Doc Ref: SCR102/19-R27

Report on methods to ventilate enclosed car parks – Part 2 *System Design*

Advanced Smoke Group Limited

February 2019

Foreword

During the last 15-20 years, I have witnessed some excellent and some appalling car park ventilation systems. Some of these systems, quite frankly, have bordered on being potentially dangerous.

Over the last 15 years, many companies have "jumped on the bandwagon" of the advent of jet fan, or impulse fan, ventilation systems. Many of those who jumped onto that bandwagon believed that the design and installation of such systems looked so easy anyone could do it. How wrong those people were.

Some fan manufacturers even thought that bolting a silencer onto the inlet and outlet of a standard axial fan converted the axial fan into a jet fan, completely misunderstanding what a jet fan was and how it was actually rated. This would be laughable if the consequences were not so serious.

Equally serious, due to the misunderstanding of how jet fan systems work, is how some jet fans have been installed, with outlets just 500-600mm from the face of downstand beams or ductwork, totally destroying the Jetstream and, consequently, the performance of the jet fan. Also fans suspended 700mm or more from the soffit on flimsy tie rods with the installer not realising that the thrust of a 50N jet fan will cause the eventual failure of the fixing.

And then we have fire rated cabling fixed to inverted trays by nylon ties, creating a serious hazard to fire fighters entering a car park to tackle the fire.

Having seen all these things and many others, I have been prompted to ask our engineering team to put together a report which sets out the correct way to approach car park ventilation design. The following report provides some tips which may help improve system design whilst also saving money.

With personnel who were in the vanguard of the introduction of jet fans systems into the UK working on this report, I am sure that, with the design and installation experience the team has, the following report will be of help to many.

David Royle,
Managing Director

Why car park ventilation - Introduction

The efficient ventilation of an enclosed car park, whether above or below ground, is essential, not only to maintain a fresh environment on a day to day basis, but to protect occupants from the toxic exhaust fumes generated by the moving vehicles and to aid fire fighters from the major effects smoke and heat in the event of fire.

Exhaust Pollution ventilation

The criteria for providing day to day ventilation is outlined in building regulations which relates to the maximum, time weighted level of carbon monoxide (CO). Even though there has been a significant increase in the number of vehicles with diesel engines, there is no current regulatory control of Nitrogen Oxide (NOx) levels in terms of pollution levels within car parks.

As it leaves the vehicle exhaust and enters the atmosphere Nitrogen monoxide (NO) emitted from diesel engine, it is oxidised to Nitrogen dioxide (NO_2) which, at very low levels, is a respiratory irritant. Up to now, it is has been considered that controlling the rate of ventilation to meet the required maximum CO levels will also provide adequate control of NO_x levels.

However, with the increase in the number of diesel driven vehicles and the consequential increase in the level of NOx emissions, consideration should be given to this potential hazard. Only in Appendix D of approved document F1 are NO_x emissions mentioned as one of the "typical emission sources that need to be considered including at traffic junctions and in underground car parks."

Furthermore, little is known about the emissions from the batteries of electrically driven vehicles. For example, what vapours or fumes are given off whilst being driven, or what happens to the battery once the vehicle is parked and how long the battery needs to cool down and what level of ventilation is required. This also requires more research.

Smoke ventilation
With a concentration of vehicles stored in a confined space there is always the risk of fire and, with the inherent potential fire load of the parked vehicles, the risks associated with a vehicle fire can be very significant from both heat and smoke.

The localised heat load in the event of a car fire can be extremely high; in research undertaken in real fire tests by the Building Research Establishment (BRE) a few years ago, localised temperatures of up to 900^{0}C were recorded within a test rig they had built to simulate a car park. Such temperatures with no intervention will quickly cause the spread of fire to adjacent vehicles.

The BRE tests involved only internal combustion engine powered cars, the research program did not include electrically powered vehicles; however, it is now recognised in many quarters that work needs to be carried out in this area. The fire related risks associated with electrically powered vehicles that are connected to electric hook up points should certainly be addressed, as this facility are increasingly being provided in enclosed car parks, including those serving residential accommodation.

Car park ventilation systems designed in accordance with current building regulations (code compliant systems) are designed to provide assistance to the fire service attending an incident, they are not required to provide for the safety of occupants of the car park and are, consequently, not considered as life safety systems. However, the regulations do require a standby power supply and at least two extract fans are required to be installed, although each fan is only required to provide 50% of the maximum airflow.

As with many aspects of fire engineering in buildings, “engineered solutions” are often submitted as alternatives to the code compliant solutions in order to secure concessions from the regulatory authorities. Some of these engineered solutions bring car park ventilation closer to a life safety type of application and these will be discussed later in this report.

System Design Regulations & Standards
There are two sets of regulation documents applicable to car park ventilation, Approved Document F (AD F1) relating to day to day ventilation for the control of vehicle exhaust pollution, and Approved Document B (AD B3) relating to the requirements for the ventilation of the products of combustion in the event of fire.

There is also a British Standard relating to the design of car park ventilation systems catering for a fire condition, BS7346: Part 7: 2013 – *Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks*. This British standard covers the full range of ventilation options from full natural ventilation to comprehensive smoke control making provision for life safety.

There is currently no European standard for this application, although a “Technical Specification” (TS), not a full standard, is being drafted. This document has been worked on by a CEN committee for several years now though still not yet ready for publication at the time of this report. However, there is a proposal to extend the scope of work of the drafting group following publication of the TS. The intent being that, after an initial period of use, the document will be adopted as a full European Standard (EN) incorporating any changes that are considered necessary since the initial launch of the TS.

System Design Options

Regulation (Code) Compliant Ventilation

A "code compliant" system, one that is designed strictly in accordance with the performance criteria set out in the relevant building regulations Approved Documents F1 and B3. The following is a summary of the options available for car park ventilation.

Natural ventilation – 5% of the net floor area of the car park (that area not occupied by enclosed plant space) should be available in ventilation openings linked directly to atmosphere with 50% of those openings split equally between two opposing walls. The remaining openings may be located elsewhere in the car park.

Assisted natural ventilation – 2.5% of the net floor area of the car park (that area not occupied by enclosed plant space) should be available in ventilation openings linked directly to atmosphere with 50% of those openings split equally between two opposing walls, the remaining openings may be located elsewhere in the car park. In addition mechanical ventilation providing 3 air changes per hour within the car park should be provided. The 3 air change per hour is only required under day to day ventilation conditions, as it is considered under current building regulations, that the available natural ventilation representing 2.5% of the net floor area is adequate to ventilate the smoke and hot gases under a fire condition. The basis for this consideration is that the buoyancy of the hot gases is thought to be sufficient to provide the energy to ventilate and clear the smoke in the event of fire. As it is not used under fire conditions, the extract fan is not required to be high temperature rated.

Mechanical ventilation – 6 air changes per hour required for day to day ventilation and 10 air changes per hour for a fire condition. Two extract fans rated at 300^0C to be provided, each fan capable of producing an airflow rate equivalent to 50% of the 10 air changes per hour.

Mechanical Ventilation Options – Ductwork or Jet Fans

Until about 20 years ago, a ducted ventilation system was the most common sight in most new fully enclosed car parks. Since then, jet fan systems (sometimes referred to as Impulse Ventilation systems) have become the system of choice due to their flexibility, efficiency and because jet fans are less obtrusive, as well as being less obstructive, being located at soffit level.

One of the greatest disadvantages of a ducted system is its exposure to potential damage and debris build up, particularly in a busy commercial car park. Duct branches at low level may be damaged by vehicles and debris may accumulate at the intake grilles and, in some cases, the debris may be drawn into the duct causing a reduction in system performance due to an obstruction within the duct itself.

A further disadvantage of ductwork in a car park is the level of resistance created by the duct itself, which can typically be in the order of 1000-1500Pa for a reasonable sized car park. The designer must also allow for the additional pressure drop due to potential damage and debris obstruction during its lifetime as access may be difficult for maintenance.

The jet fan option on the other hand can reduce the installed power significantly by reducing the system losses to typically 300-500Pa due to the extract fans only having to cater for the losses through attenuation and extract and discharge grilles.

The introduction of jet fans for car park ventilation systems has also enabled the management of smoke flow through car parks due to the ability of the system to automatically manipulate the operation of each individual jet fan via the system control panel. This is achieved by the use of an addressable fire detection system and is discussed later in this report.

Engineered Solutions

Of course, alternative solutions to those outlined in the approved documents may be employed, providing they can be demonstrated to meet the functional requirements of the relevant Approved Document. Opting for an engineered solution may be done to secure concessions from the regulator. Some alternative solutions for day to day ventilation systems for pollution control and for smoke extract systems in the event of fire are discussed below.

"Engineered" Mechanical System for day to day Ventilation

A mechanical ventilation system compliant with Approved Document F is designed to simply provide 6 air changes per hour within the car park. Whilst a code compliant system may be simple to design and install, for a car park of any significant size, this fixed rate of ventilation could raise several sensitive issues; for example the issue of noise generated by the ventilation system operating at full capacity 24 hours per day, and the issue of the excessive consumption of electrical power.

For the last 15 years, vehicle exhaust pollution monitoring (see figure 1) has been in common use in car parks, managing the operation of the car park ventilation systems. Clause 6.18 of Approved Document F1 of the current building regulations states that the requirement of the regulations will be satisfied:

> *"if the mean predicted pollutant levels are calculated, the ventilation rate designed and equipment installed to limit the concentration of carbon monoxide to an average concentration of not more than 30 parts per million over an eight hour period and peak concentrations, such as by ramps and exits, of not more than 90 parts per million for periods not exceeding 15 minutes".*

Adopting these criteria as the design conditions, it is possible to vary the air change rate according to the level of pollution detected at any one time. It may also even be acceptable to shut the system down overnight, during which period there will be little or no traffic movement. In this situation, the ventilation system would reactivate in the event that a rise in carbon monoxide pollution is detected. This principle of control is in common use nowadays.

FIGURE 1 – Carbon monoxide sensor

The airflow rate of the extract fans and the speed of the jet fans are controlled according to the level of pollution detected by the CO monitors (see figure 2) and the use of frequency inverters. CO sensors should be mounted at 1200mm above finished floor level. Mounting sensors at a higher level could be potentially harmful to children or those in wheel chairs due to sensors reading the further diluted concentration of gases.

Enhanced day to day ventilation system

This variation in system control could potentially be used to further reduce the maximum air change rate adopted for day to day ventilation from the maximum 6 air changes per hour to a maximum of 3 or 4 air changes per hour. The design process would involve an assessment of the predicted peak traffic movement and the consequential level of exhaust pollution. Having established the predicted pollution level then a relatively simple calculation can be made on the appropriate level of ventilation required.

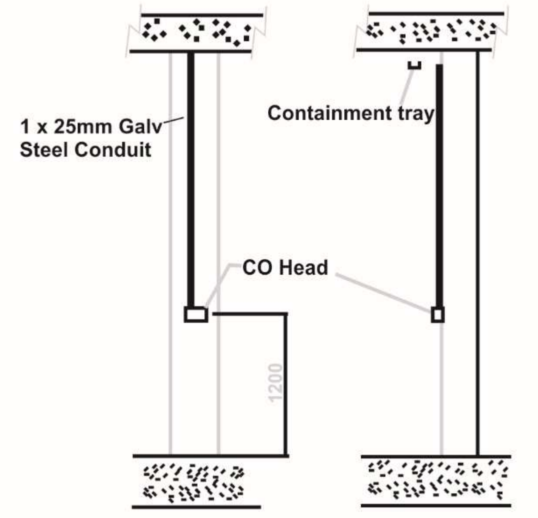

FIGURE 2 – mounting of CO sensors

The most practical and most common and way of demonstrating the performance of this engineered solution is to use computer modelling, a CFD representation of the system design can graphically demonstrate adequate air circulation, ensuring no stagnant areas, and dilution of the CO pollution. Any area in which the air speed drops below 0.1m/s should be considered stagnant.

Such an option could make significant reductions in electrical power requirements, potentially reducing the installed power by over 50% against that of a code compliant system for larger car parks. This reduction could make significant savings in the installation costs of extract fan capacity, power supply to the system, attenuation and standby power provision, e.g. standby generator size.

Ventilation in event of fire

The requirement quoted in Approved Document B for the ventilation system in the event of fire in an enclosed car park is an extract rate of 10 air changes per hour. This basic code compliant design is based on providing a smoke clearance system.

Until relatively recently it was acceptable not to install any fire detection within the car park and to activate the smoke ventilation system from the fire service override switch once the fire brigade arrives. With the introduction of BS7346: Part 7: 2013, the installation of an automatic fire detection system for the purpose of activating the car park smoke ventilation system is now advised.

The approved document also states that BS7346: Part 7: 2006 (this standard has since been updated in 2013) provides an alternative method of ventilation. In addition to outlining the “code compliant” solutions for ventilating a car park, this British Standard also provides guidance on designing an engineered solution based largely on a design fire load for which it provides a table covering sprinklered and unsprinklered car parks.

Designing for Smoke Control

The conventional way in which car park ventilation systems are designed is based on the air change rates indicated in Approved Documents F1 and B3, i.e. 6 air changes per hour for day to day ventilation and 10 air changes per hour in the event of fire. Designing the system based on a specific fire load, selected in line with the table given in BS7346: Part 7: 2013, can result in an air change rate lower than the 10 air changes quoted in AD B3.

The use of a jet fan ventilation system to control the flow of smoke in the event of fire, rather than simply function as a code compliant smoke clearance system, may be adopted to secure concessions against the code compliant performance criteria; for example to gain approval to remove the need to individually ventilate lobbies, or to reduce the air change rate for a large car park.

The smoke control option

When considering the design for a jet fan car park ventilation system to provide smoke control in the event of fire, there are a number of key points that must be considered in order to provide a viable system:

Principle layout of the system & zoning

The initial consideration must be the basic layout of the car park, for example the location of the entry ramp is located, as this more than likely the major (if not only) route for the supply of fresh air make up, and then any other source of make-up air. Only once this has been established can the most suitable location of the extract chamber be considered.

An engineered smoke control solution notionally breaks the car park down into fire zones of approximately $1000m^2$. A fully addressable automatic fire detection is used to enable the location of a fire to be identified to the control system. The information received at the control panel will in turn cause the appropriate jet fans to be activated and also determine which set of extract fans (if there is more than one set) are activated.

Calculating airflow rate & selecting extract fans

The rate of extract will depend almost entirely on the design fire load, BS7346: Part 7: 2013 publishes a table listing suggested design fire loads, 4MW for a sprinklered car park and 8MW for unsprinklered. Where car stackers are installed, a figure of 10MW is suggested on the basis of sprinklers being installed; the standard states that no reliable design fire load can be quoted for a stacker system if sprinklers are not installed.

A further consideration in calculating the airflow rate is the velocity of air needed through the affected fire zone in order to control the direction of smoke flow. On the basis of a $1000m^2$ maximum fire zone, not more than 100m in length, the air velocity through the zone should be in the order of 1.1m/s based on an 8MW design fire load.

The extract rate for which the fans are selected must meet the airflow requirements under a fire condition and day to day environmental conditions, whichever is the higher value. The fans should be tested in accordance with BSEN 12101-3 and rated to F300, i.e. capable of withstanding 300^0C for 120 minutes.

Typical design criteria for a smoke control system:

- The system will meet the functional requirements of Building Regulations Approved Documents F1 and B3
- The system will extract the mass of smoke generated by an 8MW fire (4MW if sprinklered) in accordance with the guidance in BS7346: Part 7: 2013
- Protect fire service access routes from smoke migration
- Install a fully addressable automatic fire detection system
- Provide a relatively clear approach for the fire service to within 15m of the fire
- Protect lobbies from smoke migration

An engineered solution is unlikely to be particularly beneficial in car parks of less than 5000m^2, however, the rewards can be significant for car parks of 7000m^2 and above in terms of the cost of fans, attenuation, cabling, generator capacity and plant room size, not to mention the electricity bill.

The fan chamber and attenuation

Adequate provision must be made for the extract fan chamber. The architect will undoubtedly be under pressure to resist what a developer may consider "an excessive" amount of space being made available, but it will be the attenuation necessary to meet the specified maximum noise levels that will take up the space rather than the fans.

A specified maximum overnight noise level of 20dBA at 5m from the fan chamber discharge and a maximum 42dBA daytime level are not uncommon. To achieve these levels and provide for the large quantities of air associated with car park ventilation, a significant amount of attenuation will be necessary and often creative design is necessary to fit all the equipment into the available space (see figure 3).

It should be remembered that, whilst the attenuation banks are rated to limit the noise breakout to occupied spaces under day to day operating conditions, the resistance created under a fire condition must also be taken into account due to the potentially higher airflow rate.

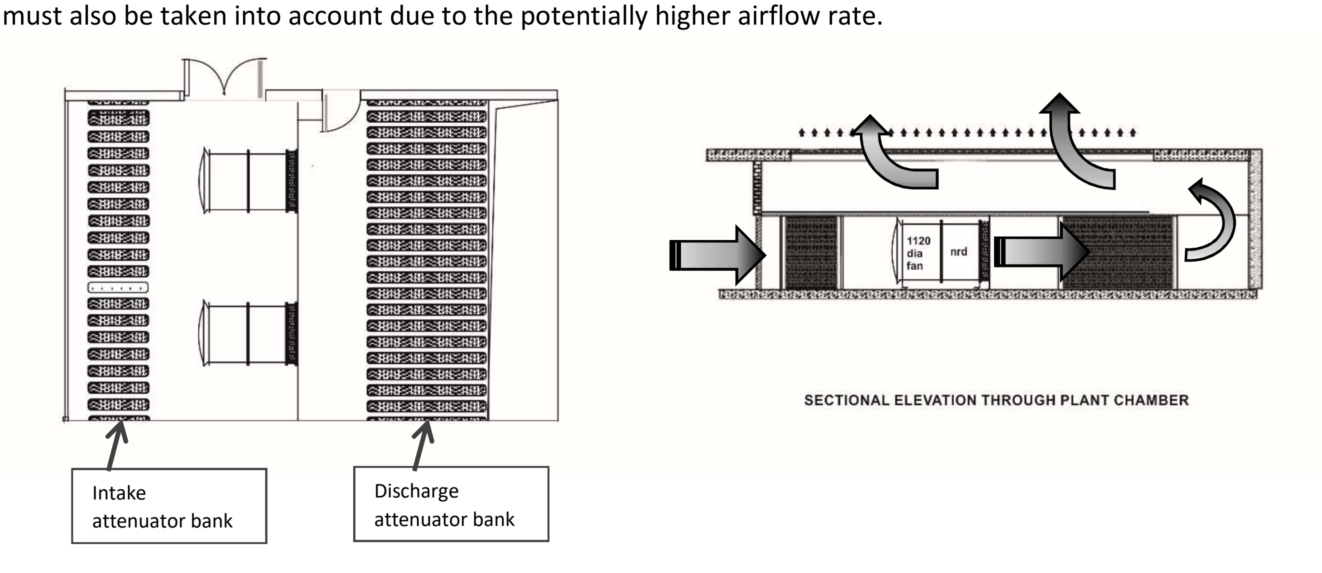

FIGURE 3 – Creative designs are sometimes necessary to fit the attenuation into the fan chamber

A typical extract fan installation will involve two free standing axial fans mounted in parallel and fitted with inlet cones and guards, non-return dampers to avoid air recirculation and mounting feet with antivibration mounts. The two fan assemblies will be mounted via fire rated flexible connections against a wall separating the intake chamber from the discharge chamber.

Some appalling extract fan installations have been witnessed. One particular installation was where the intake splitter bank attenuation has been mounted directly onto the extract fan inlet, seriously compromising the performance of both attenuation and airflow rate. To realise the full design performance from both fans and attenuation, at least a distance equivalent to one fan diameter musty be allowed between the fan inlet and the attenuation and similarly, between the fan outlet and the discharge attenuation.

The fans will each be rated at 50% of the maximum airflow rate, providing a 50% standby capability. A 100% standby capability would be required if the system is to provide a life safety capability, the criteria for which is given in BS7346: Part 7: 2013. In such a case, 2 x 100% total airflow or 3 x 50% total airflow fans may be installed, enabling 100% of the design airflow to be maintained in the event of a single fan failure.

Discharge location & design
There are four considerations in connection with the location of the discharge:

- The discharge should not increase or spread the fire risk, e.g. not adjacent to openable windows
- It should not impede escape (not closer than 5m to a fire exit)
- It should not compromise fire service access (not closer than 5m to a nominated fire service access point)

The fourth consideration is noise, and this is often overlooked or simply given inadequate consideration by those responsible for the design and installation of car park ventilation systems, especially where residential accommodation is involved.

The size of extract fans and air volumes handled for larger car parks serving residential developments are significant. There will invariably be a specific noise limitation applicable to a residential facility and there will usually be an acoustic report associated with the development. Splitter intake and discharge attenuators will more than likely be necessary to meet the specified noise criteria.

FIGURE 4 – ASG “Low loss” louvre at the discharge of a car park extract chamber

If weather louvres are to be installed at the discharge of the extract chamber, the area required should be borne in mind, especially with the limited free area available from this type of louvre, usually no more than 50%. The discharge velocity when using a weather louvre should not exceed 2.5m/s if high resistance and noise regeneration is to be avoided. Consideration may be given to an alternative type of terminal such as a 70% free area flat bladed “low loss” louvre (see figure 4), where higher velocities can be accommodated without such severe penalties.

Source of makeup air
For the efficient operation of any ventilation system it is essential that there is an adequate provision of make-up air.

The most common route for make-up air to enter the car park is via the entrance ramp. However, this may not always be practical, possibly due to the proximity of the ramp to the available location of the extract chamber, or maybe there are some areas that require additional intake points to avoid them becoming stagnant.

The recommended maximum velocity for intake air is 2.5m/s to avoid significant disturbance to the flow of smoke in the event of fire.

The highest permissible velocity in any escape route is 5m/s; higher velocities will cause difficulty to the mobility of the elderly, infirm or young children. Whilst the ramp cannot be considered as a route for escape under the terms of the building regulations, this limitation of air velocity will also apply to the ramp.

Jet Fan selection & installation
The selection and installed positions of the jet fans is vitally important to the performance of the system. The type of fan, the thrust required, the spacing of the fans and the proximity of the fans in relation to other facilities and services, all have to be taken into account when considering the overall system layout.

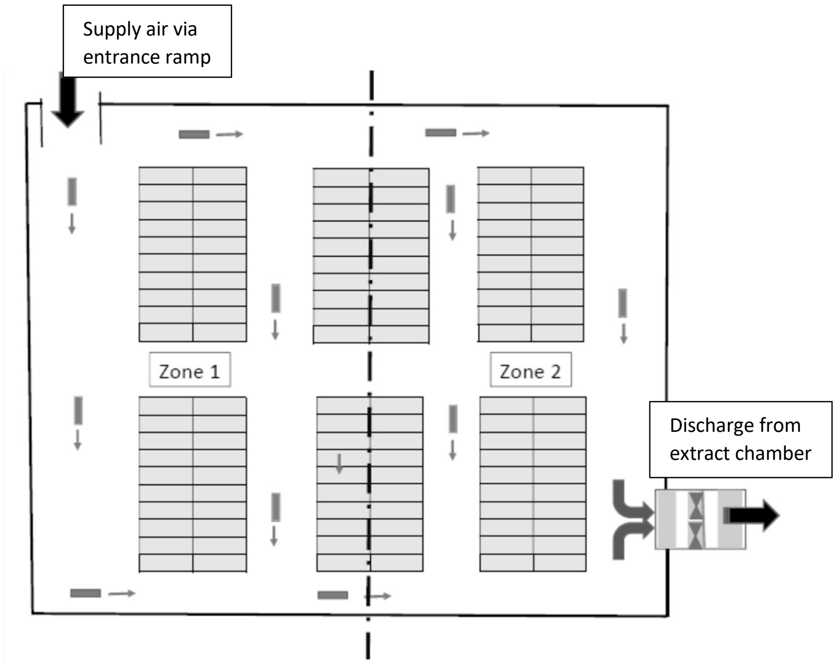

Figure 5 – Typical ventilation system layout

Flat soffits with no services to create an obstacle to airflow are virtually unheard of, so it is important to consider the resistance created by the downstand beams, the ductwork, drainage pipes and the electrical cable containment. Only once this has been done can the fan spacing be accurately assessed. Even those with responsibility for signage must be made aware of the hazards associated with positioning a sign immediately in front of a jet fan.

Jet fan spacing
The most common jet fan used in car park ventilation is rated at 50N; the physical size of fan is compact and versatile. The distribution of fans should ideally be in a "staggered" formation (see figure 5) to optimise the control of airflow, with approximately 10m spacing between rows subject to the geometry of the car park. The spacing of the fans can vary between 20m to 40m dependant on the resistance created, largely by the soffit mounted services, but also other structural features.

Jet Fan types
There are two types of jet fan commonly used in car park ventilation (see figure 6), the axial flow impulse fans and the centrifugal induction fan. Both fans function on the same principle of inducing airflow by the creation of a Jetstream and are selected on the basis of thrust.


Axial Flow Impulse Fan


Centrifugal Induction Fan

FIGURES 6 – Impulse fan and induction fan

Both fans have their advantages and disadvantages; the axial flow impulse fan creates a more efficient airflow pattern whereas the induction fan is more suitable for car parks with more restricted headroom.

The calculation of resistance and spacing of the jet fans is, of course, very important. For example, the proximity of the discharge of a jet fan to a downstand beam, particularly a transfer beam, is critical to not only the resistance to airflow, but also to the fan's overall performance due to the disturbance to the fan's discharge jet stream. For this reason, for a typical beam depth of 350mm the fan discharge should be located at least 1500mm from the beam (see figure 7) and where a particularly deep transfer beam is installed, the fan should be lowered to a position in which the underside of the fan is flush with the underside of the deep beam.

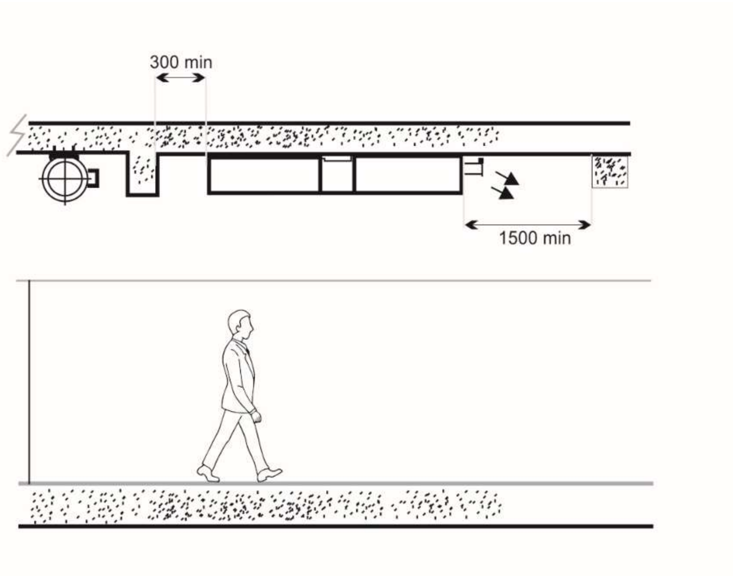

FIGURE 7 – positioning jet fan in relation to downstand beam

In certain cases, the jet fan will be suspended from the soffit to a lower level to overcome an obstruction such as a deep transfer beam. In such cases, where a jet fan's own fixing brackets are not attached directly to the soffit but instead are connected by extended brackets, careful consideration should be given to the nature of a jet fan. The forces associated with a fans thrust on an extended frame can cause fatigue at the soffit joint due to a rocking motion if the supporting framework is not properly designed (see figure 8).

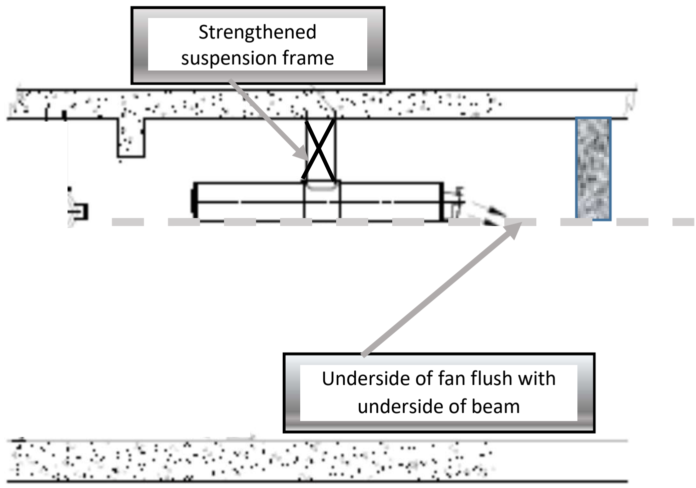

FIGURE 8 – positioning jet fan in relation to Transfer beam & strengthened support frame

Jet fans should never be installed in a position that would cause the Jetstream to be discharged directly onto a lobby door that connects to a stairwell, is an escape path or is an access route for the fire service. The fans should always be located in positions that create a negative pressure in the area around the lobby doors, thereby reducing the risk of smoke migration into those areas.

Air movement by jet fans
It should be remembered that a jet fan can induce the movement of air the equivalent of up to eight times the amount of volume passing through the fan, therefore a 50N jet fan having an airflow of 1.9m^3/s when operating at full speed can induce the movement of air up to 15m^3/s (see figure 9). For this reason, one must be careful not to activate too many fans mounted in parallel at full speed otherwise the extract fans could become overloaded and resulting in smoke being recirculated instead of being extracted in the event of fire.

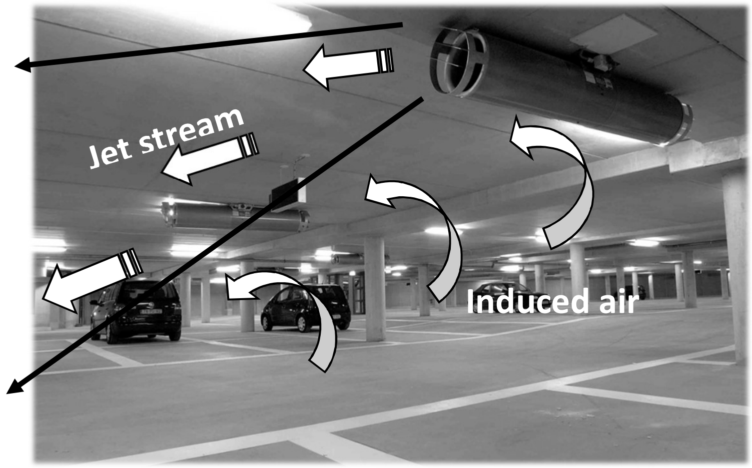

FIGURE 9 – Diagram showing principle of induction of airflow

The range of jet fans used, like all smoke extract fans, in accordance with BSEN12010-3 *Smoke & Heat Exhaust Systems – Part 3 Specification for powered smoke and heat exhaust ventilators* to verify suitability for the application for which it is to be used.

Jet fan systems and sprinklers

The operation of jet fans in the event of fire in a car park that is fitted with sprinklers will interfere with the sprinkler pattern. All steps necessary to minimise such interference should be taken.

There are some simple steps that can be taken to minimise the impact of the jet fans on the performance of the activation and performance of the sprinkler system:

1. Activate the jet fans from the sprinkler system. The sprinkler system itself could be designed on a zoned basis, with a signal from a flow switch mounted within the activated sprinkler line activating the smoke ventilation system.
2. The sprinklers will do their most useful work over the parked vehicles, therefore, where possible, restrict the mounting of the jet fans to a position located within the roadways not over vehicles (see figure 10). This will reduce the impact of the high velocity airstream created by the jet fan on the sprinkler patterns.

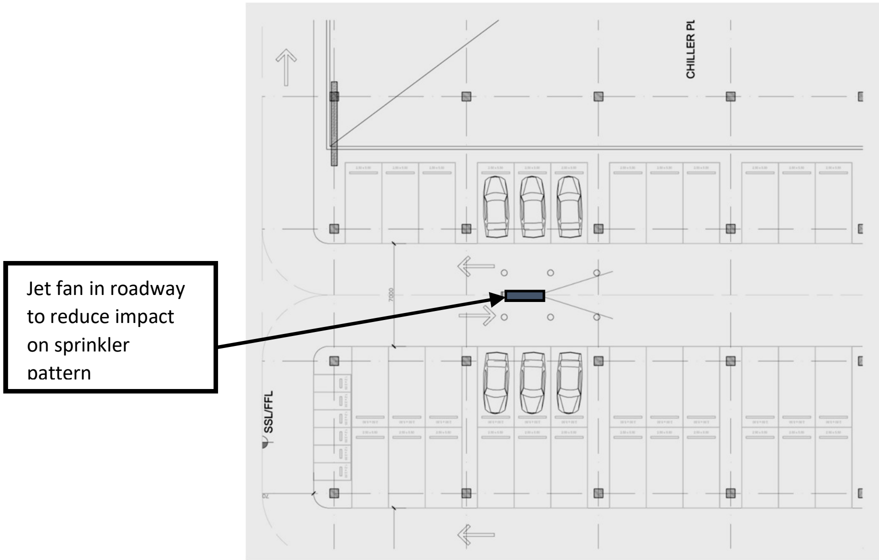

FIGURE 10 – When a sprinkler system is installed, where possible always mount jet fans in roadways to minimise impact on the sprinklers.

CFD Modelling

Whenever engineered solutions are proposed, the first thing that regulatory authorities reach for is the Computational Fluid Dynamics (CFD) report. The CFD modelling report has become the norm nowadays to provide a graphic illustration of the efficacy of the proposed engineered system design to meet the declared objectives as well as meeting the requirements of the building regulations.

It is not unusual to find that a jet fan ventilation system has been designed using CFD modelling as the only tool used for design. This is a quick and easy way to design a system; however it is an unreliable way to undertake the design without having a full understanding of the fundamentals of system design. Much like the use of a calculator, one must have a “feel” for the resultant answer if to have any confidence in the value displayed on the screen is correct.

CFD modelling is a very useful tool available to the designer when used correctly to verify a system design prior to installation. However, CFD modelling should not be used to replace the need for a comprehensive demonstration of a system once installed; only at this stage will the Building Control authority be able to witness the true performance of the system.

It is worth pointing out at this stage that any report on a CFD model created without consideration given to the services attached to the soffit is not worth the paper it is printed on as those services will have a significant impact on system performance.

Controls & Power Supplies

In order to protect them from the smoke and hot gases in the event of fire, the controls panel(s) must be located within their own one hour fire rated compartment. The electrical cabling between the control panel and the extract fans and jet fans should have in the appropriate fire rating.

It cannot be stressed too strongly how important it is to specify the correct cabling for a smoke ventilation system.

All cabling must be appropriately fire rated, the extract fans and jet fans cable to BS8491 and to all other equipment, including fire service switches and fire detection system to BS7629. Cabling should be secured in all cases by metal ties (not nylon) and the use of inverted trays should be avoided.

Backup power supply

A standby power supply must also be provided, this could be in the form of a second sub-station, diesel generator or a battery powered UPS pack. These back up supply facilities will be linked to an automatic transfer switch (ATS) which will sense the failure of the normal power supply and switch to the backup system. Where a backup generator or a UPS battery system is employed, a 3 hour supply capability is required.

HVAC Systems & other interfaces

The design of the car park ventilation system should be independent of any other ventilation system. In the event that the car park ventilation system is activated in fire mode, all HVAC systems linked to the car park should automatically shut down.

Any ventilation or HVAC system linked to the car park should automatically be physically isolated from it in the event of fire by an appropriately fire rated barrier to avoid the risk of fire spread. The isolation dampers must be carefully monitored for any sign of potential failure.

Occasionally, for whatever reason, the smoke control system serving the occupied residential or commercial areas of the building are linked to the car park extract system. In such cases, there must be a reliable communications link between the control systems in order that the programmed cause and effect for each system enables it to function correctly according to the conditions prevailing in either area. In the event of a fire in the car park, the system serving the residential area must be physically isolated by an appropriately rated fire damper. The damper should be monitored and regularly tested for operation as part of the planned maintenance regime.

Technical Submissions

In order to comply with Regulation 38 of the building regulations, it is required that all fire safety information for new or altered buildings be passed to the responsible person as defined in the *Regulatory Reform (Fire Safety) Order* on the completion of a building or on occupation, whichever comes sooner. This will apply to a car park ventilation systems and a full technical submission detailing the operation of the installed car park ventilation scheme should be included in the documents handed over. A technical submission should include, but will not necessarily be limited to, the following:

Detailed written description of the system, including objectives, design and performance criteria
All calculations to support the design

- Cause & effect chart
- Layout drawings
- Schematics
- CFD report where applicable
- Commissioning certificate
- Product test certificates for all equipment used, e.g. fans, & dampers

Commissioning
BS7346: Part 7: 2013 includes a very useful guide to the commissioning of a car park ventilation system, including a check list for those carrying out the commissioning and those inspecting it.

CFD modelling should never be adopted as the sole means of verifying the performance of a system. CFD modelling cannot fully represent the actual installed environment, only at this stage can the true performance of the installed system be established.

Cold smoke generation is an extremely useful process to demonstrate actual air movement and control; it very quickly identifies the stagnant areas much more accurately than a vane anemometer. Inspection of the installed cables and the product test certificates is also strongly advised.

The subject of commissioning is covered in more detail in Part 2 of this report which will be published later this year.

Advanced Smoke Group Limited, 46 Kenilworth Drive, Oadby, Leicester, LE2 5LG

www.advancedsmoke.co.uk