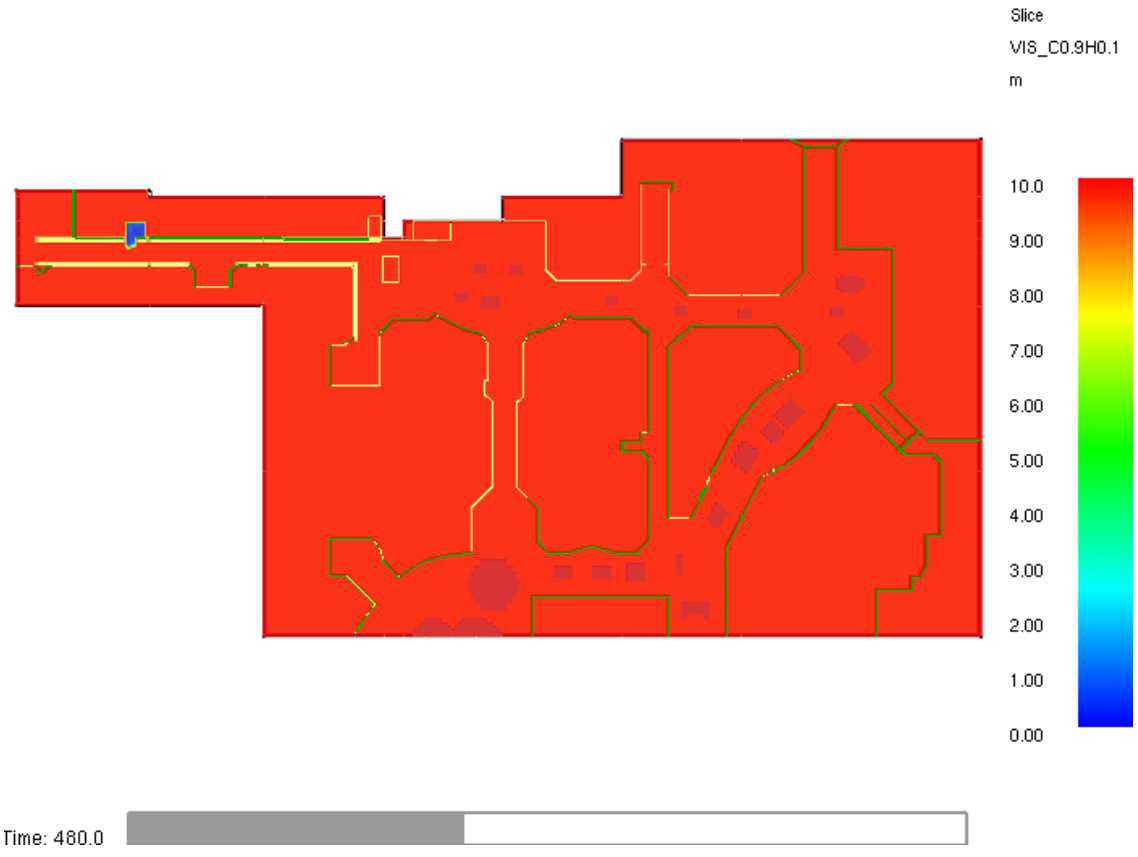

Figure 19-37: Fresh Food Market visibility level 1– Temperature at **480 Seconds**

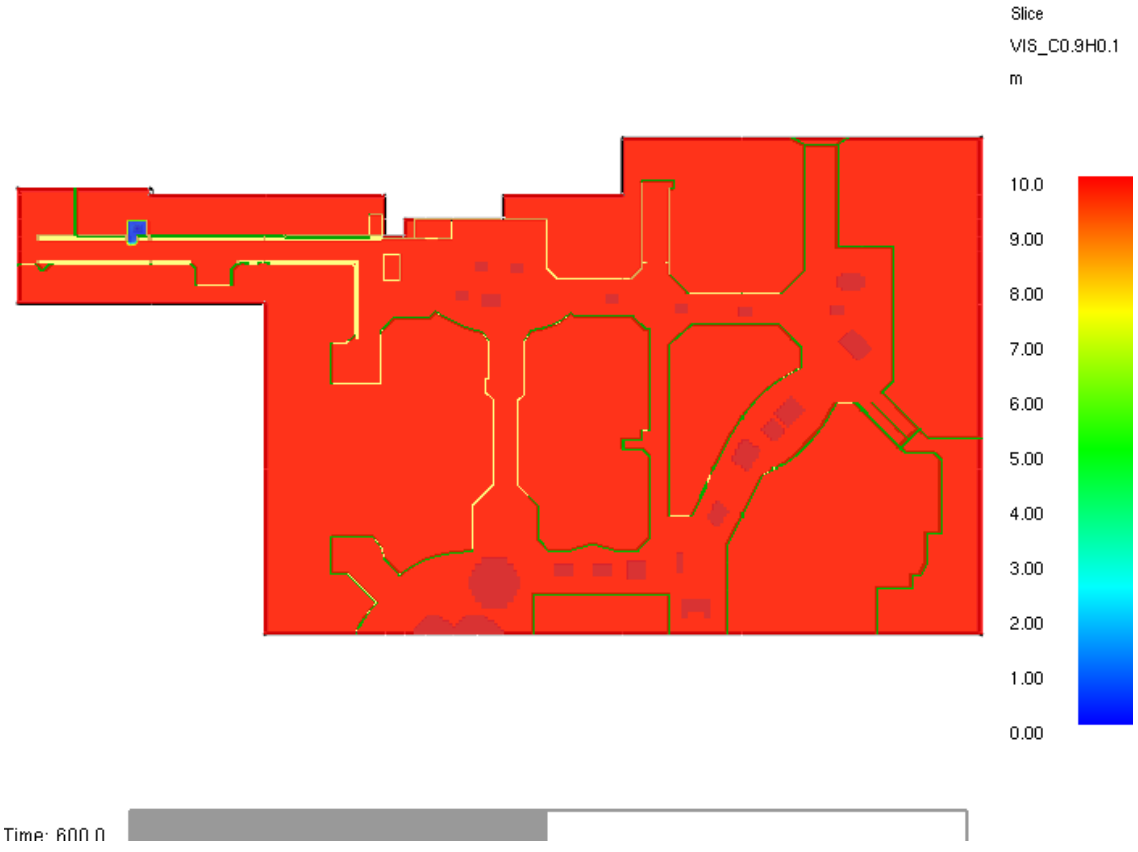

Figure 19-38: Fresh Food Market visibility level 1– Temperature at **600 Seconds**

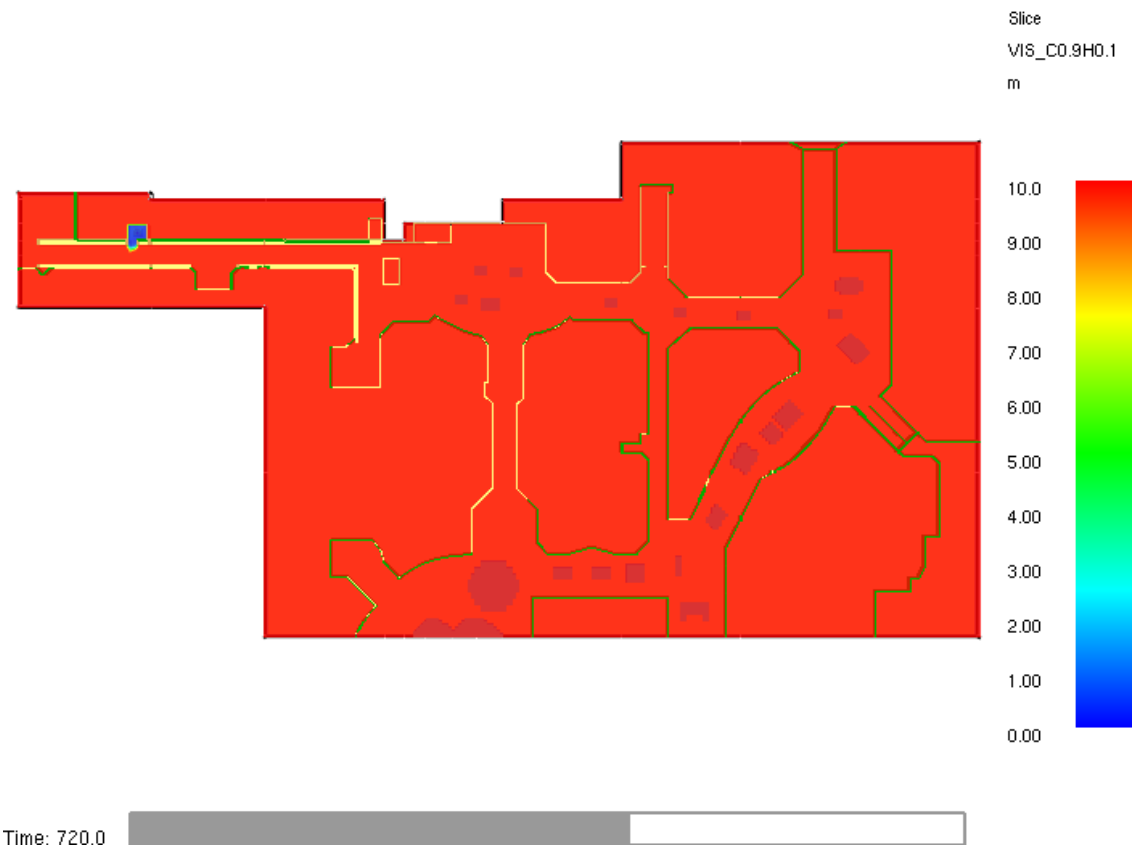

Figure 19-39: Fresh Food Market visibility level 1– Temperature at **720 Seconds**

19.5.2 TEMPERATURE OF THE RETAIL MALL (RFS-FFM-02)

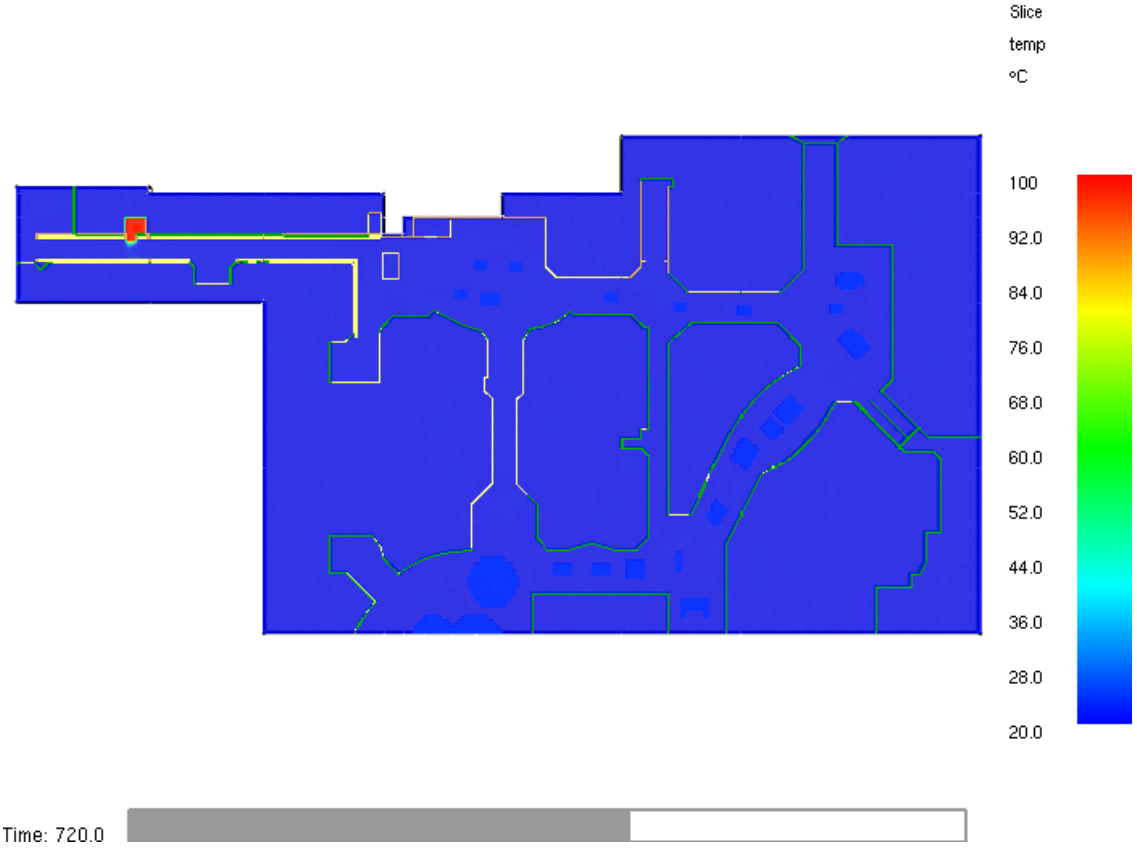

Figure 19-40: Fresh Food Market Mall Area level 1 – Temperature at **720 Seconds**

20. APPENDIX D – EVACUATION RESULTS FROM EGRESS MODELLING USING PATHFINDER

The following is the summary of the output data from Pathfinder for the egress modelling for the Tenancy MM-1010 of Warringah Mall.

20.1 TENANCY MM-1010 EVACUATION RESULTS

FIRE ENGINEERING PROFESSIONALS
ENGINEERING BETTER ALTERNATIVE SOLUTIONS FOR THE CONSTRUCTION INDUSTRY
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Time For Passage Calculations (Occupant Queue Time)

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Project Title:

Calculations	Comments
Time For Passage	
$t_p = \frac{P}{(1 - a\,.\,D)\,.k\,.D\,.W_e}$	Time for passage (SFPE, 2016)
where D is derived from:	
$F_s = (1 - a\,.\,D)\,.k\,.D$ if $F_s < F_c$	Specific Flow
or	
$F_c = (1 - a\,.\,D)\,.k\,.D\,.W_e$ if $F_s > F_c$	Calculated Flow (For unassisted doorways only)
Assumptions	
1) Queuing will occur at the exit	
$F_s = F_s(max)$	Maximum specific flow for corridors, aisles, ramps and doorways (SFPE, 2016a)
$F_s(max)$ = 1.3 persons / s / m of effective width	
2) For doorways that are not mechanically held open, the following condition will apply.	
$F_c = F_c(max)$	Maximum calculated flow for unassisted doorways (SFPE, 2016b)
$F_c(max)$ = 50 persons / min / door leaf	
Characteristics of the Evacuation Compartment	
Population Size (P): 295 *persons*	
Number of Exits: 4	
Exit Route Element: *Door, archways* →	Proceed to Table 1.1
Boundary Layer: 150 *mm*	Boundary Layer (SFPE, 2016c)
Constants k 1.4	
a 0.266	

Table 1.1

Exit No.	No. of Door Leaves	Door Leaf Closing Mechanism
1	2	Self-closing
2	2	Self-closing
3	2	Self-closing
4	2	Self-closing

Table 1.2

Exit No.	Clear Exit Width (mm)	Effective Width (mm)	Number of Occupants	Population Density	Time For Passage (s)
1	2000	1700	74	0.93	44.25
2	2000	1700	74	0.93	44.25
3	2000	1700	74	0.93	44.25
4	2000	1700	74	0.93	44.25

Total time for passage (T_p) 45 seconds

20.2 MALL AREAS EVACUATION RESULTS

20.2.1 OUTPUT FILES

The output file from the Pathfinder simulation for the identified egress scenario is presented below:

Simulation: 2021.09.24 - Westfield Warringah

Version: 2015.2.1012

Mode: Steering

Total Occupants: 14224

Exit Times (s):

Min: 0.8

Max: 825,6

Average: 201.5

StdDev: 156.9

20.2.2 EVACUATION RESULTS

The following is the output data from egress modelling using the Pathfinder software. The evacuation (i.e. egress time) of the mall areas at Warringah Mall is as illustrated in **Figure 20-1**, presented below.

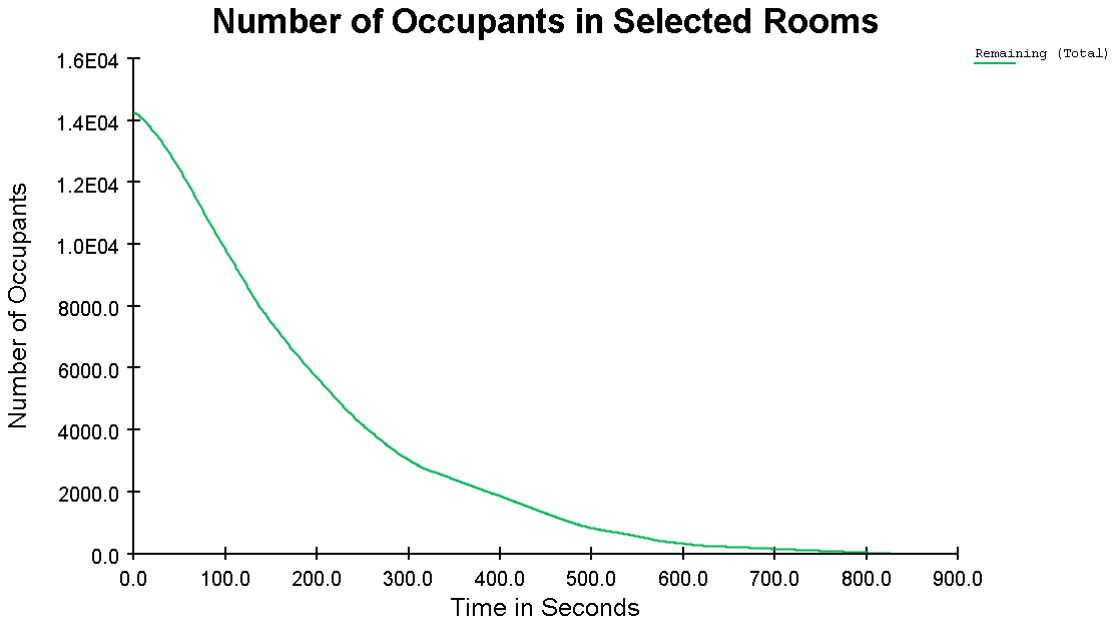

Figure 20-1: Occupation Evacuation Graph – **mall areas** Warringah Mall

20.2.3 PATHFINDER SNAPSHOTS

The Pathfinder snapshots of the evacuation of the mall areas of Warringah mall are documented in the figures below.

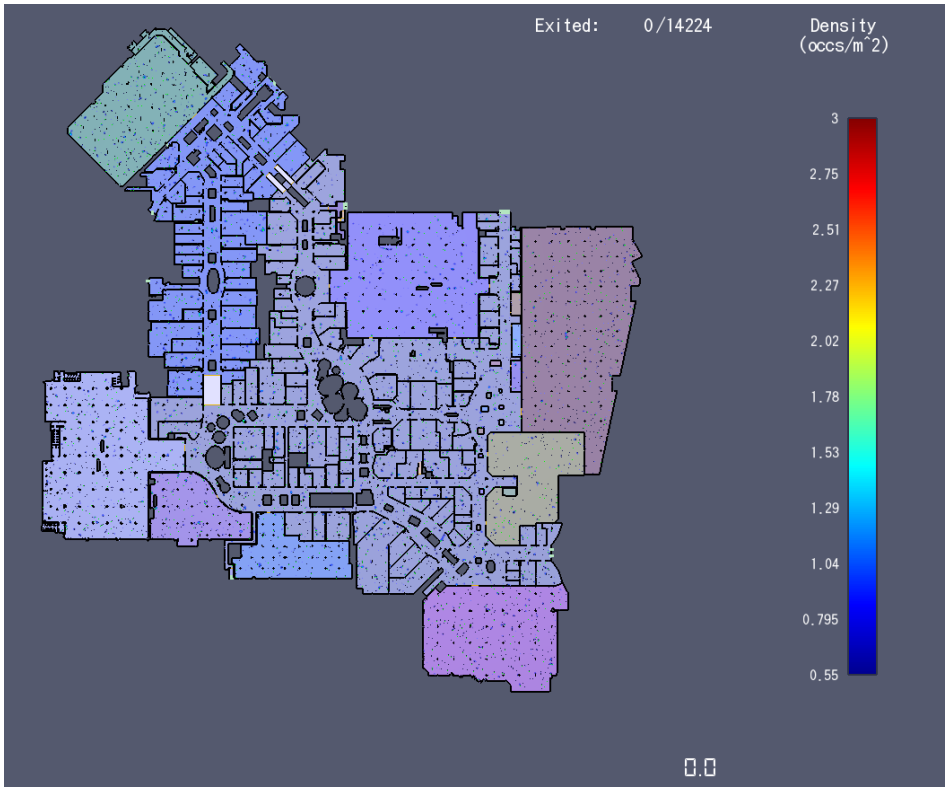

Figure 20-2: Location of occupants at egress time of **0 seconds –** Ground Level Warringah Mall

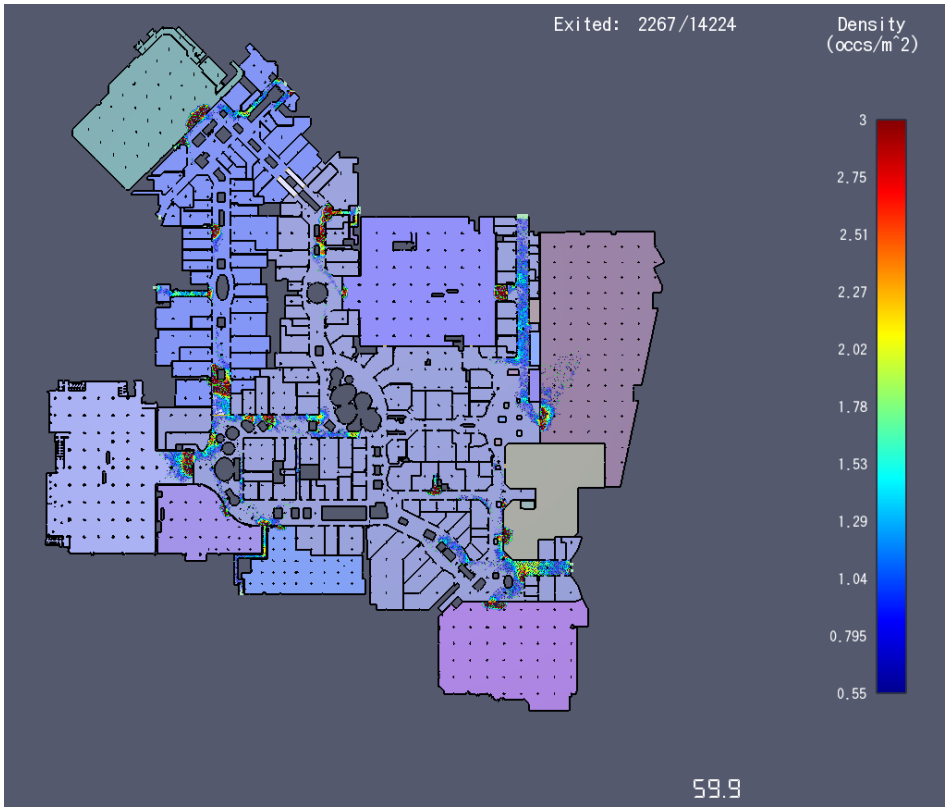

Figure 20-3: Location of occupants at egress time of **60 seconds –** Ground Level Warringah Mall

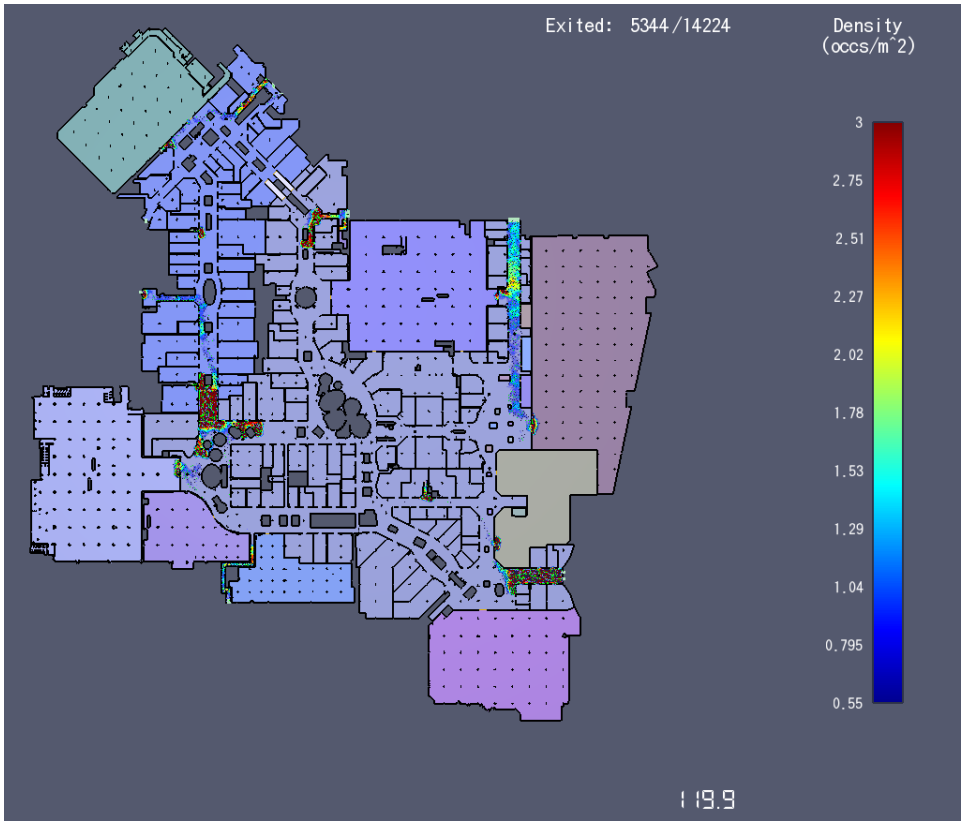

Figure 20-4: Location of occupants at egress time of **120 seconds –** Ground Level Warringah Mall

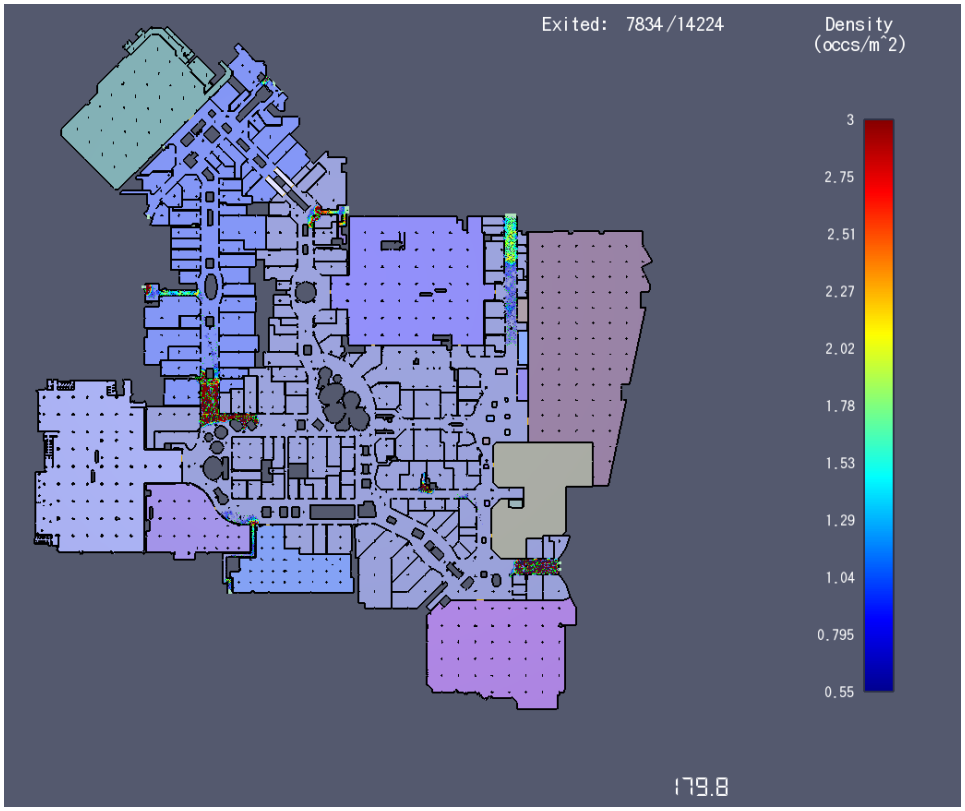

Figure 20-5: Location of occupants at egress time of **180 seconds –** Ground Level Warringah Mall

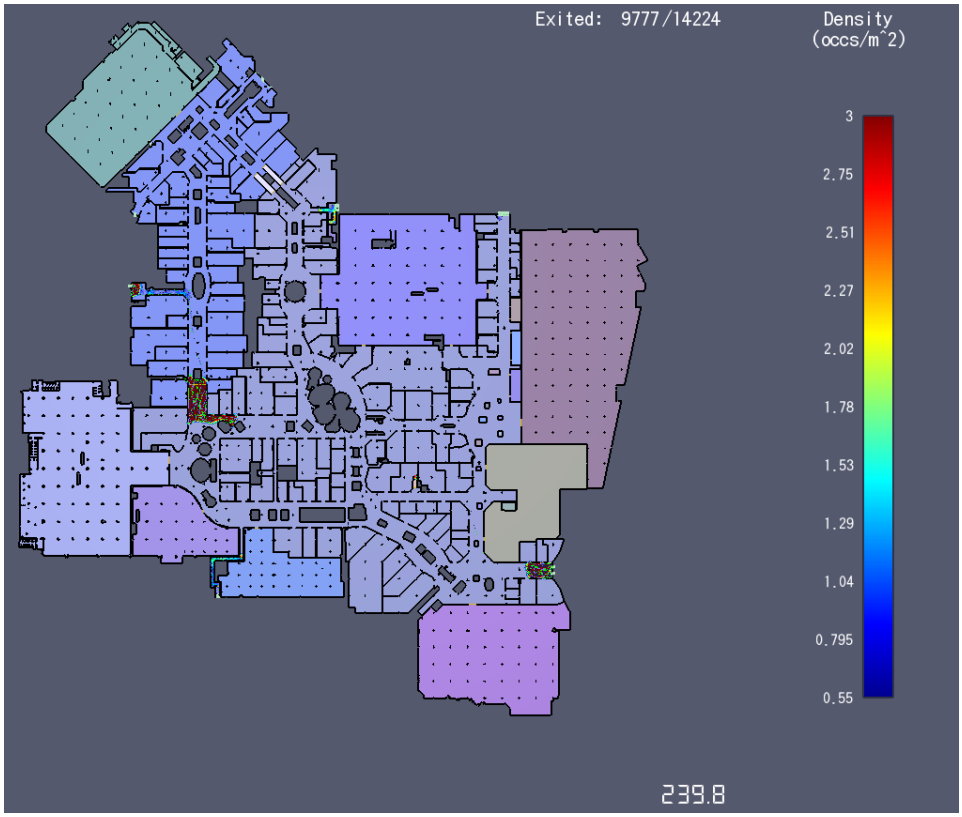

Figure 20-6: Location of occupants at egress time of **240 seconds –** Ground Level Warringah Mall

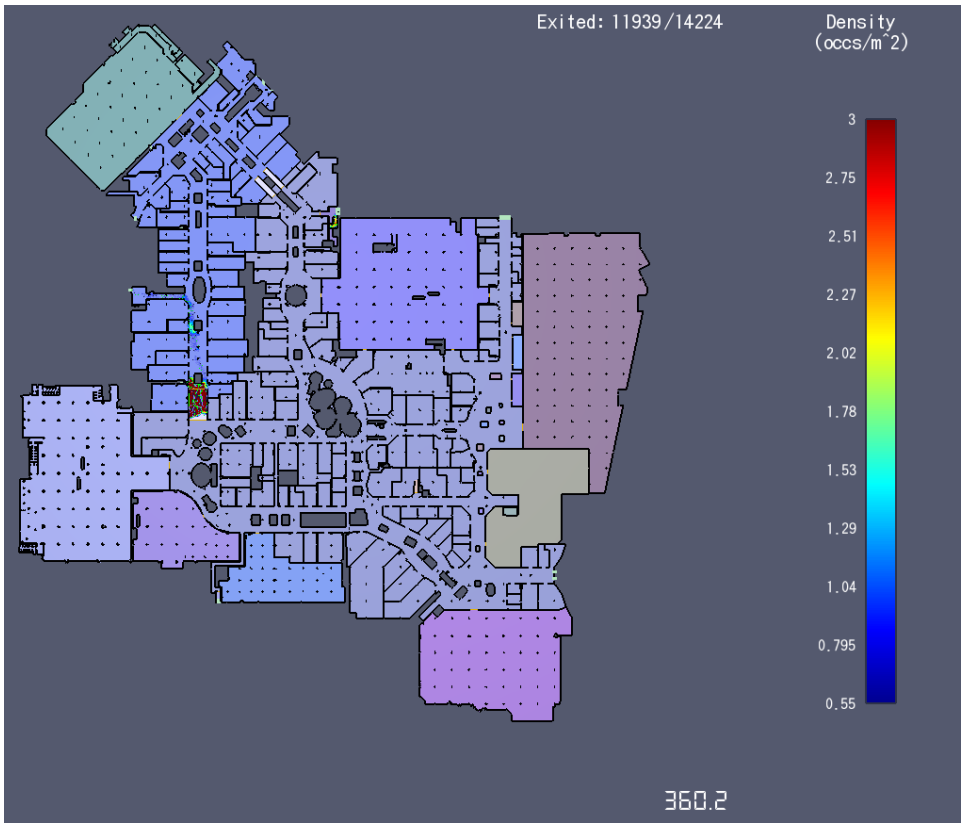

Figure 20-7: Location of occupants at egress time of **360 seconds –** Ground Level Warringah Mall

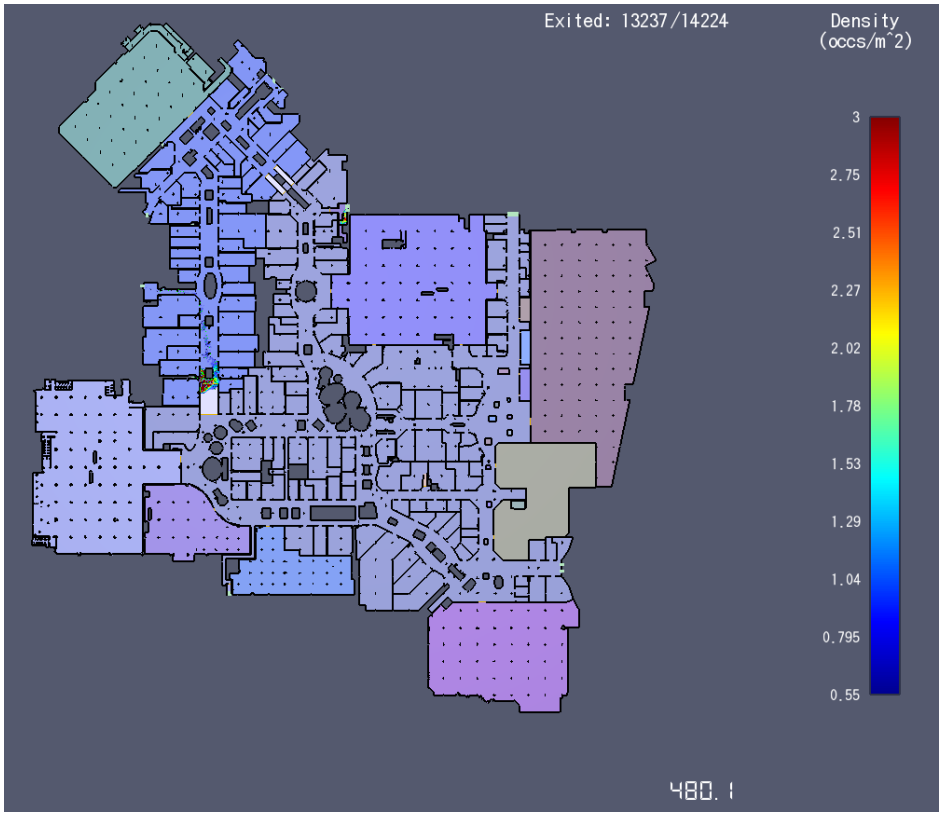

Figure 20-8: Location of occupants at egress time of **480 seconds –** Ground Level Warringah Mall

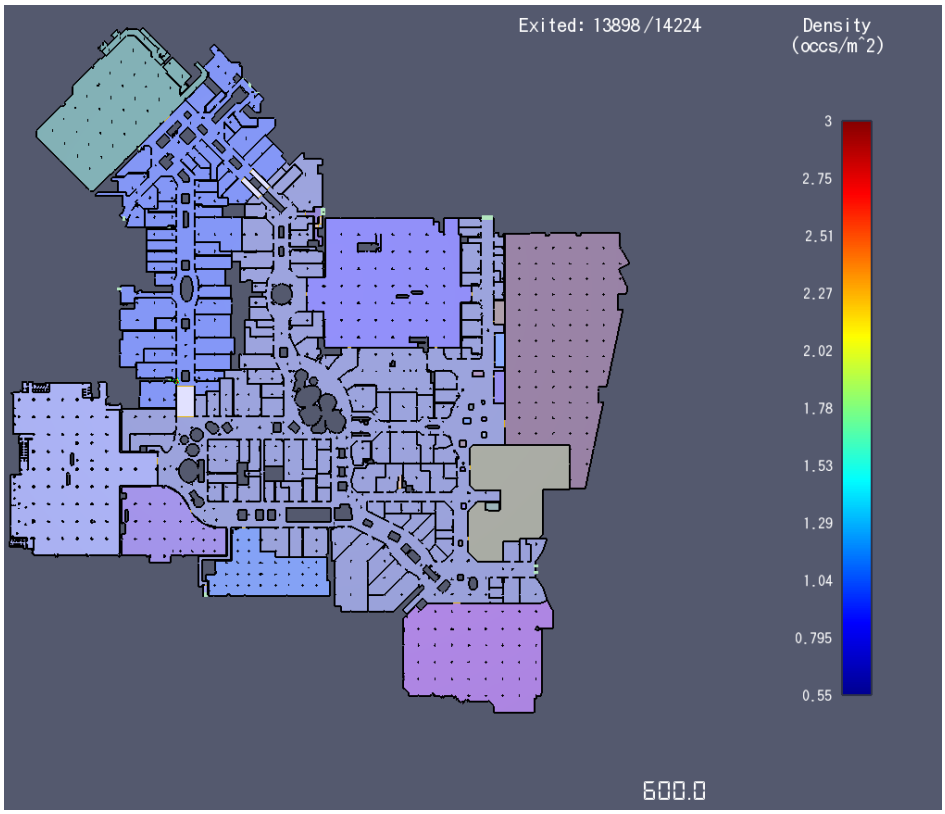

Figure 20-9: Location of occupants at egress time of **600 seconds –** Ground Level Warringah Mall

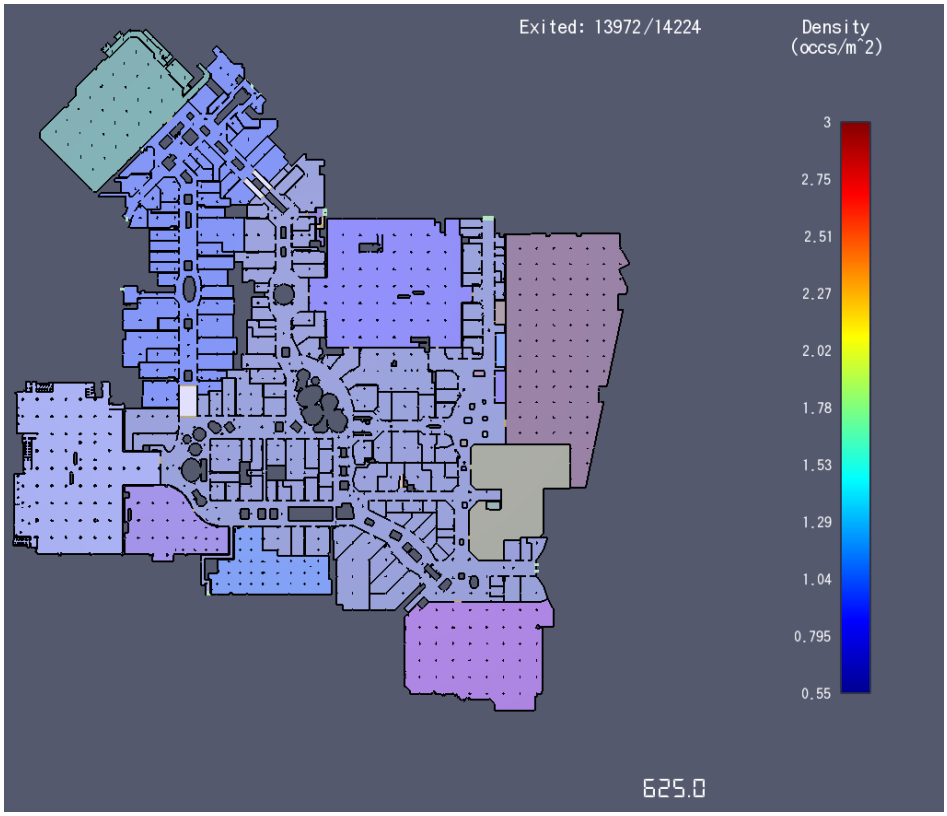

Figure 20-10: Location of occupants at egress time of **625 seconds –** Ground Level Warringah Mall

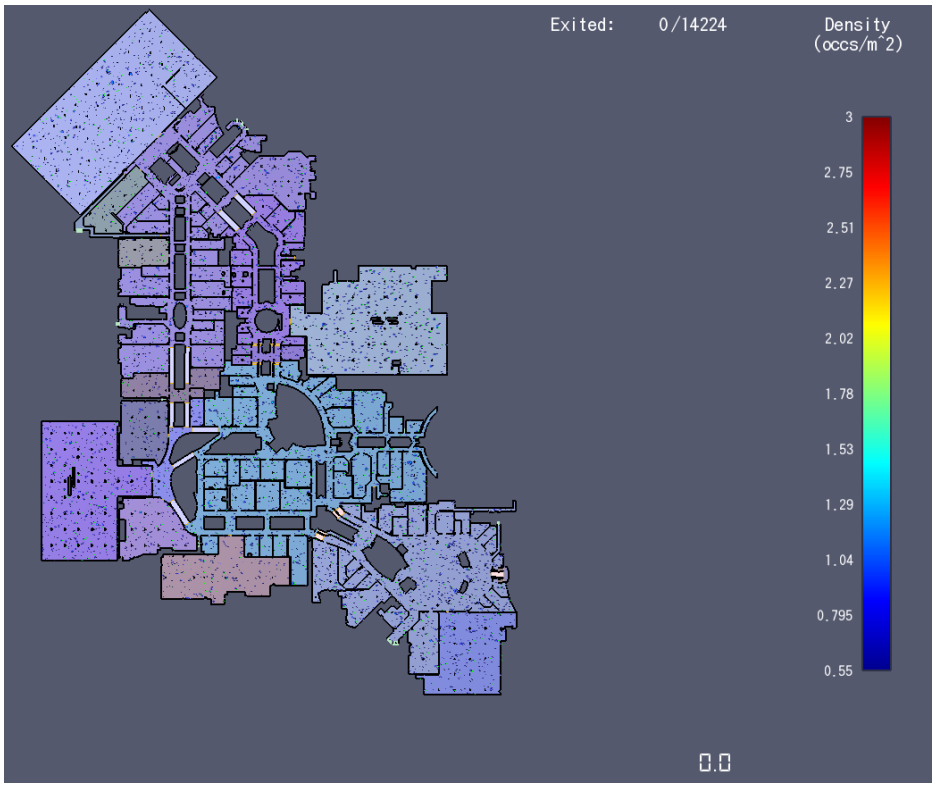

Figure 20-11: Location of occupants at egress time of **0 seconds –** Level 1 Warringah Mall

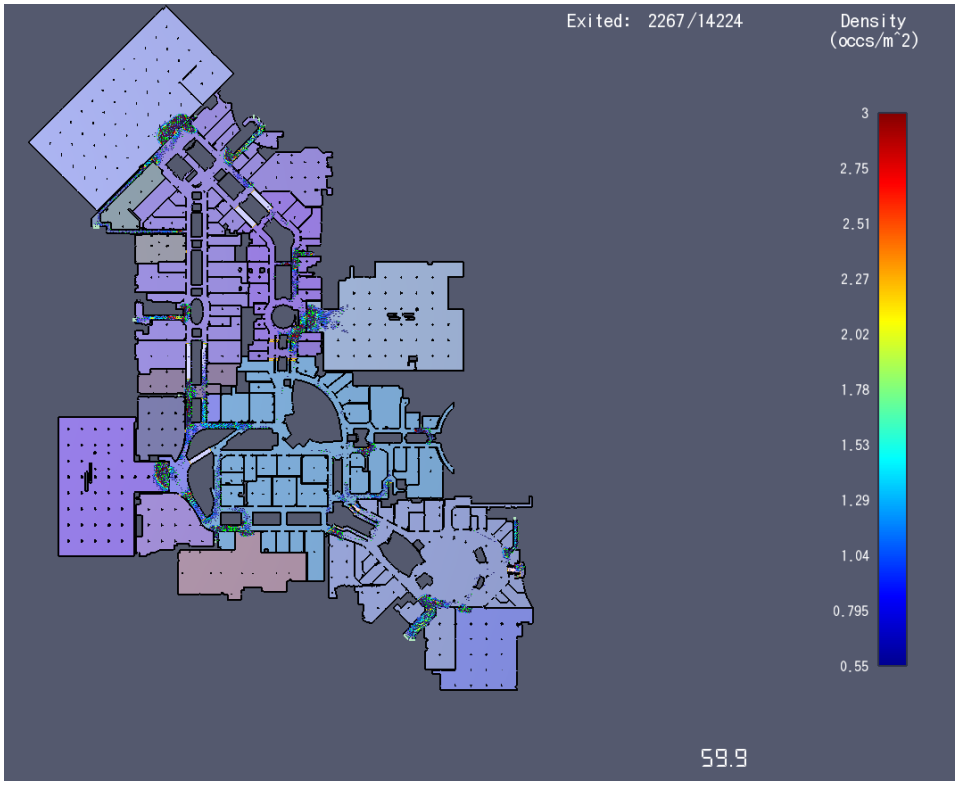

Figure 20-12: Location of occupants at egress time of **60 seconds –** Level 1 Warringah Mall

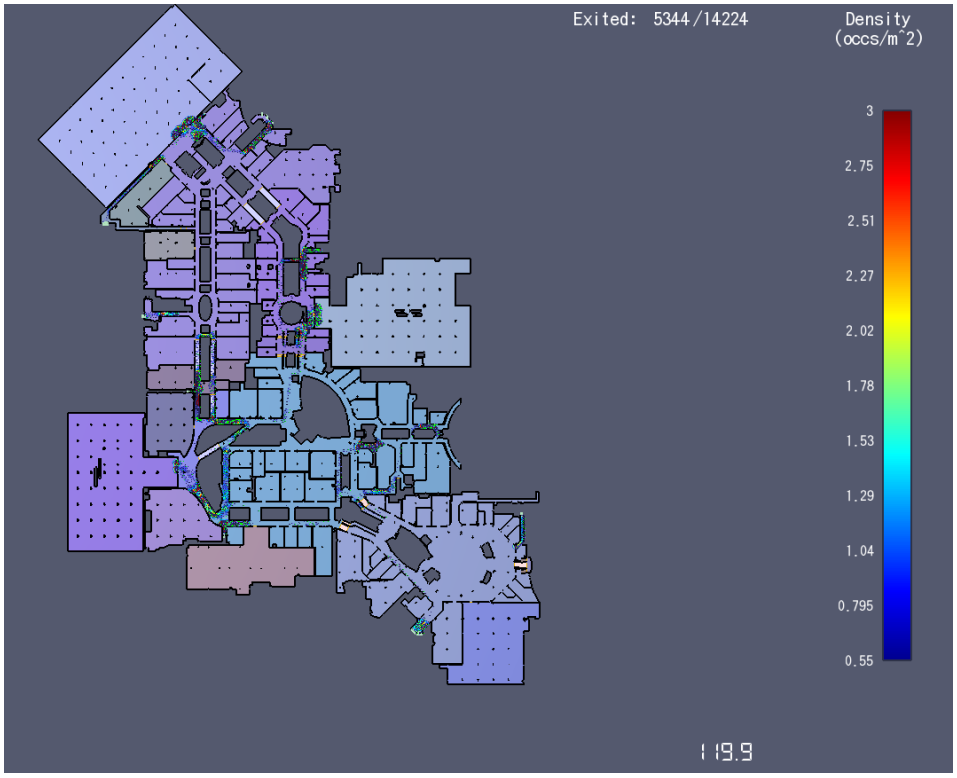

Figure 20-13: Location of occupants at egress time of **120 seconds –** Level 1 Warringah Mall

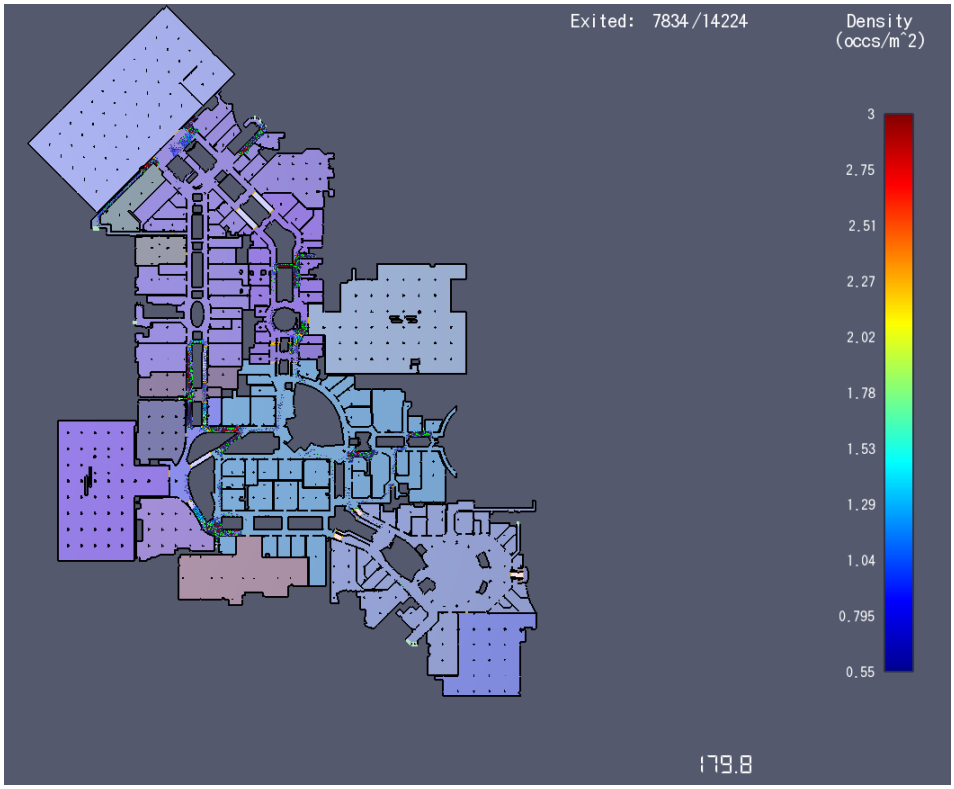

Figure 20-14: Location of occupants at egress time of **180 seconds –** Level 1 Warringah Mall

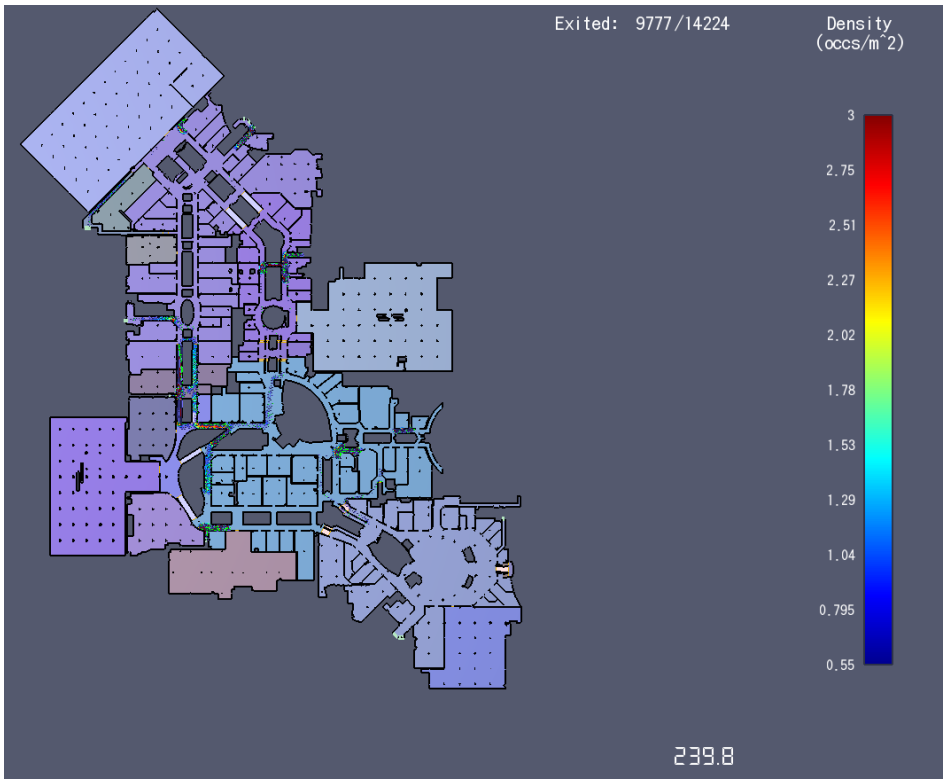

Figure 20-15: Location of occupants at egress time of **240 seconds –** Level 1 Warringah Mall

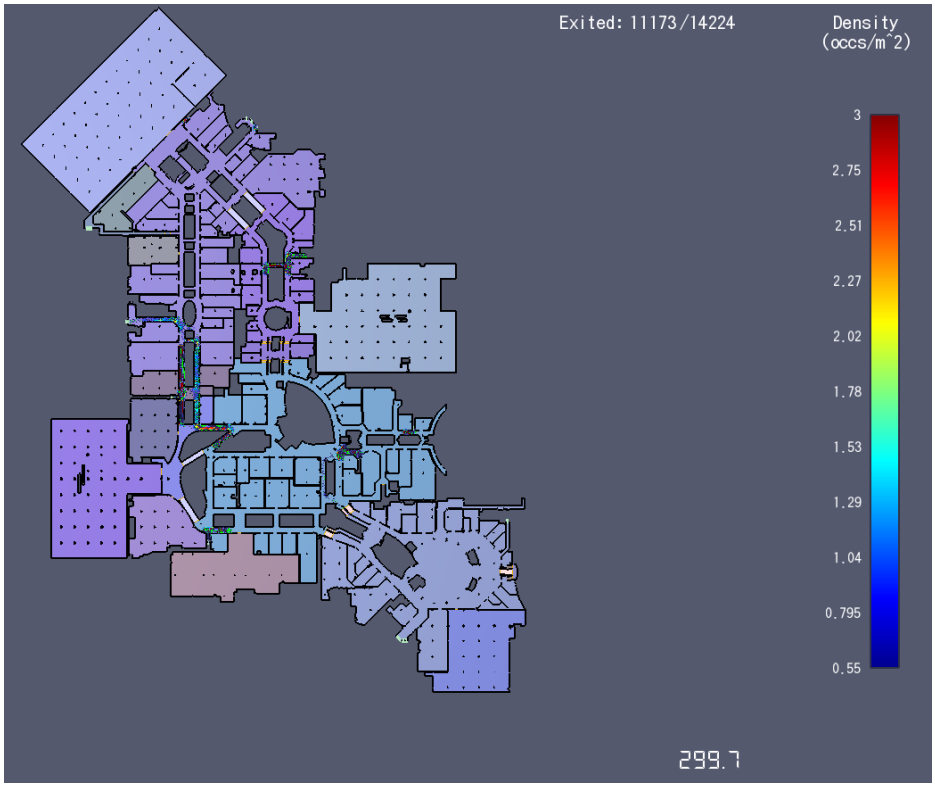

Figure 20-16: Location of occupants at egress time of **300 seconds –** Level 1 Warringah Mall

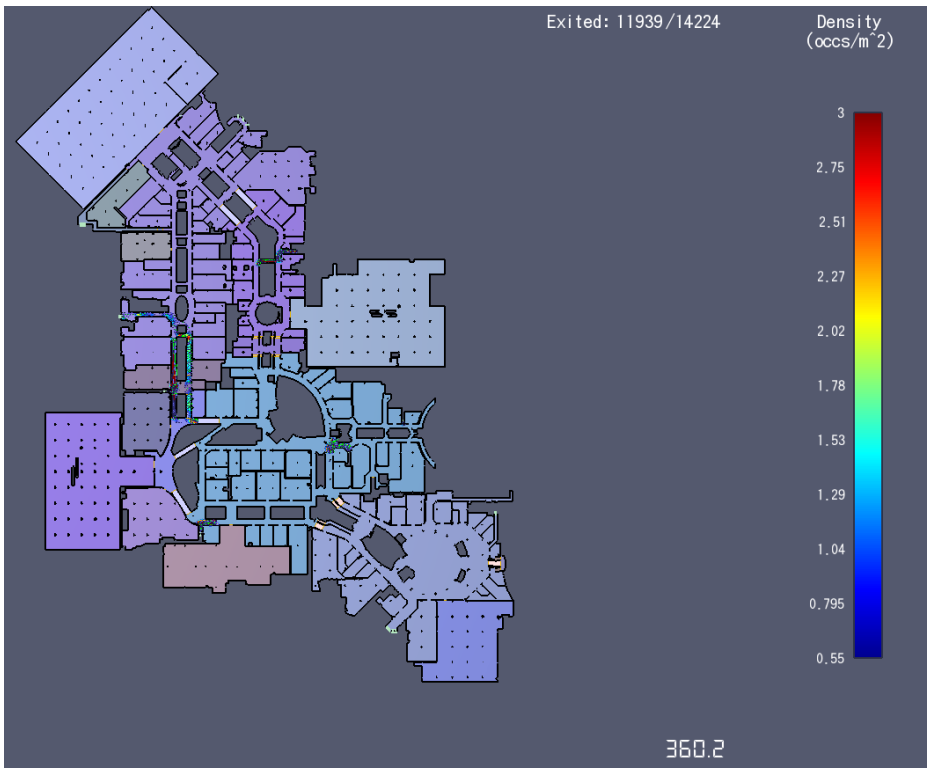

Figure 20-17: Location of occupants at egress time of **360 seconds –** Level 1 Warringah Mall

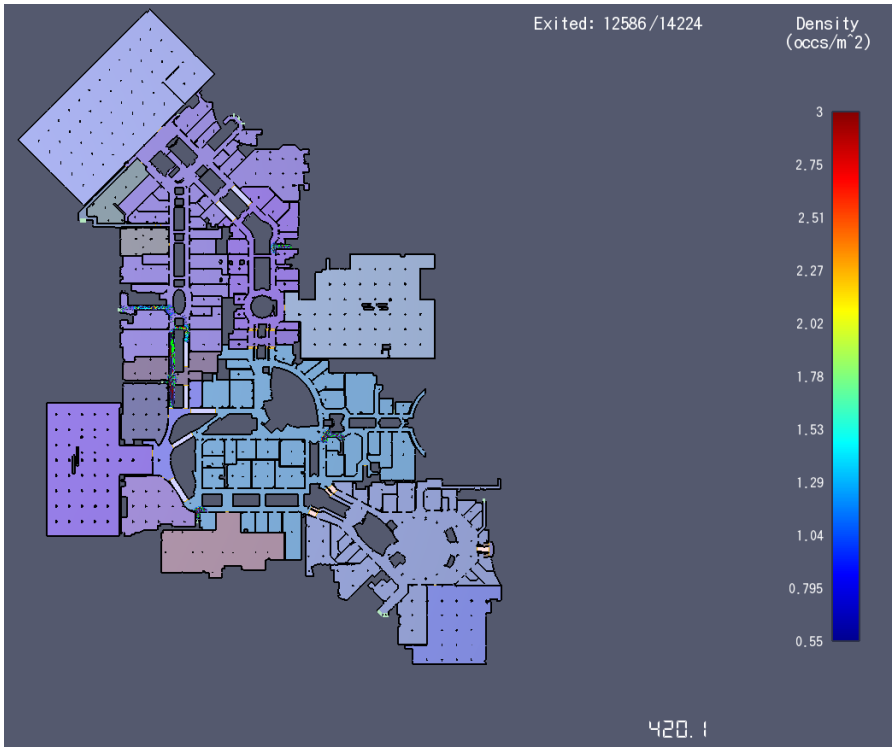

Figure 20-18: Location of occupants at egress time of **420 seconds –** Level 1 Warringah Mall

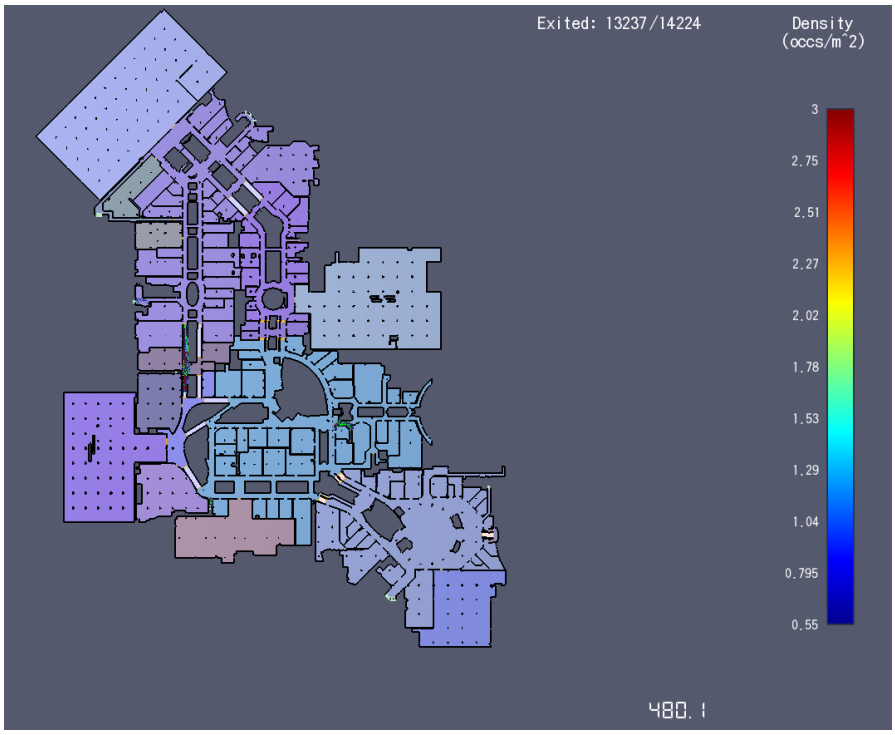

Figure 20-19: Location of occupants at egress time of **480 seconds –** Level 1 Warringah Mall

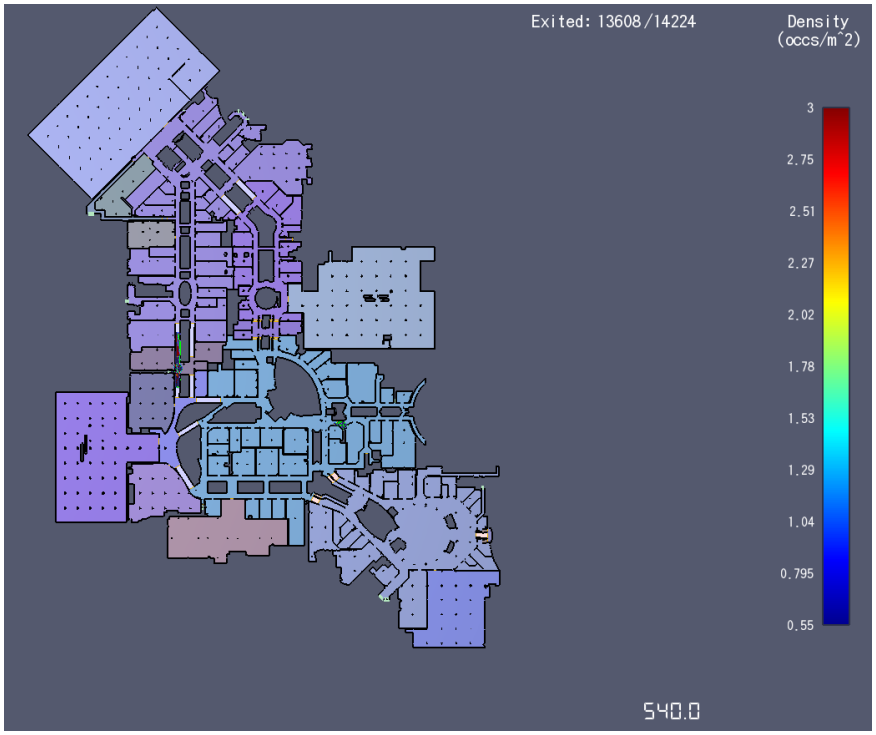

Figure 20-20: Location of occupants at egress time of **540 seconds –** Level 1 Warringah Mall

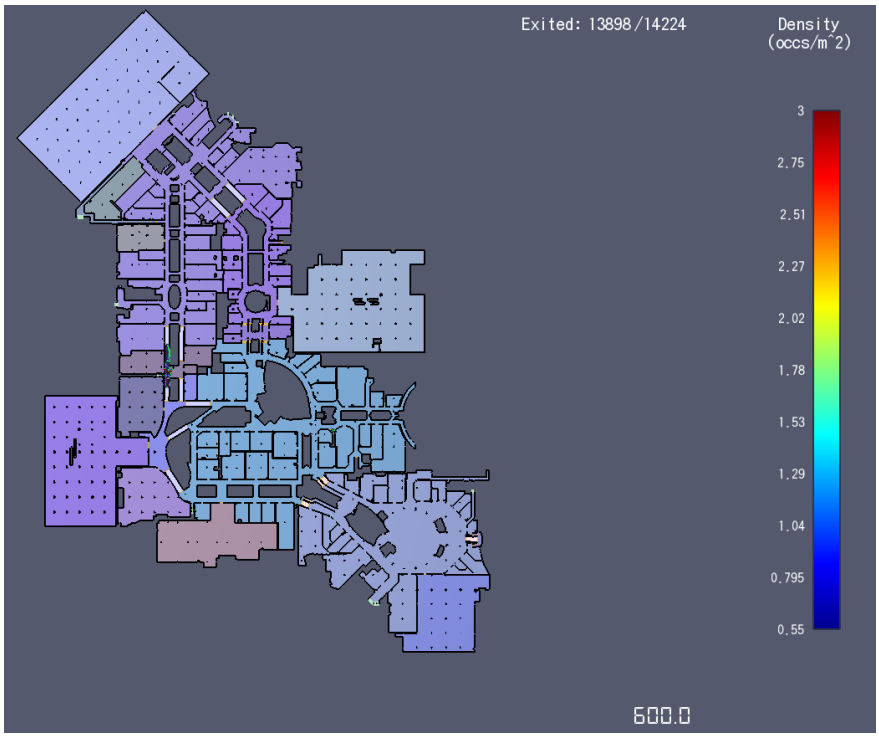

Figure 20-21: Location of occupants at egress time of 600 seconds – **Level 1 Warringah Mall**

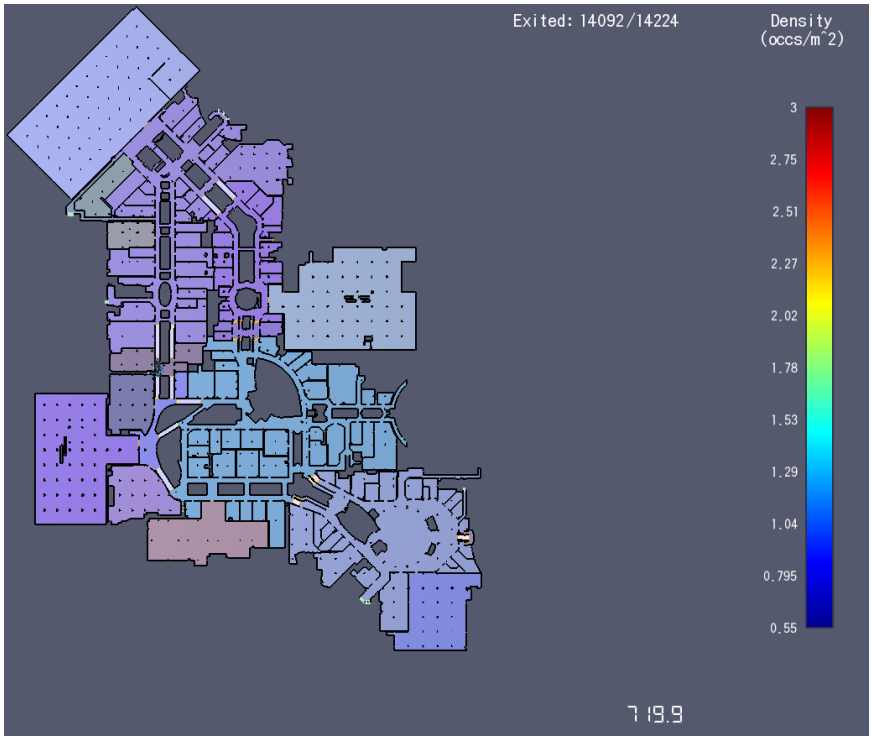

Figure 20-22: Location of occupants at egress time of 720 seconds – **Level 1 Warringah Mall**

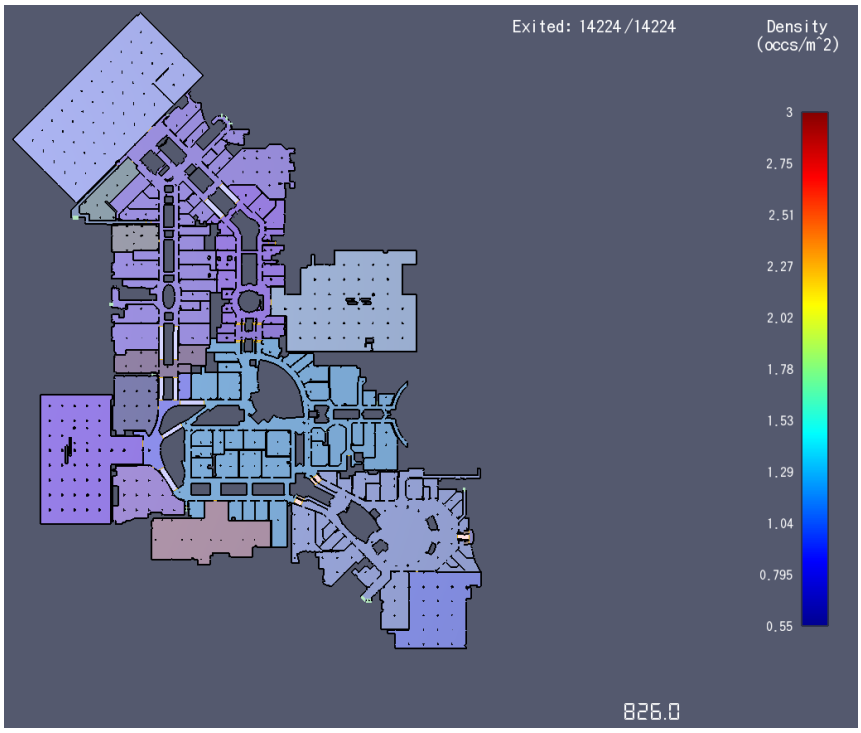

Figure 20-23: Location of occupants at egress time of 826 seconds – **Level 1 Warringah Mall**

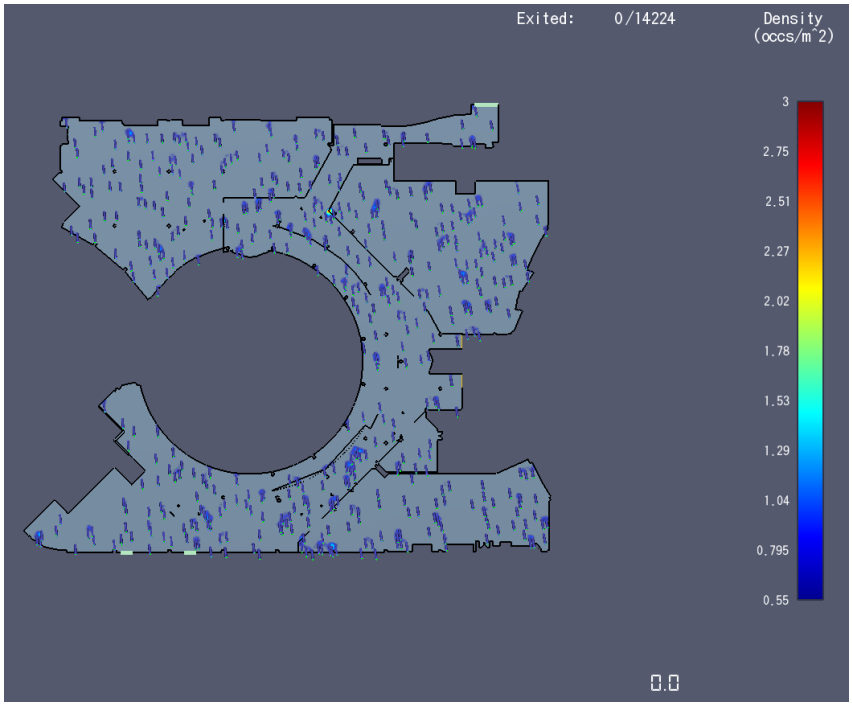

Figure 20-24: Location of occupants at egress time of 0 seconds – **Level 2 Warringah Mall**

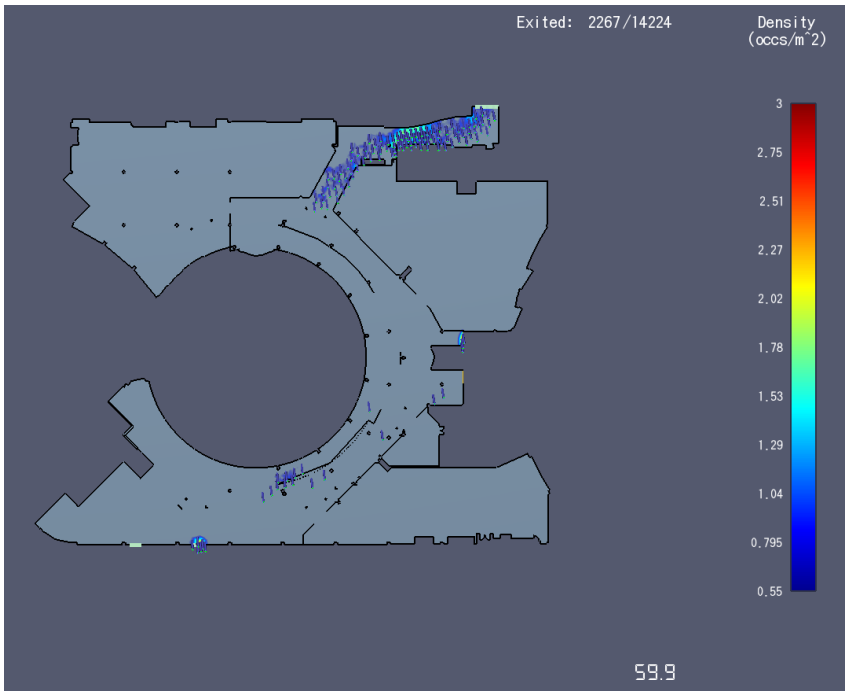

Figure 20-25: Location of occupants at egress time of 60 seconds – **Level 2 Warringah Mall**

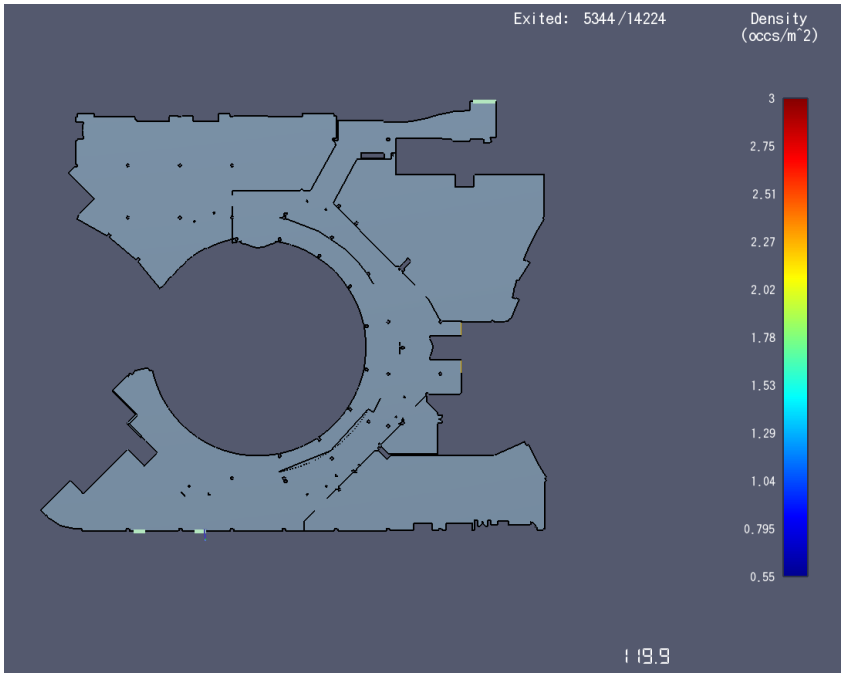

Figure 20-26: Location of occupants at egress time of 120 seconds – **Level 2 Warringah Mall**