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Authorised: Manager Built Environment Branch

GL-14: Fire Safety in Car Stacker Systems

PURPOSE:

The purpose of this guideline is to provide hydraulic consultants, developers and fire engineers with sufficient information to facilitate the design and installation of the appropriate fire safety measures into car parks that include Multi-tiered Vehicle Stacking Device (MTVSD) installations so as to satisfy the Department of Fire & Emergency Services (DFES) requirements for approval of this element of current building proposals. It also seeks to provide guidance to building certifiers with their assessment of plans which include a MTVSD system prior to submitting to DFES.

SCOPE:

The scope of this guideline predominantly relates to all closed car parks containing multi-tiered car stacking devices.

1. BCA PERFORMANCE REQUIREMENTS:

The relevant performance requirements applicable to car parks incorporating multi-tiered vehicle stacking devices have been identified within this guideline generally in accordance with the principles of clause A0.10 of the current Building Code of Australia (BCA).

1.1 Relevant DTS Provisions

The following DTS provisions are generally considered to be applicable: E1.5 – Sprinklers inter-alia Table E1.5 and Specification E1.5).

Note: Clause E1.5 of the BCA requires a fire compartment within Class 7a car park (other than open deck car parks) containing more than 40 vehicles, to be provided with a fire sprinkler system.

1.2 Directly Related Performance Requirement

Performance Requirements EP1.4 is considered to be directly relevant to the DTS provisions identified above.

1.3 Indirectly Related Performance Requirement

Performance Requirements CP1, CP2, EP1.1, EP1.2, EP1.3, EP1.5, EP1.6, EP2.2 are considered to be relevant to any aspects of a performance based design applying to the construction of closed car park buildings.

2. DEFINITIONS:

The following definitions apply for the purpose of this guideline:

Car Park means:

A building that is used for the parking of motor vehicles but is neither a private garage nor used for the servicing of vehicles, other than washing, cleaning or polishing.

Open-Deck Car Park means:

A car park in which all parts of the parking storeys are cross-ventilated by permanent unobstructed openings in not fewer than 2 opposite or approximately opposite sides, and –

a) each side that provides ventilation not less than 1/6 of the area of any other side; and
b) the openings are not less than ½ of the wall area of the side concerned.

Closed Car Park means:

A car park other than an open-deck car park as defined within this section. For example, an above- ground car park whereby the parts of the parking storeys are not cross-ventilated by permanent unobstructed openings to at least 2 opposite or approximately opposite sides.

Fire Resistance Level (FRL) means:

The grading periods in minutes determined in accordance with BCA Specification A2.3 for the following criteria –

a) structural adequacy, and
b) integrity, and
c) insulation

and expressed in that order.

Heat Release Rate means:

The rate at which heat is released by a fire.

Multi-tiered Vehicle Stacking Device (MTVSD) means:

A mechanical device which stores vehicles either above or beneath another (in a tiered configuration).

Vehicle Storage Arrangement means:

The vehicle fuel loading storage configuration or vehicle parking arrangements (ie horizontal vehicle storage arrangements or vertical storage arrangements as is the case where MTVSD's are utilised).

3. BACKGROUND:

Traditionally, vehicles stored in car parks have typically been parked in a horizontal plane meaning that only one vehicle is stored in a single parking space. However recent trends have included the use of MTVSD's within car parks, allowing multiple vehicles to be parked within the horizontal space of a single vehicle bay.

MTVSD's are utilised for, (but not limited to), the following reasons:

- Maximising the physical space/ land area available within a vehicle parking area
- To satisfy off-street parking requirements which may be imposed by planning permits
- Reduced cost solution providing additional vehicle parking spaces without overcapitalising on building structural costs.
- Developers are able to offer residential/ commercial tenants more than a single vehicle parking space as part of a property sale/lease.

During the mid-1980's, a shift towards the construction of more economical car parks, utilising structural steel and composite floors, was instigated via a series of tests that were conducted by BHP Steel. The purpose of the tests was to gain a better understanding of the effects of fire associated within car park buildings. The document '*Economical Car Parks – A Guide to Fire Safety'* was published by BHP Steel, indicated that the series of fire tests that BHP had conducted consistently demonstrated that fire spread between vehicles occurred, large quantities of dense toxic smoke were generated and that occupants within a building would experience a significant degree of reduced visibility.

As a result of these tests, the earliest editions of the BCA began to prescribe that most car parks are to be afforded sprinkler protection where accommodation for more than 40 cars is proposed.

One of the most significant aspects of the BHP Steel publication, is that the research itself was based on full scale fire tests where vehicles stored within a horizontal configuration only (ie cars parked next to one another). MTVSD's were not considered in the testing regime.

As MTVSD's are more commonly being utilised within car parks, DFES is concerned that building professionals will be satisfied with the fire safety of these car park designs using the '40 cars accommodated' requirement contained in BCA Clause E1.5, without necessarily considering the fuel load storage arrangement, and the basis of the testing regime for which most of the car park fire safety requirements within the BCA are based. In the past, the strict literal interpretation of Clause E1.5 of the BCA, which identifies the 40 vehicle limit, has been applied.

4. ISSUES:

Fire incident statistics trending nationally reveal that approximately 60% of fires within traditional Class 7a car park buildings are caused by vehicles, of which 25% of these fires are caused by 'stationary' vehicles. As stationary vehicle fires are therefore considered likely events, the probability of fire spreading to more than one (1) vehicle is also considered likely when MTVSD's are used. The presence of fire in these instances results in the generation of dense toxic smoke and reduced visibility, which has the potential to significantly impact on the safe evacuation of occupants, quickly reduce fire-fighter access, as well as impacting on fire control and extinguishment effectiveness.

As a consequence, DFES is of the opinion that the following items in Section 7 (Considerations) should be addressed and Section 8 (Recommendations) be implemented by building surveyors (Building Certifiers) and fire safety engineers when MTVSD's are proposed within a car park building.

5. CONSIDERATIONS:

5.1 Fire Engineering Analysis Considerations

DFES considers that building professionals need to be cognisant of the relevant arrangements necessary when MTVSD's are specified in car park areas. All car parks using MTVSD's are considered by DFES to fall outside the scope of BCA Clause E1.5, and must therefore be considered as a Performance Solution, supported by suitably justified fire engineering analysis.

Vehicle fires in car park buildings incorporating MTVSD's are likely to generate a larger heat release rate, potentially promoting untenable conditions within a much shorter period of time (ie reduced time for occupant evacuation and Fire Brigade access and setup). Therefore a deterministic analysis should be utilised in the fire engineering analysis that is consistent with the principles of the IFEG.

In addition to the above mentioned considerations, suitable factors of safety should be considered to satisfy the relevant acceptance criteria for occupant life safety and the fire-fighter tenability.

5.2 Design Considerations

Where a large number of vehicles are accommodated within a car park, the likelihood of a fire starting increases and ultimately results in a fully developed multiple vehicle fire within a non-sprinkler protected closed car park building prior to or following Fire Brigade arrival (fire initiation and development).

In an MTVSD, the potential exists for more vehicles to be involved in a fire incident. In such instances, fire spread could occur both horizontally and vertically, therefore a multiple vehicle design fire scenario should be considered (fire development and spread).

The consequences associated with a fire incident within a car park building incorporating MTVSD's is perceived to constitute a greater risk to the occupants of the building, fire fighters attending the fire incident as well as the structural stability of the building (structural adequacy of the building).

With limited structural protection afforded to the MTVSD under fire conditions, the likely fire intensity may cause structural failure of the device. In this instance, the vehicle stacker may collapse, promoting further fire spread (structural adequacy of the MTVSD).

The potential may exist for increased fire development should fire spread to vehicle fuel tanks and the like (fire spread and impact).

***Note**: This is likely to be exacerbated with alternative fuels such as LPG.*

For sprinkler protected car parks incorporating MTVSD's, the following should be considered with regard to sprinkler system design:

- An Ordinary Hazard 2 (OH2) category sprinkler system, as prescribed by AS2118.1, has not necessarily been tested in association with the vertical storage of vehicles. The increased fire load, even in a sprinkler protected car park, may exceed the performance of the OH2 category sprinkler system, (ie 5 mm/m over 144m2). Therefore, the appropriateness of the sprinkler system, in terms of the schematic design, sprinkler spacing and locations, sprinkler spray technology and hydraulic requirements should be designed to the specific vehicle storage arrangement.

- It may be an appropriate strategy to consider the use of a single sprinkler head located at high level (ie just beneath the ceiling/roof) to activate all the sprinkler heads covering a column of cars. This may obviate the potential problems of sprinkler heads at lower level not being activated by the fire plume if not located directly in the path of hot rising fire gases, or being affected by the cooling action of the spray from other sprinklers if it is not activated prior to other sprinklers at higher level. Similarly, fire hydrant system performance should also be validated given the potential for a multiple vehicle fire.

- For open-deck car parks incorporating MTVSD's, building surveyors should also be cognisant of MTVSD's and whether the vertical storage arrangements impact on the 50% cross ventilation requirements for the open deck car park.

5.3 Fire-fighting Considerations

There are potential difficulties associated with fire-fighting relating to:

- Accelerated horizontal and vertical fire spread within the car park. This potentially compromises Fire Brigade intervention times for search, rescue, control and extinguishment activities.
- More rapid development of heat and dense toxic smoke, consequently limiting the time available for fire-fighting operations prior to fire fighter tenability limits being exceeded.
- Difficulties in applying effective fire-fighting media to the seat of a shielded fire. At least 2 access points to the car park containing the MTVSD would be appropriate to allow fire fighters an alternative means of access to the area to facilitate fire-fighting of a shielded fire in a dense load storage configuration.
- Where the MTVSD has a rise of more than one parking level above the ground level, or a pit area where parked vehicles can descend to, stair access to those levels and pedestrian platforms around the vehicles in those levels should be provided to permit fire-fighters to freely move around the vehicles to achieve final extinguishment of a vehicle fire. The design of the pedestrian platforms must consider movement of fire fighters wearing full breathing apparatus.
- From a structural perspective, issues such as local collapse of the building, structural failure of the MTVSD, spalling of concrete elements, reduced Fire Resistance Levels (FRLs) to structural members should all be considered when quantifying an appropriate duration for Fire Brigade intervention.

6. RECOMMENDATIONS:

In order to minimise the fire and life safety risks within car parks incorporating MTVSD's a sprinkler system complying with AS2118.1 should be specified to serve the entire car park fire compartment.

When considering a sprinkler system designed to fully comply with AS2118.1 'Automatic fire sprinkler systems' may not be readily adaptable to a MTVSD due to the implications of shielding, moving parts, and pre-wetting of bulbs, the system should initially be designed meet compliance with AS2118.1, however it is acknowledged that minor design enhancements or departures from the standard will be necessary for the system to be considered 'fit for purpose'. The purpose being to contain a fire to a single vehicle (of fire origin) within the MTVSD.

The Australian Standard for sprinkler systems in residential buildings (AS2118.4), currently allows a building classified as residential to be provided with a residential sprinkler system extended throughout the entire building (with an enhanced discharge density within areas such as the car park). DFES recommends that the overall sprinkler system performance (particularly within the car park) be validated to ensure it meets the design intent for the specific hazard involved.

MTVSD's should be specified using non-perforated and non-combustible materials, thus minimising the likelihood of direct impingement of flame from the vehicle situated on the lower tier to the vehicle located on the upper tier. A non-perforated, non-combustible tier deck will also minimise the likelihood of any fuels, lubricants or oils dripping onto the vehicle below.

Where penetrations through fire rated car park barriers exist, appropriate protection commensurate with the FRL of the specific construction element should be provided. Where pipework and pipework penetrations exist, suitable fire collars shall have a Certificate of Test appropriate to AS4072.1. The fire collar installation is to consist of the same materials and is to be installed using the same methods as a prototype assembly tested in accordance with AS4072.1 and AS1530.4.

The performance criteria and (fume) exhaust fan selection provided within the car park area should meet the smoke exhaust system requirements of Specification E2.2b of the BCA. With respect to any metal ductwork, and the likelihood of that ductwork deforming, suitable passive protection should be provided (e.g. fire rated board material) to encase the entire metal ductwork as necessary. Additional protection of the ductwork will increase the reliability and robustness of the overall smoke exhaust system.

Further to the previous point, the ductwork and associated component installation required to function in fire mode, should not reduce the fire resistance of the construction element through which the duct(s) may pass.

At least 2 fire fighter access points should be provided irrespective of the car park location (above or below ground). Where stair travel is required to access the car park, fire rated construction should be considered with a complimenting self-closing, fire rated door system. *Note: DFES encourages early discussion regarding fire fighter access.*

In an effort to reduce car park fuel loads, private storage areas potentially comprising combustible materials, flammable liquids, cleaning products and other general consumables should be kept to a minimum or removed.

REFERENCES:

Building Code of Australia, ACT, Australia. ABCB
International Fire Engineering Guidelines, (2005 Edition), ABCB.
Economical Carparks - A Guide to Fire Safety, I. D. Bennetts, K. W. Poh, I. R. Thomas (1999) BHP Steel: Marketing, Construction & Engineering, Port Kembla, NSW, Australia.
GL-32 - Guideline Carparks Incorporating Multi-tiered Vehicle Stacking Devices, Melbourne Fire Brigade (2008), Melbourne, Victoria, Australia.
AS2118.4 Automatic Fire Sprinkler Systems Part 4: Residential, Standards Australia (1995) Strathfield, NSW, Australia.
AS1530.4, Methods for fire tests on building materials, components and structures (Part 4: Fire-resistance tests of elements of building construction), Standards Australia (2005) Strathfield, NSW, Australia.
AS4072.1, Components for the protection of openings in fire resistant separating elements (Part 1: Service penetrations and control joints), Standards Australia (2005), Strathfield, NSW, Australia.
AS2118.1 Automatic Fire Sprinkler Systems Part 1: General Requirements, Standards Australia (2006), Strathfield, NSW, Australia.

LEGISLATION:

Building Act 2011
Building Regulations 2012 (as amended).

***Please note**: This is a controlled document. DFES guidelines are available on the DFES Website: www.dfes.wa.gov.au under Regulation and Compliance, Building Plan Assessment then click on Publications/Guidelines.*

Should the information provided in this guideline require further clarification, please contact DFES Built Environment Branch via email bebadmin@dfes.wa.gov.au

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