Carparks without Sprinkler Systems

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1. PURPOSE

The purpose of this guideline is to communicate to industry Fire Rescue Victoria's (FRV) position on carpark performance solution designs that propose the deletion, part deletion or variation of an automatic fire sprinkler system which may also require a report and consent under Regulation 129 of the Building Regulations 2018 [1].

2. SCOPE

This guideline is applicable to carpark buildings with the following characteristics:

a) Enclosed (basement or above ground);

b) Enclosed with partial openings (but not deemed open-deck for the purpose of the National Construction Code (NCC) [2]; or

c) Multiple levels (any combination of the above).

For guidance on enclosed carparks incorporating multi-tiered vehicle stacking devices, please refer to FRV fire safety guideline *GL-32 – Buildings incorporating automated vehicle parking systems (AVPS)* [3].

3. DEFINITIONS

For the purpose of this document, the following definitions and abbreviations will apply.

- ***DTS*** means the deemed-to-satisfy provisions of the NCC.
- ***Enclosed carpark*** means a carpark other than open-deck carpark.
- ***NCC***: the National Construction Code Series, Volume One – Building Codes of Australia (Class 2 - Class 9 Buildings) and includes any amendment, remaking or replacement.
- ***Open-Deck Carpark*** has the same meaning as Clause A1.1 of the NCC.
- ***Prescribed Fire Safety Matter*** means the fire safety matters prescribed under Building Regulation 129.

4. INTRODUCTION

Statistically, fire incidents within general vehicle parking areas, relative to other classes of buildings, are infrequent but can result in large severe fires [4]. Aspects of design that do not manage fire growth and spread have the potential to increase the risk to occupants and firefighters, and also result in increased building and property damage potentially causing greater economic, social and environmental impacts.

5. NCC COMPLIANCE

DTS provisions of E1.5 of the NCC requires all enclosed car parks containing more than 40 cars to be sprinkler protected, however, car parks deemed to be "open deck" are excluded from this provision.

Any performance solution relating to the deletion, part deletion or variation of an automatic fire sprinkler system in an enclosed car park must meet the Performance Requirements of the NCC.

The Performance requirements relating to clause E1.5 of the NCC are:

- CP1 – Structural Stability (including fire brigade intervention).
- CP2 – Spread of Fire (including fire brigade intervention).
- CP9 – Access for fire brigade vehicles and personnel to facilitate fire brigade intervention
- EP1.4 – Automatic Fire Suppression System
- EP2.2 – Occupant Evacuation (including fire brigade intervention).

All aspects of the above requirements should be addressed in each performance solution design and where compliance with all requirements has not been adequately demonstrated, the performance solution design may not be acceptable to FRV. Further commentary and examples of this process are contained within Section 1.2.8.2 of the International Fire Engineering Guidelines 2005 [5] and FRV fire safety guideline *GL-33: Performance Based Design within the Built Environment* [6].

6. CONSIDERATION OF VARIATIONS UNDER REGULATION 129

When assessing an application for variations under Building Regulation 129, the Fire Rescue Commissioner is required to determine if a “satisfactory level of fire safety” will be achieved by the proposal.

In determining any Regulation 129 matters, the Fire Rescue Commissioner considers the entire building solution. The Fire Rescue Commissioner does not consider the Regulation 129 matters within a narrow context, the Commissioner considers the matters in the context of Section 32B of the Fire Rescue Victoria Act 1958, to protect life and property.

Where a prescribed matter is proposed to be varied in a building with an enclosed carpark, and the carpark is proposed not be fitted with an automatic fire sprinkler system, there is an increased likelihood of greater fire spread and development. If not adequately treated by suitable means, this may increase the risk to life, health and safety of occupants and firefighters. Additionally, it may also impact on the effectiveness of firefighting with regard to search, rescue and prevention of property loss.

Where the applicant does not demonstrate that the entire building solution will achieve a satisfactory degree of safety of fire safety, the Fire Rescue Commissioner may refuse consent.

7. ENCLOSED CARPARK FIRE RESEARCH

BRE Research [7] undertook a project titled *"Fires in Enclosed Car Parks"* in October 2009 on behalf of the UK Department of Communities and Local Government. The aim of the research project was to gather information on the nature of fires involving recent model cars for inclusion into existing guidance on fire safety strategies for enclosed carparks.

Specifically, *"the objectives of this task were to benchmark car fire sizes for a range of vehicle types in a typical car park, determine the spread of fire between cars and the severity (heat release) of car fires and to seek to determine the associated conditions (heat, smoke, toxic gas) to car park occupants exposed to such a fire, under typical conditions."*

The project involved eleven full scale tests including tests on the following:

- single cars;
- several cars involvement due to horizontal fire spread; and
- two cars involved in a *multi-tiered vehicle stacking device* in a vertical configuration.

The research considered factors ranging from:

- Ignition of the driver's seat under varying ventilation conditions;
- Fires originating in the engine bay;
- Fires resulting from subjecting the external car surface to incident radiant heat;
- Studying the spread of fire in a horizontal configuration with an adjacent car and empty spaces;
- Assessing vertical fire spread in a *multi-tiered vehicle stacking device*; and
- Assessing fire spread from the engine bay to another car in a "nose to nose" configuration.

The findings of the research included *"The ease with which a car fire in a car park might spread to nearby cars has been demonstrated. Once a very severe fire has developed, fire will spread to other cars separated by an un-filled parking bay."*

"In this situation, where a number of cars are burning simultaneously, the fire is exacerbated by heat-feedback and heat release rates in excess of 16 MW might be achieved from two or three cars. In Test 1 the initial car fire, Car 1, burned at around 2 MW for about 20 minutes and it was only then that Car 2 became involved (although Car 3 then ignited very soon after). However in Test 3, all three cars were burning after around 10 minutes. In Test 4 (Buxton – LPG), Car 2 was alight after 21 minutes and all four cars were burning after around 23 minutes. In Test 8, an engine fire test with a nearby car "nose to nose" the fire spread to the second car within 5 minutes."

"The ventilation limitations on such a fire in an enclosed car park result in a very hot ceiling jet, which spreads the fire to nearby cars with the dominant mechanism of heat transfer being radiation from the flames and hot gas layer, but with some direct flame contact. There were only a limited number of cars in each of the tests (a maximum of four); however escalation to many cars within a specific proximity in an actual car park must be expected under these conditions."

Importantly, the research demonstrated that gas temperatures in the enclosed test rig (beneath parts of the ceiling) reached 1100^{O}C in all the tests. Within Test 4 the gas temperature briefly exceeded 1200^{O}C.

8. FIRE ENGINEERING ANALYSIS AND DESIGN CONSIDERATIONS

8.1. Design Fires

The key to a realistic fire engineering assessment is to use a "worst credible case" fire scenario. The following test results have typically been adopted for car fires to assess the fire safety of a particular design and are considered a reasonable representation of the heat release rate curve associated with carpark fire assessments.

i. Joyeux, D., (1997)

Research detailed in Natural Fires in Closed Car Parks: Car Fire Tests [8], demonstrates a peak heat release rate of 8MW for later model vehicles (1990's) where the ignition source is the internal passenger cabin, which was a significant increase from earlier model vehicles. Fire tests by others [9] demonstrated a HRR of up to 8.5 MW and a van fire of up to 15MW.

It is important to remember that large vehicles such as vans and Sport Utility Vehicles (SUV's) make up a significant proportion of modern vehicles.

ii. BHP (1999)

The BHP tests [10] showed that considerable amounts of smoke were produced by old model cars. It is reasonable to expect that current vehicles would produce more smoke due to an increased use of plastics, rubbers etc.

iii. Profil ARBED Recherches (1997)

The research [11] involved two or three car fires. The two-car fire Heat Release Rate (HRR) is approximately 1.5MW at 4 minutes which remains steady until 17 minutes, at which time the HRR rises to 5.5MW at 24 minutes, and then rises to a peak HRR of 8.5MW at 26 minutes before decaying with completion at 70 minutes.

The three-car fire HRR is approximately 4MW at 12 minutes and is constant until 15 minutes before rising to a peak HRR 16MW at 26 minutes, then decays to 9MW at 38 minutes, peaking again slightly to 11MW at 40 minutes and decaying further with completion at 60 minutes.

8.2. Tenability Considerations

Fires in an enclosed basement car park can create an extremely hot and toxic environment if adequate ventilation or means to restrict fire spread and development is not provided. The BRE research demonstrated the occurrence of very hot ceiling jets (>1100°C) which spreads the fire to nearby cars through radiant heat from the hot gas layer and flames. Smoke exhaust systems should be designed appropriate to the expected conditions within the compartment to ensure continued operation in a fire event.

There are difficulties associated with accounting for the number of occupants, especially in public car parks. Therefore a search of the area is highly likely in a fire situation and may be the only way to confirm that all occupants have evacuated.

Conditions within the car park should remain tenable for the duration of a primary search by responding firefighters. A primary search is limited to teams of 2 firefighters travelling along the primary vehicle circulation paths. Use of appropriate tenability limits for firefighters and the FBIM is critical.

Tenability is considered to be exceeded when radiant heat and temperature conditions outlined in FRV fire safety guideline *GL-17: Fire Brigade Intervention Model (FBIM)* [17] general provisions are exceeded.

In an un-sprinklered car park, fire continues to develop, spread and generate large quantities of toxic smoke. Even in partially open sided and under-croft car parks, severe acrid smoke would potentially make it extremely difficult to access, locate and fight a fire. Therefore, ventilation openings in car parks need to be assessed so that an acceptable level of smoke spill to the outside of the building is provided. Where natural ventilation is proposed, the head of the opening should be located 2.1 m above ground level to allow the spill of smoke and hot gases which may increase the time for occupant and fire fighter tenability. Low ceiling heights should be avoided.

8.3. Other Design Considerations

Any storage areas near parked cars that could contribute to the overall fuel load should also be taken into account. Residential buildings commonly have storage areas within mesh enclosures inside the car park.

Exit routes and locations should be kept simplistic, predictable and readily identifiable. Design acceptance should be considerate of a smoke-filled environment. Access difficulties for firefighting personnel and equipment that lead to a delayed response in terms of search and rescue, water setup and initial firefighting activities. Delays can lead to greater risk to life and property. Access should again be simplistic, predictable and readily identifiable in a location that provides firefighters with safe access to all parts of the car park.

Open connections from the car park to other parts of the building should be avoided unless adequately separated to prevent the passage of smoke and fire. Smoke and fire protected lobbies are recommended to provide redundancy in the separation between fire compartments.

An "interactive" type addressable detection system may be proposed to provide early detection and avoid spurious alarms in the car park. A heat detection system may be considered, however, due to the delayed response time, would result in a slower intervention and evacuation time. (The expense of capital investment and maintenance with these systems should be analysed from a cost benefit point of view in comparison with sprinklers).

9. AUTOMATIC FIRE SPRINKLER SYSTEMS

Automatic fire sprinklers have been demonstrated as an effective means of preventing fire spread and development in car fires and therefore must be a major consideration in the fire safety design of *enclosed car parks*. The advantages of the fire sprinkler system are:

- Increased level of life safety for occupants afforded by sprinklers in the car park due to a significant delay in the onset of untenable conditions;
- Reduction in the amount of heat and smoke to assist with effective Fire Brigade Intervention, especially in search, rescue and locating the seat of the fire;
- Fires in sprinkler protected car parks can often be readily extinguished with first aid firefighting equipment resulting in decreased loss of property and risk to the structural integrity of the enclosing structure;
- Sprinklers will control the fire size but in an un-sprinklered car park, the provision of a smoke exhaust system may accelerate the fire growth, depending on ventilation environment.

Where carpark design incorporates sprinkler systems that do not meet the deemed to satisfy provisions of the NCC, the Fire Rescue Commissioner must be notified under Regulation 129 (3). For further technical guidance in this matter please consult Victorian Building Authority *Practice Note 59-2018 – Sprinkler Systems – Performance Solutions* [13].

10. REFERENCES

[1] Building Regulations 2018

[2] National Construction Code Series – Volume One 2019

[3] FRV fire safety guideline GL-32 – Buildings incorporating automated vehicle parking systems (AVPS)

[4] MFB Carpark Fires 1991-2011, February 2012

[5] International Fire Engineering Guidelines (2005 Edition)

[6] MFB Fire Safety Guideline GL-33: Performance Based Design within the Built Environment

[7] BRE Research Project – Fires in Enclosed Car Parks (Oct 09) on behalf of the UK Department of Communities and Local Government.

[8] Natural Fires in Closed Car Parks: Car Fire Tests. Daniel Joyeux, 1997. (Joyeux, D. “Natural Fires in Closed Car Parks”, CTICM, INC-96/294d-DJ/NB, 1997).

[9] Australasian Fire Authorities Council "Fire Safety Guidelines for Road Tunnels: Design Fires", June 2001.

[10] BHP, "Economical Car parks-A Guide to Fire Safety", March 1999.

[11] Profil ARBED Recherches, "Development of Design Rules for steel Structures Subjected to Natural Fires in Closed Car Parks", 1997.

[12] MFB Fire Safety Guideline GL-17: Fire Brigade Intervention Model (FBIM)

[13] Victorian Building Authority, Practice Note 59-2018 – Sprinkler Systems – Performance Solutions