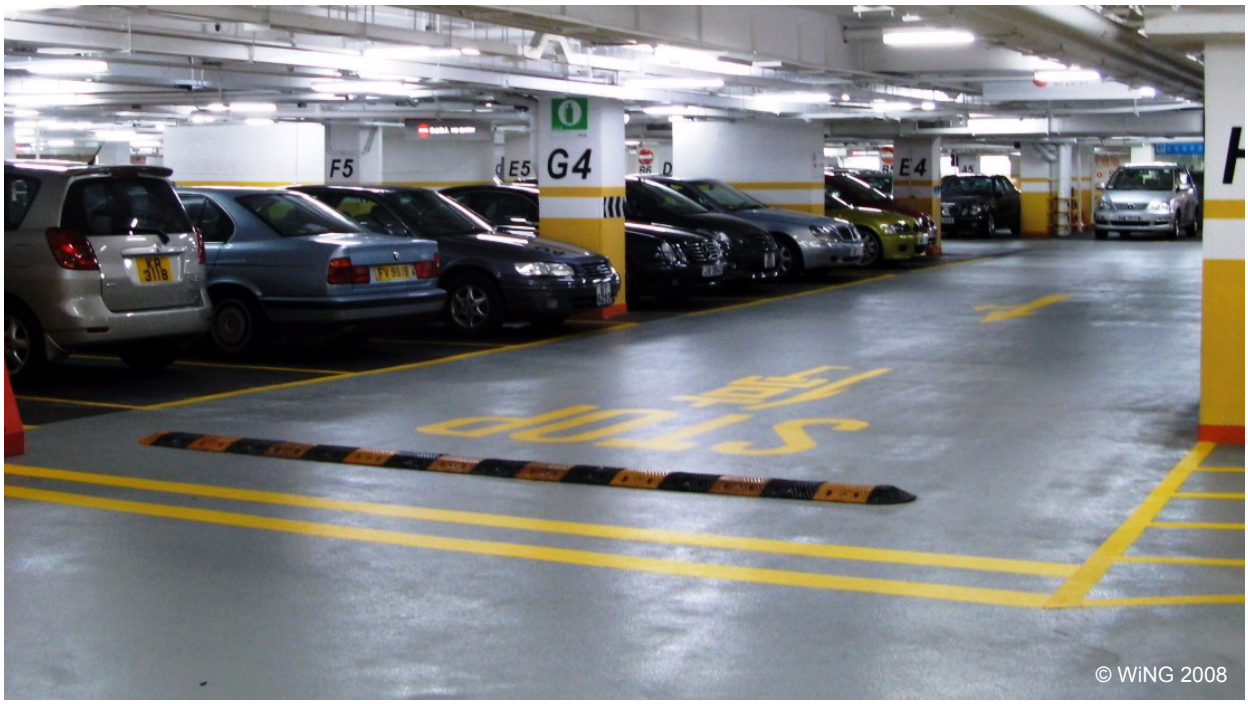
Fire & Rescue NSW

Fire Safety Guideline

Guideline for impulse fans in car parks



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Fire Safety Branch
Community Safety Directorate

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Contact Us
Fire & Rescue NSW
Fire Safety Policy Unit
Community Safety Directorate
Locked Bag 12
Greenacre NSW 2190

Hours: 9am to 5pm, Monday to Friday
Telephone: (02) 9742 7434
Facsimile (02) 9742 7483
Email: bfs@fire.nsw.gov.au
Website: www.fire.nsw.gov.au

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Contents

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1 Scope

This document details Fire & Rescue NSW (FRNSW) guidelines for impulse fans in sprinkler protected car parks. Some guidance is also provided on FRNSW interpretation of the requirements of *Australian Standard* AS 1668.2:2012 with regards to the provision of impulse fans.

2 Application

This guideline should be used by fire engineers and Principal Certifying Authorities (PCA) when preparing or reviewing a proposal involving impulse fans in sprinkler protected car parks.

Note: Where impulse fans are proposed in a non-sprinkler protected car park, the design and operation of this system should still be discussed with FRNSW during the Fire Engineering Brief.

When followed, this guideline can be used to assist in streamlining FRNSW review and comment of an alternative solution application which has certain types of fire engineering design and common *Building Code of Australia* (BCA) issues.

When not followed, applications for alternative solutions must have all criteria assessed on a 'case-by-case' basis, requiring FRNSW to allocate more time to review and comment on the application.

Responsibility remains with the PCA to ensure that the design completely and adequately meets all performance requirements of the BCA.

3 Background

It is important to note that the primary purpose of a ventilation system in a car park is to address the requirements associated with amenity and air quality, i.e. to prevent and clear the build-up of carbon monoxide generated by motor vehicles. The BCA and *Australian Standard* AS 1668.1:1998 does state that car park ventilation systems are not required for smoke control. However, there are requirements in relation to what the system should do in the event of a fire, which is to ramp up to full exhaust capacity upon detection, to assist with exhausting smoke generated by the fire.

The most common form of ventilation for car parks is based upon a traditional ducted ventilation system. The principle of the traditional ducted ventilation system is that the contaminated/polluted air (carbon monoxide) is drawn to the exhaust fans and exhausted from the car park and replaced with fresh air from supply fans.

Traditional ducted ventilation systems have detailed design and performance specifications set out in the BCA and the Australian Standards. These requirements are well understood and accepted as standard practice.

Impulse fans, also known as jet fans, are a form of mechanical ventilation in enclosed car parks that is relatively new in Australia, however they have been in common use in other parts of the world for some time. Impulse fans are low profile ceiling mounted fans and provide air at a velocity to provide momentum to produce air movement towards an exhaust point.

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Impulse fans are generally installed on the underside of the car park ceiling locating the fan inlets and outlets close to the ceiling.

This principle differs from the conventional ducted system in that whilst there is some supply air for fresh air make up, impulse fans are located in strategic positions within the car park, usually in the centre of the drive lane, to push air towards the exhaust points. The supply and exhaust points may or may not utilise fans as normally expected with a conventional ducted system.

Notwithstanding the efficiencies of either system, the potential benefits of an impulse fan system from a design viewpoint is less energy consumption due to the reduced supply and exhaust fan sizes, reduced slab to slab height and potentially reduced installation costs.

Note: The recent increasing use of impulse fans in Australia is associated with them providing significantly cheaper building costs.

FRNSW recognise the need for reduced construction costs (where proposals still provide required levels of safety) consistent with the current ABCB project, which aims to realise benefits from regulatory reform through increased use of the performance-based approach.

4 Areas of consideration

In contrast to conventional ducted systems, there is no detailed design or performance specification for impulse fans in the BCA or Australian Standards other than in AS 1668.2:2012, which gives a specification for the scenario of where one fan is used in dead end areas.

If a design is to involve a larger number of impulse fans, the design and performance needs to ensure they meet the same BCA objectives for ventilation and fire performance as the conventional ducted system.

Areas of consideration for providing impulse fans in lieu of a conventional ducted mechanical system within enclosed sprinkler protected car parks, include:

- the potential impact on the operation and effectiveness of installed fire safety systems, and
- the potential impact on conditions within the car park.

FRNSW consider that the relevant performance requirements applicable to a proposal incorporating impulse fans are EP1.4, EP2.2 and FP4.4 of the BCA.

This guideline sets out the objectives and supporting information for the process of submitting an alternative solution that will incorporate the use of impulse fans in a sprinkler protected car park.

Note: The intention of this guideline is to assist industry to have more certainty during the design and subsequent approval stages.

5 FRNSW position

FRNSW is of the view that the installation of impulse fans is not a Deemed-to-Satisfy solution in the current AS 1668.2:2012 unless the design consists only of a single impulse fan serving a dead spot in a car park. Where the installation exceeds this, such as a series of impulse fans, the system is no longer considered Deemed-to-Satisfy and an Alternative Solution would be required.

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The Alternative Solution must be achieved through a collaborative stakeholder approach in accordance with the Fire Engineering Brief (FEB) process as outlined in the *International Fire Engineering Guidelines*.

The following key items need to be considered as part of the Alternative Solution:

(1) Performance requirement EP1.4 must be assessed to demonstrate that the sprinkler design and performance is not adversely affected.

(2) Performance requirement EP2.2 must be assessed to demonstrate that conditions within the car park are not adversely effected.

The provision of a detection system to quickly shut down the impulse fan system and the correct positioning of the impulse fans within the car park may assist in addressing these items of consideration. Examples of detection systems that may be utilised include:

- beam detectors
- aspirating smoke detectors
- duct probe detectors.

Note: The alternative solution will need to justify the detection system proposed.

Whilst it is acknowledged that there have been studies undertaken demonstrating that the impact on sprinkler performance is negligible if the impulse fans are located in between rows of sprinklers, there is currently only limited information available, and no actual fire tests have been undertaken to demonstrate this. Similarly, there is limited research available discussing the impacts on tenability conditions within the car park for various modes of operation of impulse fans.

Each car park design and impulse fan system design and layout is different, which may result in different patterns of airflows throughout the car park, and therefore it is considered that analysis specific to each car park design must be undertaken.

5.1 Design requirements

The following details the minimum requirements that need to be addressed in the design:

(1) The impulse fans should be located in driveways and access ways, and not above car parking spaces or other areas where there are stagnant fire loads.

(2) The impulse fans should be located between rows of sprinklers and it should be demonstrated that the air jet from the impulse fans does not impinge upon any sprinkler heads.

(3) The impulse fans are to shut down upon detection of fire within the car park, including activation of any sprinkler system. However, in addition, an appropriate means of shutting down the impulse fan system via the provision of a suitable detection system is also to be provided. This detection system should only shut down the impulse fan system and not activate the occupant warning system or fire brigade notification unless it is appropriate to use within a car park environment and would not cause spurious alarms.

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(4) Manual control of the impulse fans should also be provided for fire-fighters at the Fire Fan Control Panel (FFCP) so that the impulse fans can be used during fire brigade intervention if required.

(5) The shutdown operation of the impulse fans by the proposed detection system should be tested during the commissioning tests prior to occupancy. The test procedures should be in accordance with the relevant Australian Standards for the applicable detection system.

(6) Sprinklers, where required, must be installed as per the BCA and AS 2118.1:1999.

The final design solution for fan locations, operation and shutdown must achieve both mechanical and fire safety objectives. It is important that the main objective of the ventilation is to deal with the carbon monoxide. This should not be compromised when dealing with fire related alternative solutions.

5.2 Analysis required

5.2.1 Impact on sprinkler performance

The analysis should demonstrate that the difference in sprinkler activation times between the scenario where the fans are running at full design speed and when the fans are off is negligible. This should be undertaken for two scenarios, a fire located within the immediate air flow directly in front of an impulse fan and a fire located outside the immediate air flow (see Figure 1 below).

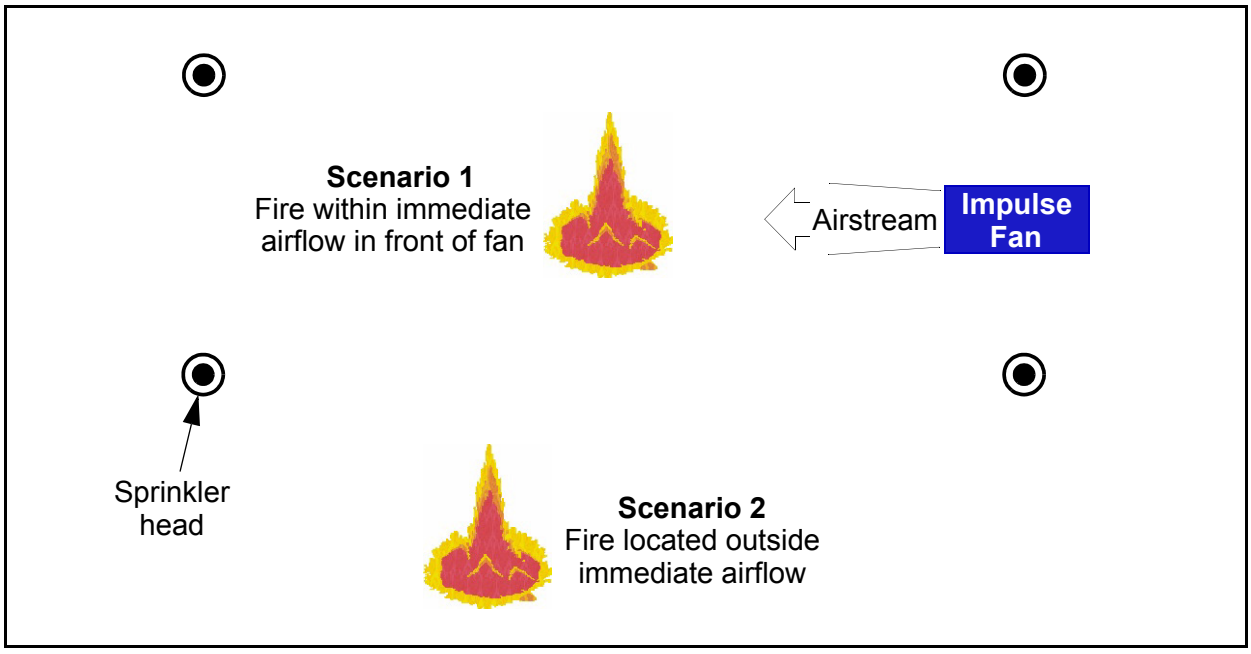

Figure 1 Fire scenario locations for analysis of sprinkler performance

As stated previously, analysis will need to be undertaken for every design as car park layout and dimensions, as well as fan layouts, will impact on air velocities throughout the space.

FRNSW expects this analysis to be undertaken using CFD modelling. The methodology, depth of analysis, scenario selection and detailed CFD modelling over the entire car park environment must be sufficiently detailed to address all of the fire safety issues and agreed in the FEB process.

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5.2.2 Impact on conditions for occupants and firefighters

The analysis should demonstrate that the proposed means of shutting down the jet fans via the detection system results in an appropriate shutdown time such that conditions within the car park are not adversely affected by the operation of the impulse fans. Whilst it is acknowledged that the shutdown time will vary for various fire scenarios, the time for shutdown of the impulse fans for each scenario assessed should be documented in the Alternative Solution Report to provide an indication of the shutdown time.

In order to demonstrate that conditions in the car park are not adversely affected, it should be demonstrated that either:

(a) Tenability is maintained for the period of time occupants take to evacuate the car park with a suitable factor of safety; or

(b) Conditions within the car park, throughout the time of occupant evacuation, are at least equivalent to those which occur if the car park was provided with a ventilation system complying with the Deemed-to-Satisfy provisions of the BCA.

This should be undertaken for two scenarios, a fire located within the immediate air flow directly in front of an impulse fan and a fire located outside the immediate air flow, as per Figure 1.

As stated previously, analysis will need to be undertaken for every design as car park layout and dimensions, as well as fan layouts, will impact on air velocities throughout the space.

FRNSW expects this analysis to be undertaken using CFD modelling. The methodology, depth of analysis, scenario selection and detailed CFD modelling over the entire car park environment must be sufficiently detailed to address all of the fire safety issues and agreed in the FEB process.

5.2.3 Fire Brigade intervention

In addition to analysis of impacts on sprinklers and tenability conditions, manual control of the impulse fans should be provided for firefighters at the FFCP so that the impulse fans can be used during fire brigade intervention if required.

If the building has no FFCP, then the location of manual controls should be discussed with FRNSW.

5.2.4 Commissioning

The shutdown of impulse fan operation by the detection system should be tested during the commissioning tests prior to occupancy. The test procedures should be in accordance with the relevant *Australian Standards* for the applicable detection system.

6 Australian Standard requirements

Clause F4.11 of the BCA references AS 1668.2:2012 as the standard of performance for mechanical ventilation systems in car parks. The commentary to Clause 4.1 of this standards states that '*This Standard applies to the provision of mechanical ventilation to enclosures intended to minimize the potential for adverse health effects from contaminants generated by combustion engines*.'

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Clause 4.4.2 of AS 1668.2:2012 permits the use of impulse fans in car parks, however this is restricted to the provision of a single impulse fan serving a dead spot in a car park. Where the installation exceeds this, such as a series of impulse fans, the system is no longer considered Deemed-to-Satisfy and an alternative solution would be required.

The current version of AS 1668.1:1998 does not specifically refer to the operation of impulse fans in fire mode. AS 1668.1 is currently undergoing a revision and is intended to incorporate requirements for impulse fans permitted to be installed in accordance with AS 1668.2:2012. Until this revision of AS 1668.1 is published, FRNSW recommend the design requirements outlined in Section 5.1 of this guideline should be addressed in the design.

7 Impulse fans in non-sprinklered car parks

Where impulse fans are proposed in a non-sprinkler protected car park, the design and operation of this system should still be discussed with FRNSW during the Fire Engineering Brief.

Potential impact on conditions in the car park, means of shutting down the fans, and other items would still need to be addressed, however the details and extent of analysis should be discussed during the FEB process.

8 References

Standards Australia, 1998, *Australian/New Zealand Standard AS 1668.1:1998, The use of ventilation and airconditioning in buildings - Fire and smoke control in multi-compartment buildings*, Standards Australia Limited, Sydney

Standards Australia, 2012, *Australian Standard AS 1668.2:2012, The use of ventilation and airconditioning in buildings - Mechanical ventilation in buildings*, Standards Australia Limited, Sydney

Standards Australia, 1999, *Australian Standard AS 2118.1:1999, Automatic fire sprinkler systems - General requirement*s, Standards Australia Limited, Sydney

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Fire & Rescue NSW

Fire Safety Branch
Community Safety Directorate
1 Amarina Avenue
Greenacre NSW 2190

Telephone: (02) 9742 7434
Facsimile: (02) 9742 7483
Email: bfs@fire.nsw.gov.au

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www.fire.nsw.gov.au

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