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Acknowledgement of Country

Engineers Australia acknowledges the traditional custodians of the country throughout Australia and recognises their continuing connection to land, waters and community.

We pay our respects to them and their cultures; and to elders past and present and emerging.



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Overcoming challenges of occupant fire evacuations from childcare centres

27 January 2022

Society of Fire Safety



CPD  online

Overcoming challenges of occupant fire evacuations from childcare centres



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Overcoming Challenges of Occupant Evacuations from Childcare Centers

This part of the presentation will look at the challenges in providing a Fire Engineering evacuation assessment of a multistorey ECC that has a rise in storeys of more than 2.

Using a simulated mixed use ECC building as a worked example/ case study.

Particular focus will be on the fire safety systems, pre-movement times, and the evacuation speeds of child-care occupants.



NCC (BCA) Requirements

D1.18 Egress from early childhood centres

- (a) Every part of a Class 9b *early childhood centre* must be wholly within a *storey* that provides direct egress to a road or *open space*.
- (b) The requirements of (a) do not apply in a building with a *rise in storeys* of not more than 2, where the Class 9b *early childhood centre* is the only use in that building.

Explanatory information:

D1.18(a) recognises the difficulties associated with evacuation of *early childhood centres*. Should an *early childhood centre* be proposed within a *storey* that does not meet the requirements of D1.18(a), a *Performance Solution* is to be used to demonstrate compliance with the relevant *Performance Requirements*.



DtS Minimum Egress Requirements

BCA Clause	Egress Requirement
D1.2 – No. of Exits Required	At least one exit from each storey
D1.3 – When fire isolated exits are required	Stairway to be fire isolated when used as an exit.
D1.4 – Exit Travel Distance	20m to a point-of-choice of exits 40m to an exit
D1.5 – Distance between Alternative Exits	Between 9m and 60m apart
D1.6 – Dimensions of exits	Unobstructed width of 1m required (except doorway)
D1.13 – No. of Persons Accommodated	4m ² per person



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Other Relevant Legislation

Child Care Services Act 2007

Child Care Services Regulations 2007

Child Care Services (Child Care) Regulations 2006

Staff Number (Educator:Child)	Childrens Age (Years)
1:4	0 – 2
1:5	2 – 3
1:10	3 – 5



Performance Solution

DP4 Exits

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.



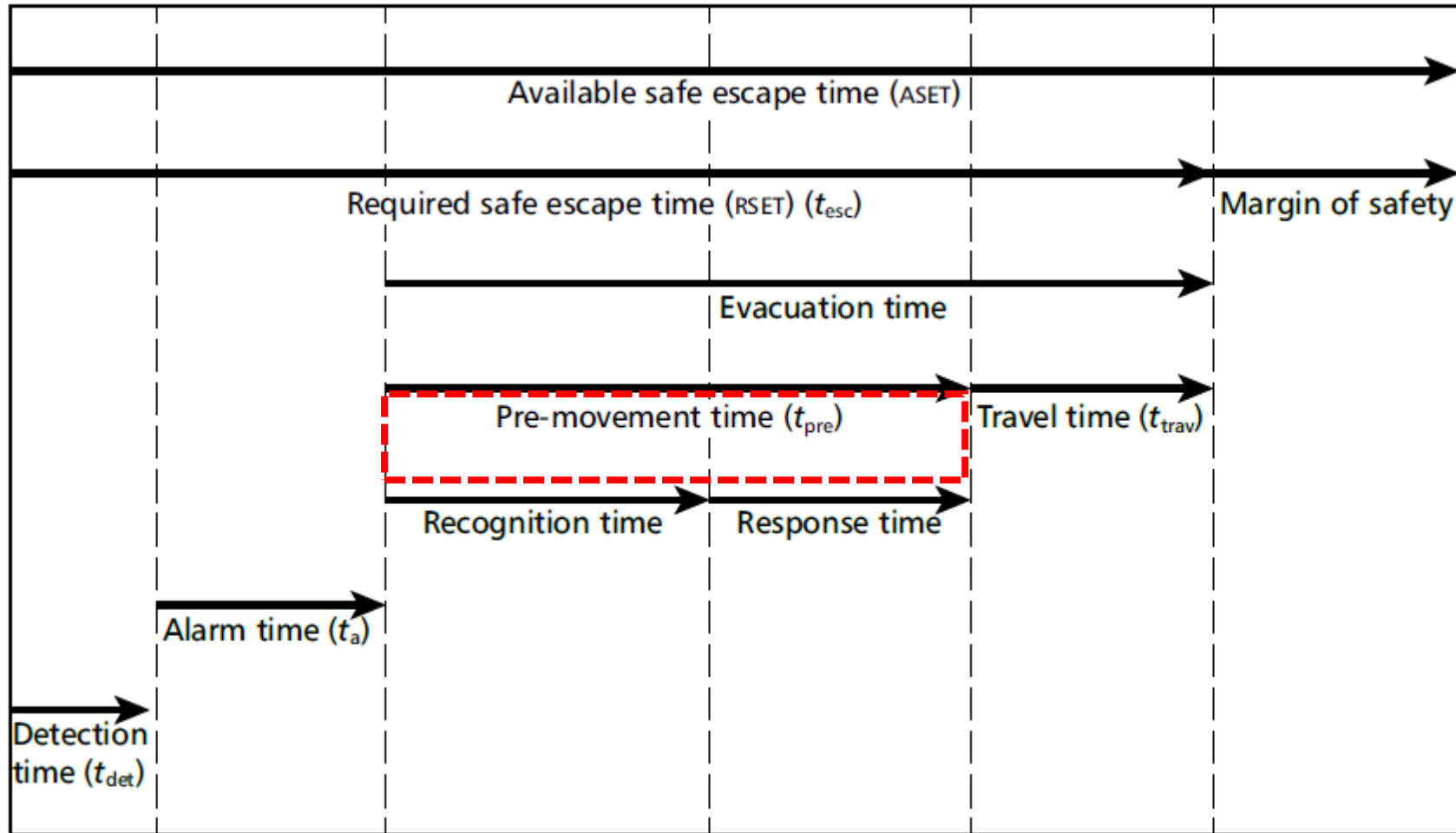
Performance Solution

EP2.2 Safe evacuation routes

- (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.



ASET v. RSET Assessment





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Overcoming Challenges of Occupant Evacuations from Childcare Centers

It is considered that a ECC greater than 2 storeys may not have adequate fire safety systems as required under the DtS Provisions

A Fire Engineer Assessment is therefore required, where a Performance Based Solution is provided to justify the design and the egress strategy for the ECC.

One of the biggest challenges for an egress assessment of an ECC is that there is currently limited data and peer reviewed reports available for the pre-movement times in an ECC, walking speeds for staff carrying children and also for the walking speeds young children self-egressing under the supervision of staff.



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Overcoming Challenges of Occupant Evacuations from Childcare Centers

To be able to make an accurate assessment of an occupant evacuation from an ECC requires the following:

- Intended number of children and ages.
- Intended staff to child ratio.
- Operators' intended evacuation strategy.
- Proposed fire safety systems.
- Benchmarks of the acceptance criteria for the assessment.

This requires early input from stakeholders, where guidance from the intended operator is highly beneficial.

This is sometimes problematic as the proposed operator may be uninvolved the design process or there is not an operator on board yet.



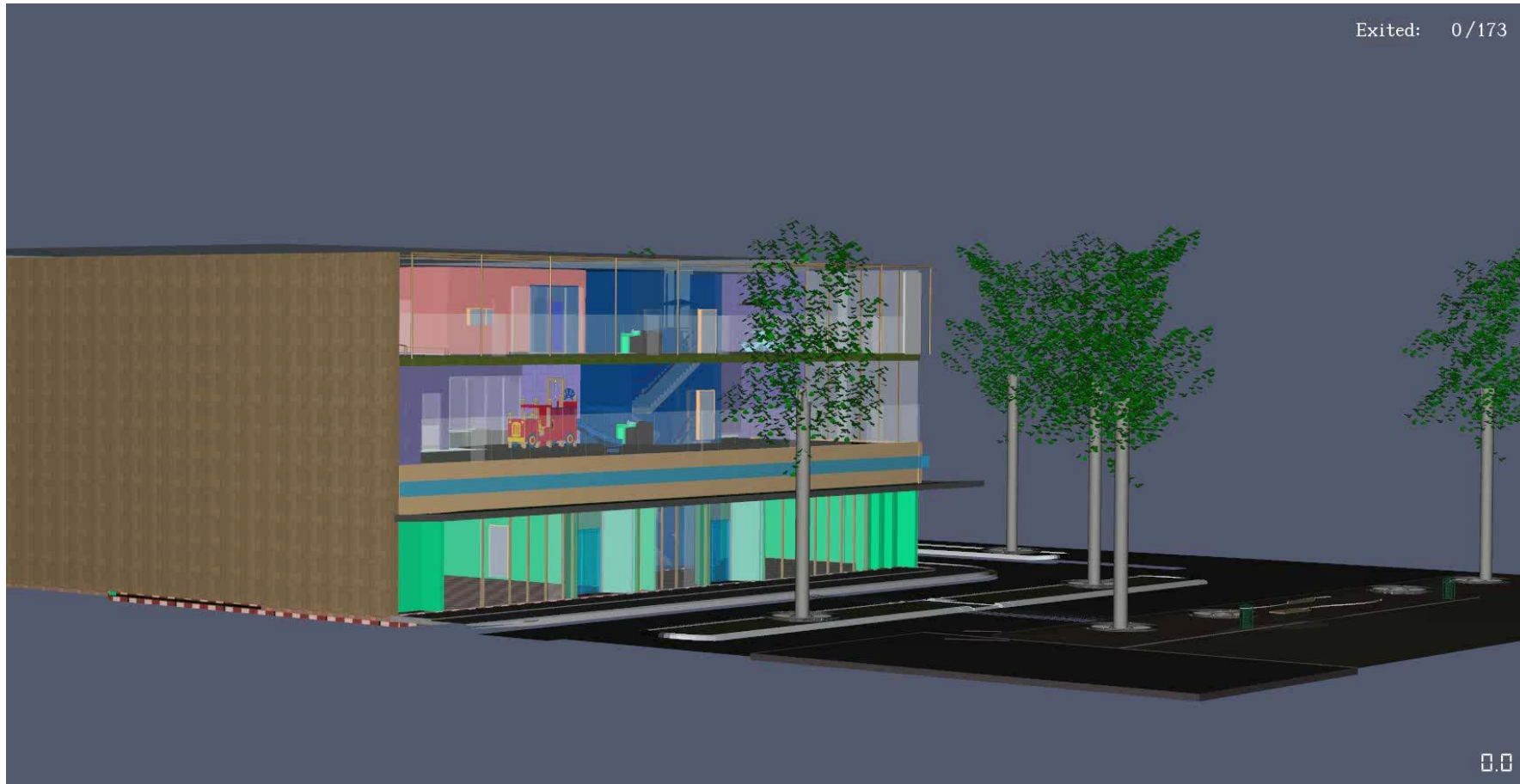
Overview of ECC Building

- 3-Storey Building.
- Type A construction.
- Boarded on 3 sides by roads.
- A small park on the other side of the road is intended to be used as an emergency assembly area for the childcare.
- Ground floor: two-Class 6 retail parts and a Class 7a carpark (more than 40 car bays).
- Level 1: ECC (children aged less than 24 months).
- Level 2: ECC (children older than 24 months).
- Each childcare level is provided with two large outdoor play areas.
- Two sets of fire isolated stairs.



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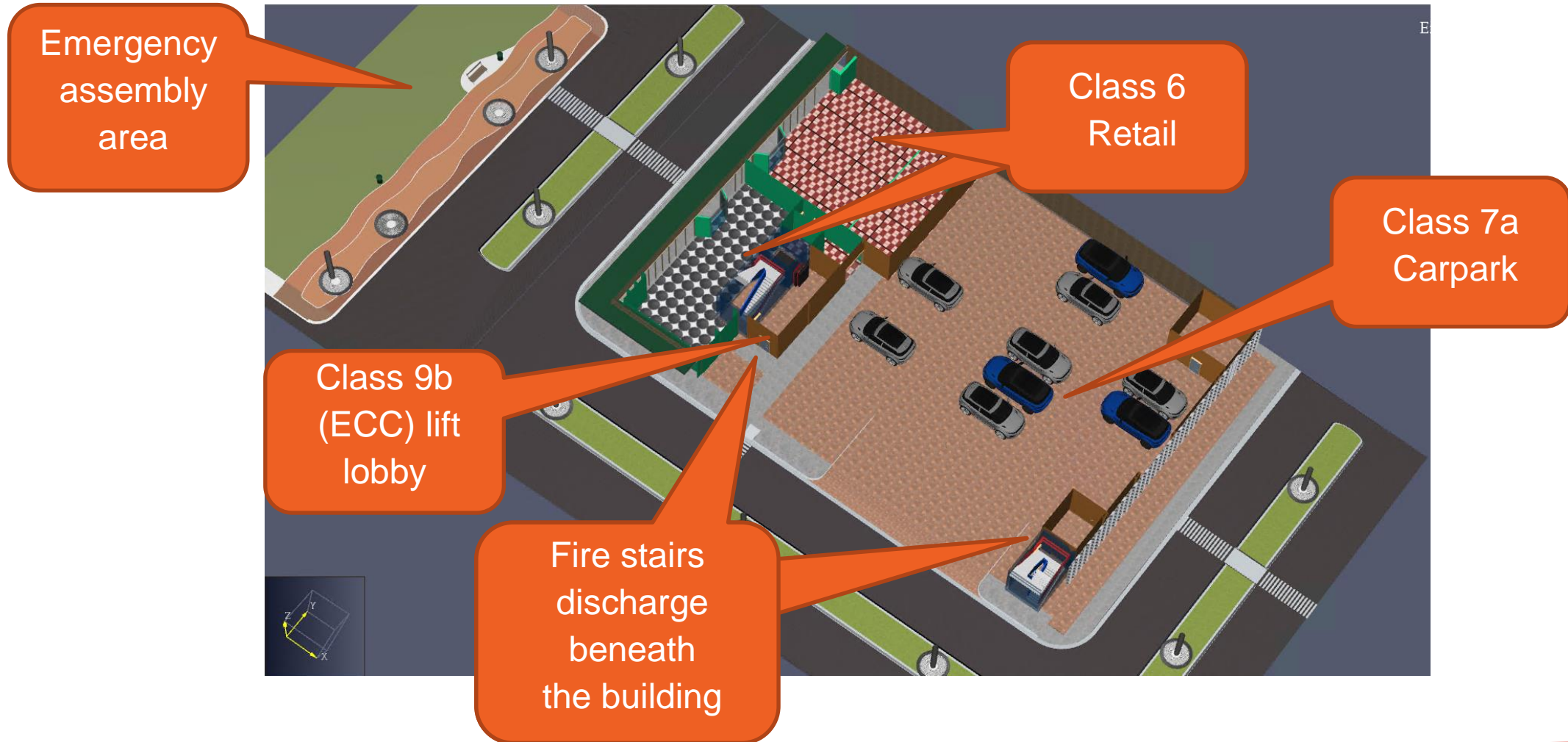
Overview of ECC Building





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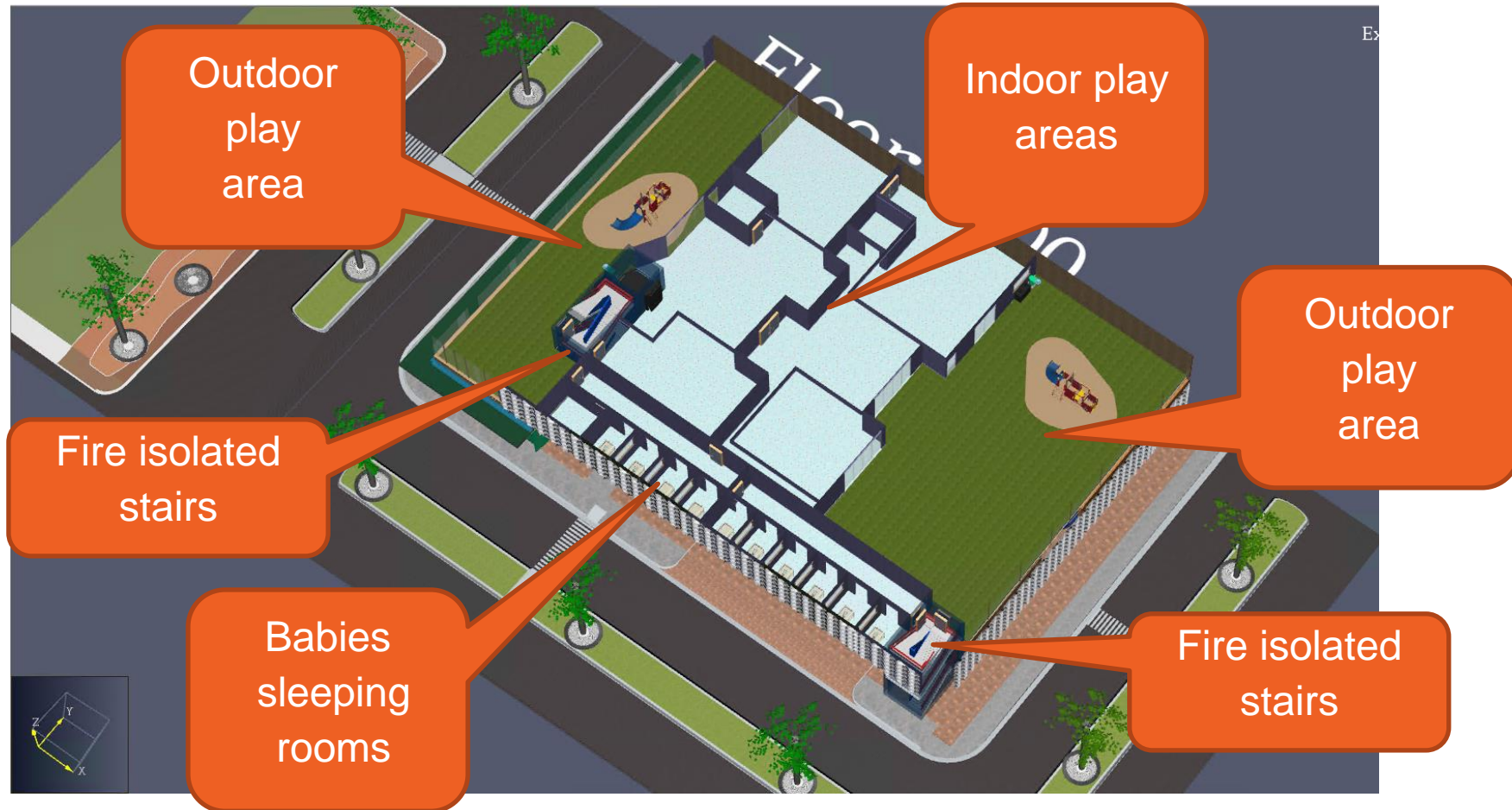
Building Characteristics: Ground Floor





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Building Characteristics: Level 1





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Building Characteristics: Level 2





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Fire Engineering Assessment

A Performance Based Solution is to be provided for this simulated building to review the location of the ECC in a building with a rise in storeys more than 2 and the internal discharge of the fire isolated stairs at ground floor.

Relevant DtS Provisions: D1.7 and D1.18.

Relevant Performance requirements: DP4, DP5 and EP2.2.

Assessment method: A2.2 (2)(b)(ii) Other Verification Methods.

AFEG subsystem : Sub System E.

Method of analysis: Quantitative / Absolute Assessment.



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Fire Engineering Assessment

The following slides identify the fire safety measures that have been used in support of the evacuation strategy for this simulation, and are based on Sections C,D and E of the BCA.

Some of these measures are in addition to those required the Deemed to Satisfy (DtS) Provisions of the BCA for this type of building.



Section C - Fire Resistance

- The ground floor car park is to be fire separated with a 180/180/180 fire walls to the Class 6 parts.
- The ECC levels are to be further divided into separate fire compartments to achieve 120/120/120 FRLs in support the evacuation strategy this measure is in addition to the BCA DtS provisions which would not require fire compartmentation of the ECC floor plate for this building.
- Each stair is to be fire-isolated, with all stair doors and doors between fire compartments to be self-closing -/60/30 fire doors and fitted with cold and medium temperature (fin or brush) smoke seals.

Class 6 retail

Class 6 retail

Fire wall 180/180/180

Class 7a carpark

Fire isolated stairs

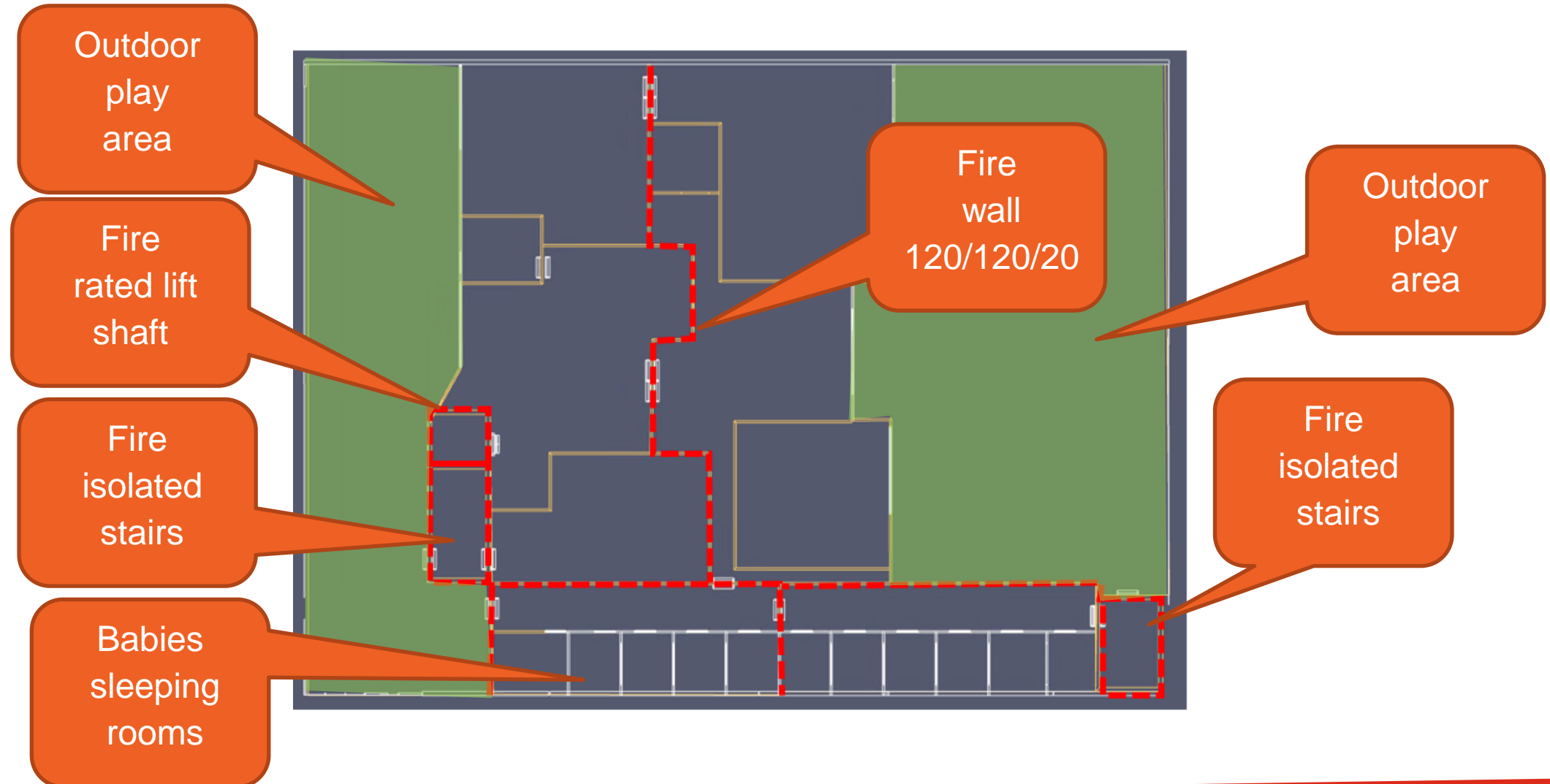
Fire isolated lobby

Fire isolated stairs



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Section C - Fire Resistance: Level 1





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Section C - Fire Resistance: Level 2





Occupant Load

The intended numbers of occupants for this building is as follows:

- The ground floor will have 93 occupants in accordance DtS provision D1.13 for the number of persons accommodated.
- Level 1 will have 40 children (16 babies less than 24 months and 25 toddlers between 24 to 36 months) and 12 staff.
- Level 2 will have 40 children (aged 36 months to 48 months) and 10 staff.

The staff to child ratios are in accordance with the National Quality Assurance (QA) standards National Quality Assurance (QA) standards www.acecqa.gov.au/nqf/educator-to-child-ratios.



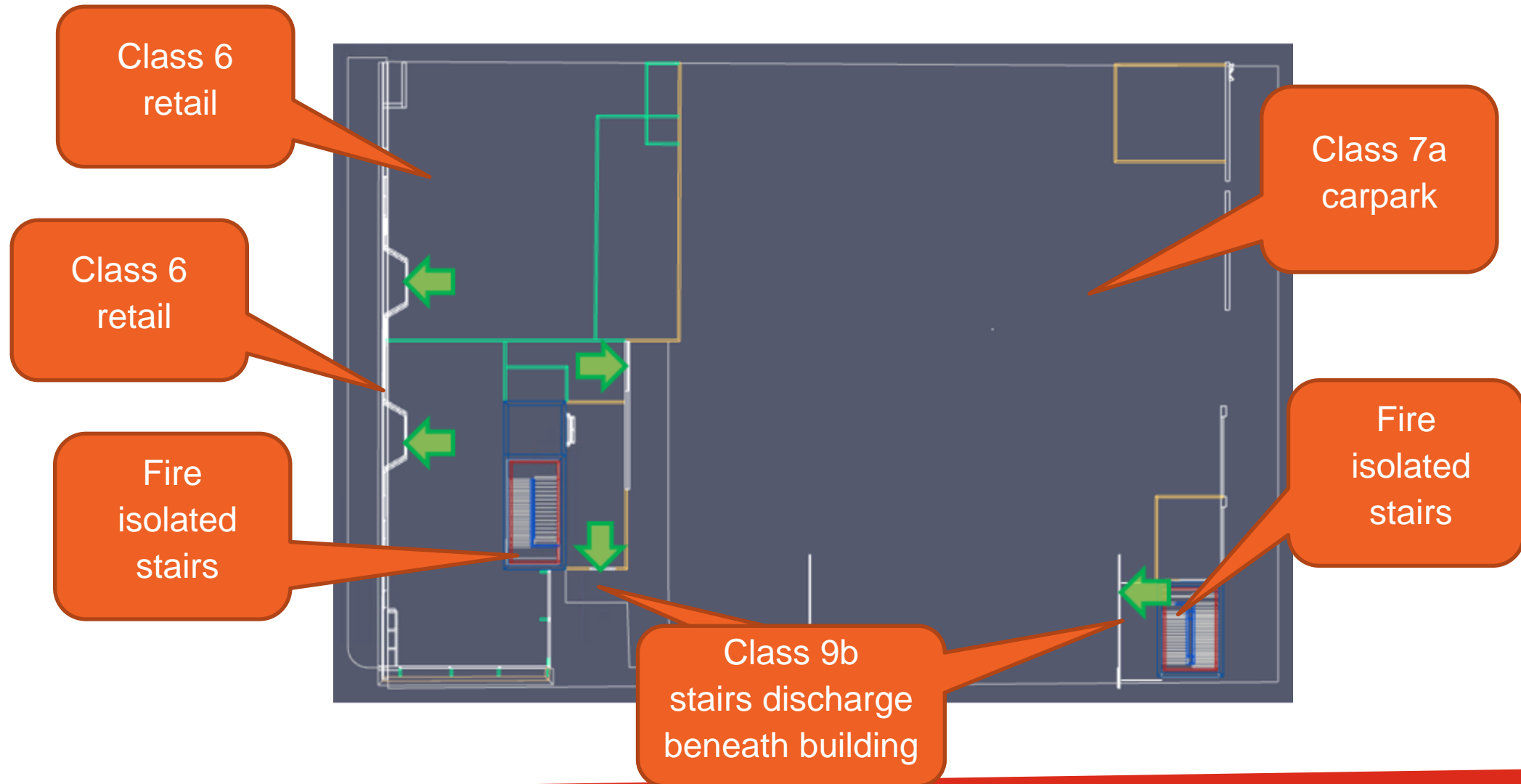
Section D - Means of Escape

- The egress from the childcare is separated from the retail parts until occupants are outside the building.
- The large outdoor areas provide places of relative safety and are large enough to safely house all of the occupants on each floor.
- Horizontal exits are provided between fire compartments.
- Handrails suitable for children would be provided in the stairs.
- During an emergency re-entry is available for staff to the fire isolated stairs.
- Considerations have been given to use the emergency lift to assist the evacuation
- The emergency lift is provided within a fire-resisting shaft having an FRL of 120/120/120.



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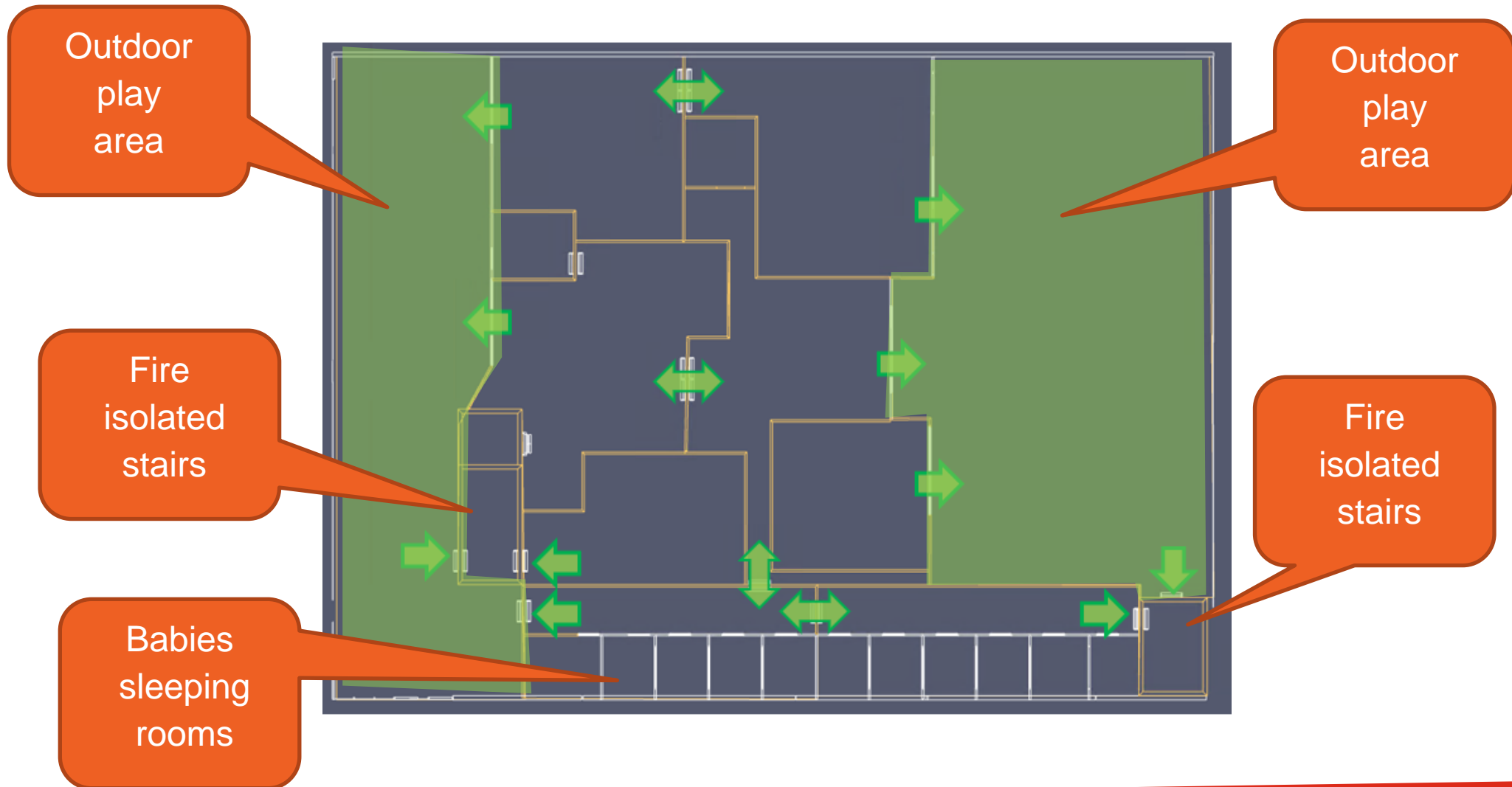
Section D - Means of Escape Ground Floor





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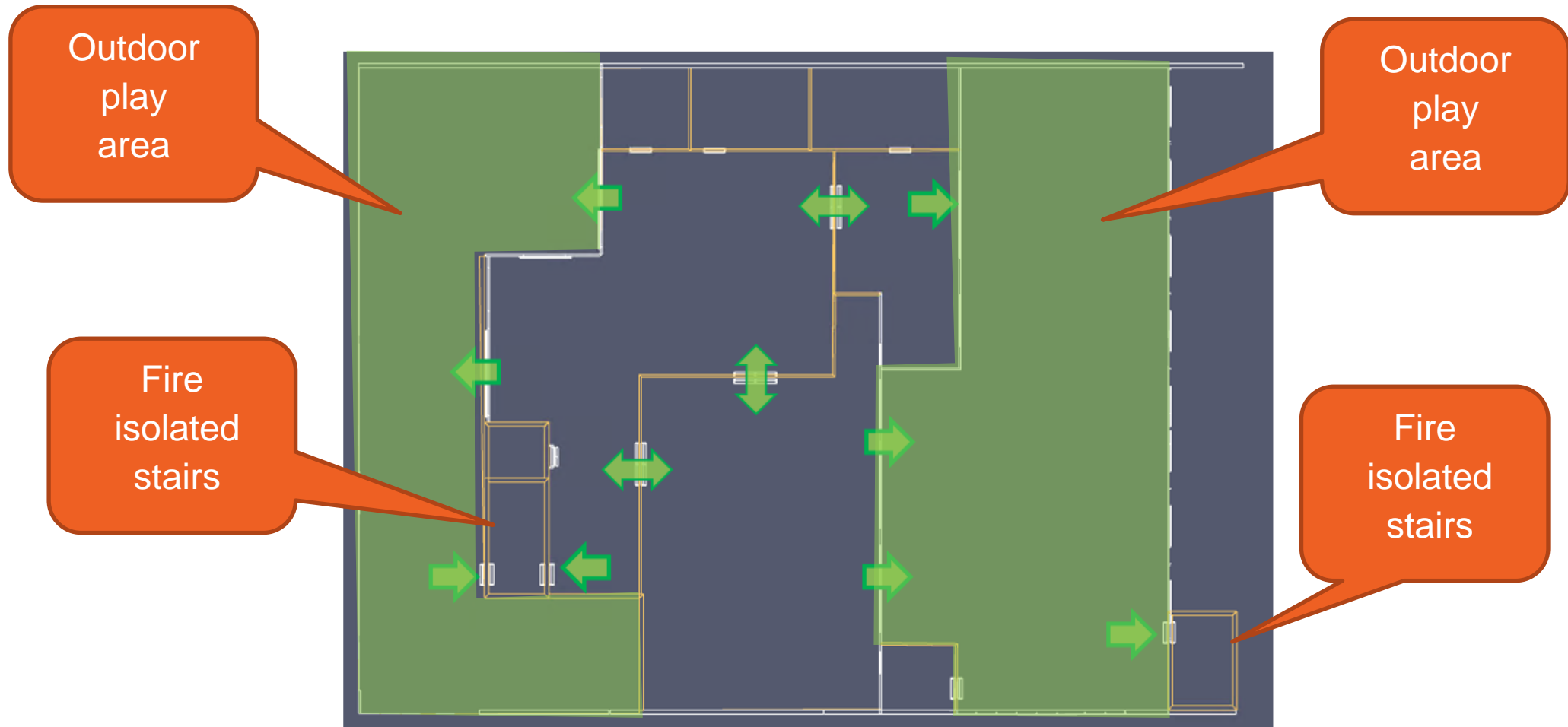
Section D - Means of Escape Level 1





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Section D - Means of Escape Level 2



Section E – Fire Systems

In this simulation the carpark has over 40 bays and would require sprinkler protection in accordance with the BCA, however the retail parts and the ECC would not require sprinklers.

The assumptions of the fire engineering assessment has been based on a fully sprinklered building which is intended to lower the risks associated with the evacuation of children.

The building is to include earlier warning by the AS 1670.1 fire detection and occupant warning system.

An Emergency Sound and Intercom System be provided to all building areas in accordance with AS 1670.4 to broadcast live and recorded voice messages.

Speakers to the internal and outdoor play areas with a pre-recorded evacuation message throughout.

The outdoor play areas to be provided with visual beacons connected to the fire detection and alarm system to provide visual warning to occupants.



Evacuation Strategy

In the event of a required full building evacuation, the children aged less than 24 months are assumed to be carried down the stairs by staff, (each staff member is perceived to be able to carry up to a maximum of two children) they are then transferred to mobile cribs and transported to the muster point in the park across the road.

The mobile cribs are located in a storage area on the ground floor.

Children older than 24 months are assumed to be assisted to evacuate by staff to the muster point in the park across the road.

One staff member is able to assist up to 8 children older than 24 months to evacuate.

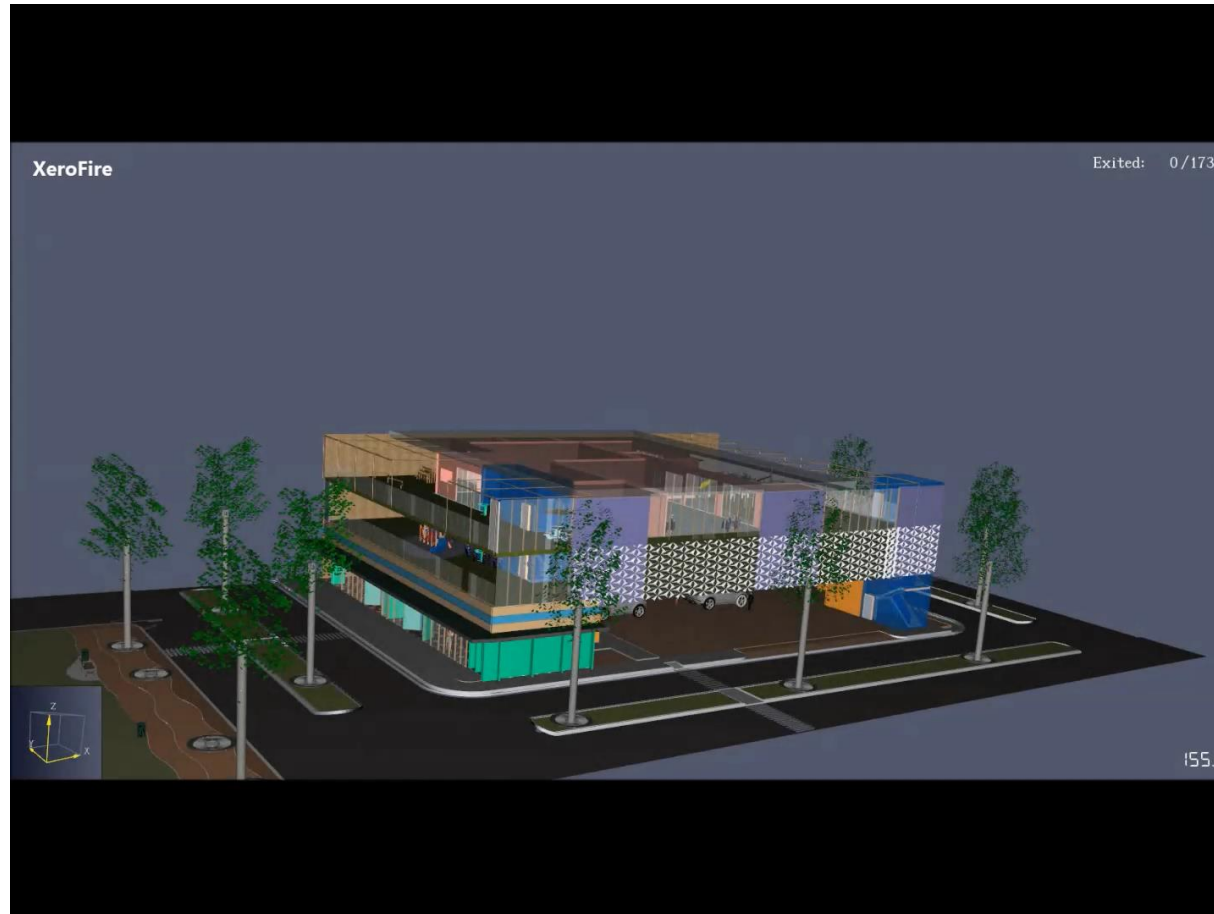
Where children are remaining in one location 1 staff member can supervise up to 15 children (1:15 ratio).

It is considered that the ground floor retail parts will evacuate independently from the ECC and none of the occupants will assist in the evacuation of the childcare.



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Occupant Egress Modelling





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Occupant Egress Modelling

The pathfinder modelling provides a visual representation of the operators intended evacuation strategy.

However, there is no prescribed maximum time to evacuate the building in accordance with the BCA.

Therefore, to benchmark the evacuation time, an agreed set of acceptance criteria is required, for example:

The operator may have a maximum evacuation time for all of its facilities,

Additional smoke modelling maybe required to provide an ASET/RSET assessment.

Smoke modelling may be problematic if there is no sprinklers, smoke control system or compartmentation to limit smoke spread.



Occupant Egress Modelling

To determine the overall time for an evacuation will depend on

- The staff-to-child ratio required for an evacuating group.
- The preparation time for staff to commence the evacuation.
- The walking speeds of staff carrying young children.
- The walking speeds for children.
- If necessary the time for staff walking back to the ECC to evacuate more groups.



Determination of Egress Time

The overall egress time for occupants to egress to an exit or to a place of safety is termed by the Required Safe Egress Time or RSET.

Pre-Movement (Response period and Delay period)

- Is the time for people engaged in activities prior to evacuating to begin moving.

Movement Period (Travel Time and Queue Time)

- The time span between the initiation and completion of the movement to a place of safety.



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Guidance On Determining Pre-movement Times

There are very few studies quantifying the premovement time for ECCs however the New Zealand Verification Method C/VM2 and Published document 7974-6 (BSI 2019) do provide some guidance.



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Guidance On Pre Movement Times C/VM2

New Zealand Verification Method C/VM2

For spaces within buildings used for Early Childhood Care

Pre-movement of staff:

- Enclosure of fire origin pre-movement of **60 seconds** for staff to respond to alarm.
- Remote from the enclosure of fire origin, pre-movement time of **120 seconds**.



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Guidance On Pre Movement Times

PD7974-6

Published document 7974-6 (BSI 2019)

PD7974-6 does not include specific categorisation for an ECC, however, staff occupants are considered to be awake and familiar with their surroundings similar to an office workplace.

This provides an applicable premovement time of between **30-90 seconds** (predicted 1st and 99th percentile values) is assumed.

For this simulation a pre-movement time of **90 seconds** from the PD 7974-6 99th percentile value was used for all staff on the floor of fire origin.

A pre-movement of **120 seconds** would be applicable for all other building occupants remote from the floor of fire origin.



Premovement Times

It is considered that the pre-movement time should also include an additional time for preparing each child for evacuation.

This would allow for the time to put on appropriate clothes (shoes and weather appropriate clothing etc.), retrieve any objects used to assist the movement of children and arranging children in groups, etc.

There is no specific guidance on the preparation time, which may have a high degree of variability based on the level of staff training and the frequency of fire drills.



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Premovement times

Where staff are carrying children the pre-movement time in the simulation included an additional **10 seconds** for preparing each child less than 24 months of age for evacuation.

Where children are self-egressing under supervision of staff, the premovement time has included an additional **60 seconds** for preparing each 8 children for evacuation.

These values are based on Fire Engineering judgement and they should also be agreed by the operator and project stakeholders.



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ECC Movement Groups

For the analysis of the egress time from an ECC there are two distinctly different occupant groups that need to be assessed:

- Type A occupants- staff carrying children (up to 24 months); and
- Type B occupants- children (24 months up to 48 months) self-egressing under supervision of staff.



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Guidance On Movement Times

Similar to the pre-movement times, there are few studies quantifying the movement time of staff carrying children and the walking speeds of young children are found in the following sources:

- RED Fire engineers report Fire Safety in Early Childhood Centres and
- Stephen Burton's presentation on Data Sets in High Rise Child Evacuation Scenarios.
- Stephen Burton's presentation on Fire Safety in Multi-Storey Childcare and Aged Care.



Guidance on Movement Times Type A

The below values based on RED Fire engineers 2019 and Burton ,2017 2018.

Description	Situation	Walking Speed (m/s)
Staff carrying up to two children aged up to 24 months	Horizontal walking	0.95
	Walking down stairs	0.43
Staff walking up stairs (without children)	Walking up stairs	0.5



Guidance on Movement Type B

Walking speeds for the staff are considered irrelevant for the Type B evacuations as the time for evacuation will be governed by the children's walking speeds

The below values based on RED Fire engineers 2019 and Burton 2017, 2018.

Description	Situation	Walking Speed (m/s)
Children aged 24 months up to 48 months	Horizontal walking	0.61
	Walking down stairs	0.33



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Determination of Egress Time

It should be noted that the actual egress time in an ECC may be different than that provided in an assessment.

As mentioned, the biggest challenges for an evacuation assessment is the limited data and peer reviewed reports available.

The uncertainty in the inputs used for the assessment and the increased risk associated with this type of occupancy should be supported by appropriate fire safety systems.



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In Summary

It is recognised that there are increased risks associated with the evacuation of early childcare centres that have a rise in storeys of more than 2.

Unlike other occupants of a building, children in childcare centre cannot self-egress and either need to be carried by their carers or be under the direct supervision of carers.

The analysis of occupant evacuation from childcares fundamentally requires a clear understanding of how the operator will use the facility and their intended evacuation strategy.

Otherwise, the Fire Engineer is imposing a strategy on the design which may not be practical for the end user/ operator, or the end user/ operator may use a different occupant evacuation strategy where the Performance Solution supporting the building design is then no longer valid and would need to be re-assessed.



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References

- Burton, S, 2017. NCC Performance Review into how to best assess Data Sets in High Rise Child Evacuation Scenarios: (Presentation at Fire Australia Conference and Trade Show).
- Burton, S, 2018. Fire Safety in Multi-Storey Childcare & Aged Care (Presentation at ADEB Seminar), Melbourne: JazCorp Australia PTY Ltd.
- EFT Consulting, Technical Review of Report: Fire Safety of Early Childhood Centres in High Rise Buildings in Australia, 2019
- Published Document 7974-6 - Human factors: Life safety strategies – Occupant evacuation, behaviour and condition (BSI, 2004).
- Pathfinder 2018 User Manual, Thunderhead Engineering, USA.
- Red Fire Engineers, Fire safety of early childhood centres in high rise buildings in Australia, 2019.