



Defire

Review of potential alternative solutions

Darling Walk, Sydney


Client Bovis Lend Lease

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Amendment schedule

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			Prepared by	Reviewed by	Approved by
		Name	Victor Tung	Micael Lundqvist	
		Signature			
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			Prepared by	Reviewed by	Approved by
		Name	Victor Tung	Micael Lundqvist	Micael Lundqvist
		Signature			
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			Prepared by	Reviewed by	Approved by
		Name	Victor Tung	Micael Lundqvist	Micael Lundqvist
		Signature			
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			Prepared by	Reviewed by	Approved by
		Name			
		Signature			

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1. Introduction

This report documents the findings of a preliminary fire safety engineering review of the proposed mixed-use Darling Walk development. The review was undertaken as a supplement to the lodgement of Environmental Assessment. The intent of the review is to develop the basis for alternative solutions to the deemed-to-satisfy (DTS) provisions of the Building Code of Australia 2008 (BCA) ¹. Defire undertook the assessment at the request of Bovis Lend Lease.

2. Description of building

2.1 Building description

The project comprises the construction of the new mixed-use Darling Walk development. This includes two commercial office buildings – Tower A and Tower B – located above four levels of common basement carparking. Ground floor of Tower A comprises commercial and retail areas and kids’ theatre, whilst ground floor of Tower B comprises commercial and retail areas. Plant for each of the buildings is located at the roof. An atrium connects Levels 01 to 08 within each of the buildings, together with a void connecting ground floor with Level 01. Fire safety systems in the buildings include a sound system and intercom system for emergency purposes, sprinklers, smoke detection, smoke hazard management and stair pressurisation.

A description of the main characteristics of the building for the purpose of determining compliance with the BCA is given in Table 1 ². The proposed use and classification of the building or part in accordance with clause A3.2 of the BCA is described in Table 2.

Characteristic	BCA clause	Description
Effective height	A1.1	Greater than 25m.
Type of construction required	C1.1	Type A.
Rise in storeys	C1.2	9.

Table 1 Main building characteristics

Part of building	Use	Classification (A3.2)
Basement – common to both towers		
Level B4	Plant, carpark	7a ancillary
Level B3	Plant, carpark	7a ancillary
Level B2	Plant, carpark, loading docks	7a ancillary
Level B1	Carpark	7a
Tower A (North Building)		
Ground floor	Loading dock entry, fire control centre, plant, retail, office, entrance and lift lobby, theatre / place of public entertainment	5, 6, 9b
East: Levels 01 to 08	Commercial	5
West: Levels 01 to 05	Commercial	5

¹ *Building Code of Australia 2008*, Australian Building Codes Board, Australia, 2008.

² Proposed commercial building Darling Walk – Pre DA BCA review, ref 08092_R02_130608, dated 13/06/08, Philip Chun and Associates

Part of building	Use	Classification (A3.2)
Roof	Plant	Adopts class 5 classification
Tower B (South Building)		
Ground floor	Retail, office, entrance and lift lobby, plant	5, 6
East: Levels 01 to 08	Commercial	5
West: Levels 01 to 05	Commercial	5
Roof	Plant	Adopts class 5 classification

Table 2 Use and classification

2.2 Occupant characteristics

The characteristics of the occupants expected to be in the building are listed in Table 3.

Characteristic	Description
Familiarity	Office – Occupants are expected to be staff who are familiar with the layout of the building and trained in emergency situations. Retail – Occupants are expected to be shoppers who may not be familiar with the layout of the building and location of fire exits. A limited number of staff are also expected to be present which are familiar with the layout of the building and trained in emergency situations. Carpark – Occupants are mainly expected to be within the carpark for short periods.
Awareness	Occupants are expected to be awake and alert to a potential emergency event such as a fire in the building.
Mobility	Occupants are assumed to have the same level of mobility as the general population. This may include a limited proportion of mobility impaired occupants. These occupants may require crutches, a wheel chair or similar to evacuate on their own or need assistance from other occupants.
Age	Occupants of all ages may be present within the building. Occupants within the commercial and atria portions of the building are expected to be predominantly between 15-65 years of age.
Language	Although occupants may have English as their second language, they are expected to understand signs and verbal instructions in English.
Occupant load	Population densities used in this assessment are based upon table D1.13 of the BCA which specifies: <ul style="list-style-type: none"> • 1m²/person – kid’s theatre, café / restaurant. Note: Population for kid’s theatre may be based upon seat count also. • 3m²/person – retail • 10m²/person – commercial • 30m²/person – carpark, plant, loading dock

Table 3 Occupant characteristics

2.3 Alternative solutions

The design of the building includes areas which do not comply with the DTS provisions of the BCA. We intend to use a performance-based fire safety engineering approach to develop alternative solutions to the DTS provisions of the BCA. Table 4 describes the BCA requirements associated with the alternative solutions. The full extent of the non-compliances with the DTS provisions of the BCA is identified within the BCA assessment prepared by Philip Chun and Associates.

No	Description of alternative solutions	DTS provision	Performance requirements (A0.10)
1.	Reduction in FRLs of ground floor retail areas from 180/180/180 to 120/120/120.	Clause C1.1 and specification C1.1	CP1 and CP2
2.	Levels 01 to 08 in both Towers A and B are connected via atriums thereby forming fire compartments which exceed the floor area and volume limits.	Clause C2.2	CP2 and CP9
3.	Travel distance to a point of choice between alternative exits exceeds 20m (up to 30m) in offices and carpark.	Clause D1.4	DP4 and EP2.2
	Travel distance to the nearest of alternative exits exceeds 40m (up to 60m) in offices and carpark.		
	Travel distance between alternative exits exceeds 60m (up to 90m) in offices and carpark.	Clause D1.5	
4.	Performance-based design of the atrium wells and building smoke control system.	Clauses E2.2, G3.3, G3.4, G3.6 and G3.8, Specification G3.8	CP2, DP4, EP1.4 and EP2.2

Table 4 BCA requirements associated with the alternative solutions

3. Scope, limitations and assumptions

3.1 Scope and limitations

- This report is limited to compliance with the fire safety aspects of the performance requirements of the BCA. Matters such as property protection (other than protection of adjoining property), business interruption, public perception, environmental impacts and broader community issues - such as loss of a major employer and impact on tourism - have not been considered as they are outside the scope of the BCA.
- This report considers single point arson as a source of ignition. Arson involving accelerants or multiple ignition sources is not considered in this assessment as it is outside the scope of the BCA.
- This report is limited to considering evacuation and fire safety issues for people with disabilities to the same degree as the DTS provisions of the BCA.
- If there are building alterations or additions, a change in use or changes to the fire safety systems in the future, a reassessment will be needed to verify consistency with the assessment in this report.
- The documentation that forms the basis for this report is listed within Appendix A.
- This report has been prepared based upon information provided by others. Defire has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated into this report as a result.

3.2 Assumptions

- The design complies with the current DTS provisions of the BCA except for the specific alternative solutions described within section 2.3.
- All of the fire safety systems are assumed to be designed, installed and operate in accordance with the appropriate Australian standards, other design codes, legislation and regulations relevant to the project unless specifically stated otherwise.
- For a satisfactory level of fire safety to be achieved, regular testing and maintenance of all fire safety systems and measures, including management-in-use systems, is essential and is assumed in the conclusion of this assessment.

4. Review of design

4.1 Possible alternative solutions required

Defire have reviewed the design based upon the documentation listed within Appendix A. The review was undertaken to determine whether a performance-based fire safety engineering approach can be adopted to develop alternative solutions for the identified non-compliances, to demonstrate compliance with the relevant performance requirements of the BCA.

The key issues identified as part of the review are outlined in the following sections.

4.2 Reduction in FRLs of ground floor retail area

4.2.1 Introduction

Clause C1.1 of the BCA requires that the building comply with the requirements of specification C1.1 for type A construction. Table 3 of specification C1.1 of the BCA stipulates that class 6 portions achieve an FRL of not less than 180/180/180.

The structures within the ground floor retail area are proposed to achieve an FRL of not less than 120/120/120 in lieu of 180/180/180 fire rated construction, thereby contravening the requirements of specification C1.1 of the BCA.

4.2.2 Preliminary assessment

It is proposed to demonstrate that the successful activation of the sprinkler system will limit the average compartment temperatures to below the critical temperatures for the structural elements in the building. In particular, the reliability of a sprinkler system, together with the impact that a sprinkler system will have on fire spread and fire intensity will be discussed.

In the case of sprinkler failure, non-sprinkler controlled fires also need to be taken into consideration. The hazard associated with reduction in fire resistance of the ground floor retail area will be assessed in terms of the potential fire intensity and ability of the fire-rated construction to withstand the fire exposure. A 2 hour FRL is considered to provide adequate redundancy to allow safe occupant evacuation and fire brigade intervention.

4.3 Increased compartment size

4.3.1 Introduction

Connections of Levels 01 to 08 in both Towers A and B result in total fire compartment sizes which exceed the maximum floor area and volume limits of 8,000m² and 48,000m³ for class 5 buildings of type A construction specified in table C2.2 of the BCA.

4.3.2 Preliminary assessment

It is proposed to demonstrate that the provision of active fire safety systems – such as automatic sprinkler system, automatic smoke detection system, mechanical smoke exhaust within the atrium in conjunction with potential smoke impervious construction that may be required – adequately reduce the risk of fire spread within the building and facilitate occupant evacuation and fire brigade intervention to the degree necessary.

4.4 Extended travel distances

4.4.1 Introduction

Clause D1.4(c)(i) of the BCA states that 'no point on a floor must be more than 20m from an exit, or a point from which travel in different directions to 2 exits is available, in which case the maximum distance to one of those exits must not exceed 40m'.

Clause D1.5(c)(iii) of the BCA states that 'exits that are required as alternative means of egress must be not more than 60m apart'.

The maximum travel distances within the design are in excess of the limits of clauses D1.4 and D1.5 of the BCA.

4.4.2 Preliminary assessment

The hazard associated with extended travel distances within the building must be assessed in terms of the ability of the occupants to safely undertake an evacuation should a fire occur. The reason that clauses D1.4 and D1.5 of the BCA stipulate travel distance requirements are to ensure that all occupants of the building in the event of a fire are within a reasonable distance of an exit so that they can safely evacuate.

The requirement relating to travel distance to the point of choice is intended to allow occupants to reach the point of choice prior to the path of travel becoming blocked. The requirement relating to travel distance between alternative exits is intended to limit the distance travelled by occupants to reach an alternative exit in the event of the first-choice exit becoming blocked.

Offices

Historically office buildings represent a low risk to life safety of occupants in fire situations than other building uses. Occupants are there within the function of their employment. They are awake for the period they are in the building, and will be able to respond quickly to the activation of a fire alarm. They are likely to be familiar with the layout and location of the exits from the building. Any visitors are likely to be surrounded by occupants who are familiar with the building layout and are able to provide guidance if evacuation is required.

The building is proposed to be protected with an automatic sprinkler system in accordance with AS 2118.1-1999. The benefits of sprinkler protection are recognised by many national building codes by a range of concessions when sprinklers are provided. Many of these national building codes allow an increase in travel distances in commercial offices (class 5 or equivalent) of up to 50% when sprinklers are provided.

The proposed AS 1670.1-2004 smoke detection system within the building is expected to provide early warning to occupants with detectors in each room thereby facilitating faster evacuation within the proposed design – despite the extended travel distances – than a generic design that complies with the DTS provisions of the BCA without smoke detection in each room.

Carpark

The open layout of the carpark – ie limited solid partitions and obstructions – means that the exits serving the carpark are visible for extended distances. The open layout of the carpark is expected to enable occupants to identify the location of a fire prior to beginning evacuation and deciding on the safest path of travel to an exit quicker than in a building with enclosed rooms and corridors where a fire may be undetected for some time – the DTS provisions place no restrictions on the partitioning of an area when considering travel distances.

As for the office portions, the beneficial impact of sprinkler systems on occupant safety is acknowledged in a range of building codes and fire safety guidelines around the world by allowing an increase in travel distance in sprinkler protected carparks^{3, 4}.

Although not in relation to travel distances, the current requirements of the BCA also recognise the low fire safety risks associated with large sprinkler protected carparks by allowing reduced fire resistance levels. Part of the reason why the requirements of the BCA were changed was the research carried out by BHP which found that 'carparks represent little risk to life or of injury, and very low monetary losses, possibly because of a very low frequency of fire starts in this type of building'⁵.

4.5 Atrium provisions

4.5.1 Introduction

The designs of Towers A and B each contains an atrium which provides connection of Levels 01 to 08. The designs of the atriums lead to a number of non-compliances with the DTS provisions of the BCA:

- Connection of the office levels results in a total fire compartment size in excess of the maximum floor area and volume limits of 8,000m² and 48,000m³ for class 5 buildings of type A construction specified in table C2.2 of the BCA.
- The atriums are not separated by bounding walls in accordance with clauses G3.3 and G3.4 of the BCA.
- The atrium roofs are glazed but not protected by a sprinkler system in accordance with clause G3.6 of the BCA.
- Fire and smoke control systems within the atrium will be designed on a performance basis in lieu of compliance with clause G3.8 and specification G3.8 of the BCA. Smoke hazard management will be based upon mechanical smoke exhaust – in particular, the system is designed to account for the proposed extended travel distances within the office levels.

4.5.2 Preliminary assessment

As previously discussed the building will be provided with a sprinkler system complying with specification E1.5 of the BCA. It is proposed to generally provide the sprinkler system with fast response heads to allow for early activation and control of the fire. The successful activation of the sprinklers is expected to suppress further fire growth and limit the spread to the area of fire origin.

Early control of the fire in conjunction with active smoke control on the office floors and within the atrium voids is intended to mitigate significant smoke spread onto non-fire affected floor. By supplying make-up air on the non-fire affected floors an increased tenability is expected allowing occupants to safely evacuate the building in the event of a fire.

On the floor of fire origin and within the atrium void the provision of smoke exhaust is intended to reduce the build-up of heat and smoke improving the tenability for evacuating occupants and facilitate fire brigade operations such as search & rescue.

An AS 1670.1-2004 smoke detection system is also proposed to activate the smoke control systems and provide early warning to evacuating occupants.

³ Acceptable solutions C2/AS1, Building Industry Authority, NZ, December 1995.

⁴ *Evacuation design guide (Utrymningsdimensionering)*, Boverket rapport 2006, Sweden, June 2006 (Swedish).

⁵ *Fire Safety in Carparks* – BHP – February 1992.

Sprinkler protection to the atrium roofs is not proposed on the basis that temperatures at the roof – for the design fire scenarios – will be below the critical temperature for the integrity of the non-combustible glazed atrium roofs.

5. Conclusion

It is Defire's opinion that the proposed alternative solutions to the DTS provisions of the BCA identified within this report can be demonstrated to achieve compliance with the relevant performance requirements of the BCA.

The specific details of the proposed alternative solutions are subject to the development of a package of fire safety measures and the outcomes of a fire safety engineering assessment. The proposed alternative solutions and subsequently required fire safety measures will be developed as part of the on-going design development for the project.

Appendix A Drawings and information

Drawing title	Dwg no	Date	Drawn
Overall Site Plan	AD000000 rev 06 (EA100%)	10/06/2008	francis-jones morehen thorp
Basement Level 01	AD0B1001 rev 04	20/05/2008	francis-jones morehen thorp
Basement Level 02	AD0B2001 rev 04	20/05/2008	francis-jones morehen thorp
Basement Level 03	AD0B3001 rev 04	20/05/2008	francis-jones morehen thorp
Basement Level 04	AD0B4001 rev 04	20/05/2008	francis-jones morehen thorp
Level 00 Reference Plan	AD000001 rev 07 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 01 Reference Plan	AD001001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 02 Reference Plan	AD002001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 03 Reference Plan	AD003001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 04 Reference Plan	AD004001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 05 Reference Plan	AD005001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 06 Reference Plan	AD006001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 07 Reference Plan	AD007001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Level 08 Reference Plan	AD008001 rev 09 (EA100%)	10/06/2008	francis-jones morehen thorp
Plant Reference Plan	AD009001 rev 07 (EA100%)	10/06/2008	francis-jones morehen thorp
Roof Reference Plan	AD010001 rev 07 (EA100%)	10/06/2008	francis-jones morehen thorp
Overall – Elevations Sheet 1	AD051001 rev 08 (EA100%)	10/06/2008	francis-jones morehen thorp
Overall – Elevations Sheet 2	AD051002 rev 08 (EA100%)	10/06/2008	francis-jones morehen thorp
Overall – Sections Sheet 1	AD052001 rev 07 (EA100%)	10/06/2008	francis-jones morehen thorp

Other information	Ref no	Date	Prepared by
Proposed commercial building Darling Walk – Pre DA BCA review	08092_R02_130608	13/06/08	Philip Chun and Associates