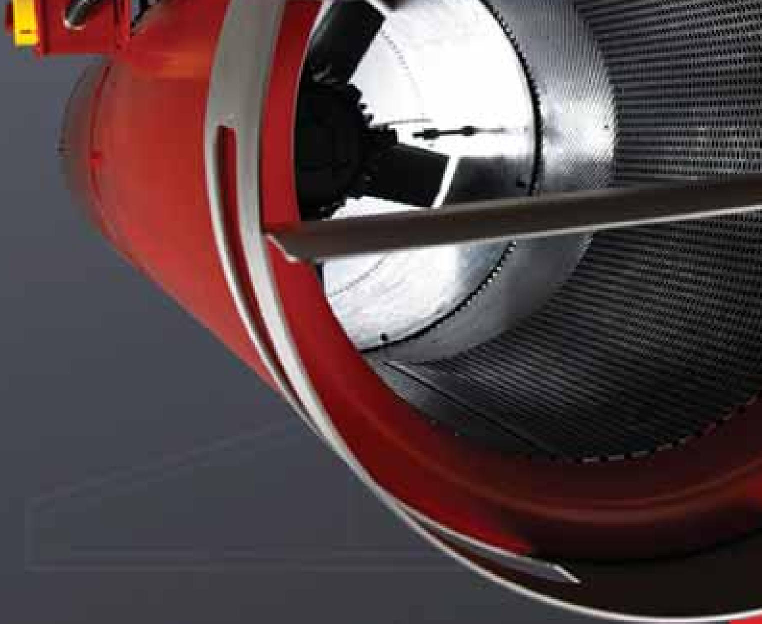

JETVENT

Impulse Ventilation for Car Parks

A Practical Guide for Selection & Application

2011
Second Edition
Revision One

FANTECH
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Contents

1.0 Introduction to Car Park Impulse Ventilation

The ventilation of car parks is essential for removing vehicle exhaust fumes containing harmful pollutants. Some of these pollutants include Carbon Monoxide (CO), Nitrous Oxides (NO_x), Sulphur Dioxide (SO_2) and heavy metal compounds.

The most significant development in car park ventilation design has been the introduction of Impulse Ventilation. It is an innovative alternative to traditional systems and provides a number of significant benefits. An Impulse Ventilation System is based on a number of small high velocity 'JetVent Fans' that either replace traditional distribution ductwork in closed car parks or increase cross-flow ventilation in open car parks.

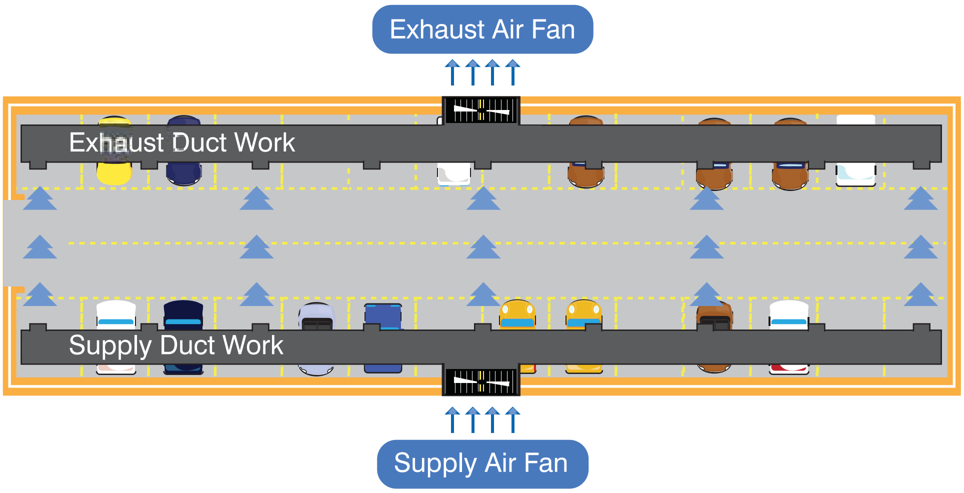

Figure 1(a). Conventional ducted system

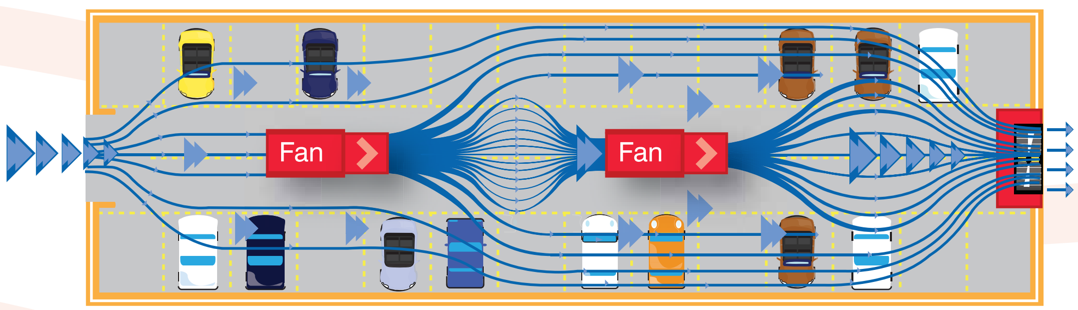

Figure 1(b). Impulse system

Figures 1(a) and 1(b) show the difference in principle between the ventilation systems. In addition to removing pollutants, the ventilation systems may also provide assistance to fire fighters by either limiting the spread of smoke in the event of a fire or clearing smoke after the fire is extinguished. Impulse Ventilation originated in Europe and has been widely used around the world for both car park ventilation and smoke management control systems. A number of National Fire Authorities in Europe now insist on Impulse Ventilation for car parks.

How it works

JetVent Fans operate on well proven longitudinal tunnel ventilation principles. The fans produce a high velocity jet of air, in turn moving a larger quantity of air surrounding the fan through a process known as entrainment. The amount of air entrained by a single fan increases with the velocity and the quantity of air being discharged by the fan. These characteristics directly relate to the thrust rating of the fan, which is measured in Newtons (N).

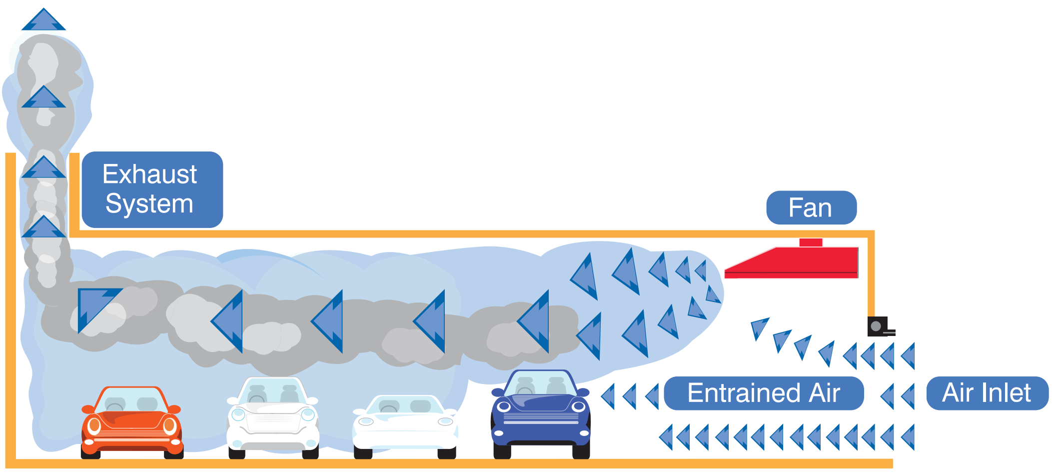

Figure 2. Workings of a JetVent or Impulse Fan

Advantages

- Largely eliminates the need for air distribution ductwork within the car park.
- Mechanical supply and exhaust systems with less resistance, smaller fans and lower power consumption.
- Ventilation risers and plant rooms reduce in size and quantity, making the car park more open and possibly yielding additional car park spaces.
- Possibility of increasing the number of control zones in the car park. Typically brings gains in operating energy efficiency over and above the best ducted car park ventilation systems.
- Great potential for reduced excavation and construction costs. System is small in vertical profile and the placement of fans can be very flexible resulting in lower floor-to-ceiling heights.

2.0 Fan Specifications

The capacity of a single fan increases with its thrust rating. All car park JetVent Fans are rated according to this in Newtons (N) of thrust. See *page 19* for further information.

All JetVent Fan types are tested to the following Standards:

- Thrust performance based on tests to BS848: Part 10:1999.
- Noise data based on tests to BS848: Part 2:1985.
- Axial and Centrifugal units tested for smoke spill requirements as outlined in AS4429:1999.

2.1 JV Series - JetVent Fans

The JV Series of JetVent Fans offer flexibility to satisfy the majority of requirements for car park ventilation. It is available in 2 sizes, 315mm and 400mm diameter and provides options for uni-directional or truly reversible air flow and single or dual speed. Units may also be speed controlled using Variable Speed Drives (VSD). Units approved to AS4429:1999 for smoke exhaust are also available.

Product Series	Fan Speed		Thrust Rating		Car park Installed Noise Levels		Free-field Noise Rating		Power Rating		Control Types	
	r/s		N		dB(A)#		dB(A) @ 3m		kW		2-Speed	Analogue
	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	Relay (See Page 27)	VSD (See Page 28)
JVU-CPA-315	48	24	20	5	71	61	59	49	0.8	0.16	✓	✓
JVU-CPA-400	48	24	50	12	73	63	62	47	1.7	0.34	✓	✓

Car park installed noise levels apply 8m away from the fan with multiple fans operating. Contact your nearest Fantech office to confirm if this is applicable to your installation.

Table 1. JetVent JV series technical data

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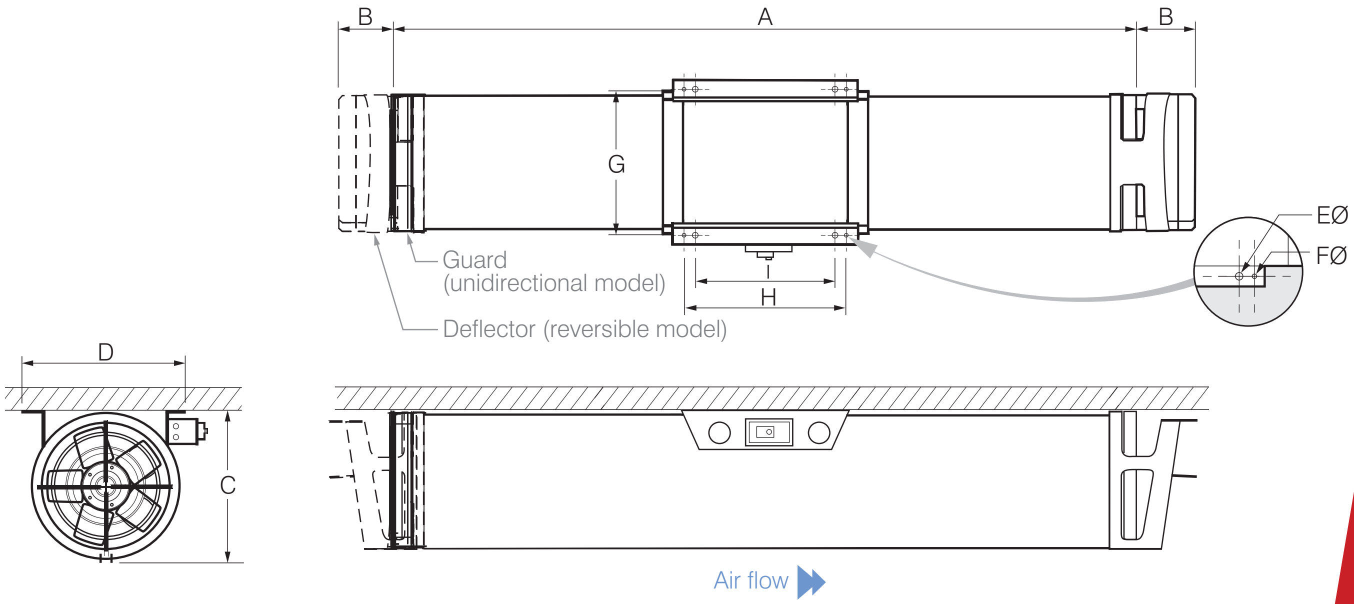
Dimensional Drawings



Product Series	A	B	Vertical Height C	D	EØ	FØ	G	H	I	Approx. Weight, kg
JVU-CPA-315	1808	142	336	417	25	13	367	420	360	62
JVU-CPA-400	2660	145	423	471	25	13	421	420	360	71

Dimensions in mm

Note:
- For the exact product codes of JV series fans, contact your nearest Fantech office.
- High/Low speeds selected by 2-speed motor. Further fan options available for Truly reversible, smoke exhaust rated and single speed models.
- Electrical supply - 415V, three-phase, 50Hz.

2.2 JIU Series - JetVent Fans

The JIU series JetVent Fans are designed for general car park ventilation requirements. All units in this range are suitable for car park installations where a low ceiling height and tight spaces make fitting the fans particularly challenging. The JIU-CPC2 series can be controlled either by a Variable Speed Drive (VSD) or two-speed switching, while the JIU-CPMF series is suitable for lower cost installations requiring only two-speed control.

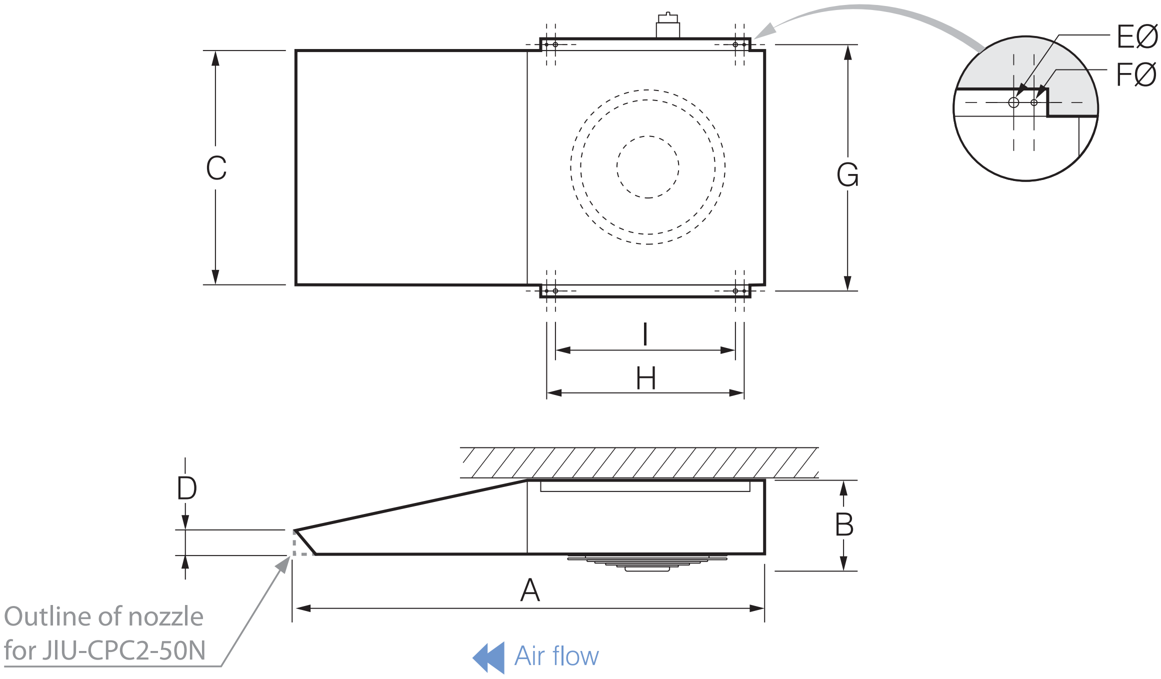
Product Code	Fan Speed		Thrust Rating		Car park Installed Noise Levels		Free-field Noise Rating		Power Rating		Control Types	
	r/s		N		dB(A)#		dB(A) @ 3m		kW		2-Speed	Analogue
	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	Relay *(See Page 27)*	VSD *(See Page 28)*
JIU-CPMF-50N	23	16	50	22	76	67	69	60	0.75	0.25*	✓	✗
JIU-CPC2-50N	24	12	50	12	82	66	73	57	1.38	0.35	✓	✓
JIU-CPC2-100N	23	12	100	18	82	66	72	57	2.42	0.61	✓	✓

Car park installed noise levels apply 8m away from the fan with multiple fans operating. Contact your nearest Fantech office to confirm if this is applicable to your installation.

* Estimated power consumption.

Table 2. JetVent JIU series technical data

Dimensional Drawings



Product Code	A	Vertical Height B	C	D	EØ	FØ	G	H	I	Approx. Weight, kg
JIU-CPMF-50N	1602	313	798	83	25	13	872	675	605	71
JIU-CPC2-50N	1265	268	784	75	25	13	866	395	325	86
JIU-CPC2-100N	1830	330	1144	69	25	13	1233	675	605	160

Dimensions in mm

Note:

- High/Low speeds selected by switching from star to delta electrical connection. Further fan options available for low noise/low Speed models. Enquire for further details.
- Electrical supply - 415V, three-phase, 50Hz.

2.3 JISU Series - High Temperature JetVent Fans

The JISU Series of High-Temperature JetVent Fans are available in 50 and 100N thrust capacities. This range is suitable for high temperature operation as required in fire/smoke control applications. The JISU series JetVent Fans are designed in a low profile, uni-directional housing. These units may be used in conjunction with Variable Speed Drives (VSD) for efficient speed control. Units are approved to AS4429:1999 for smoke exhaust.

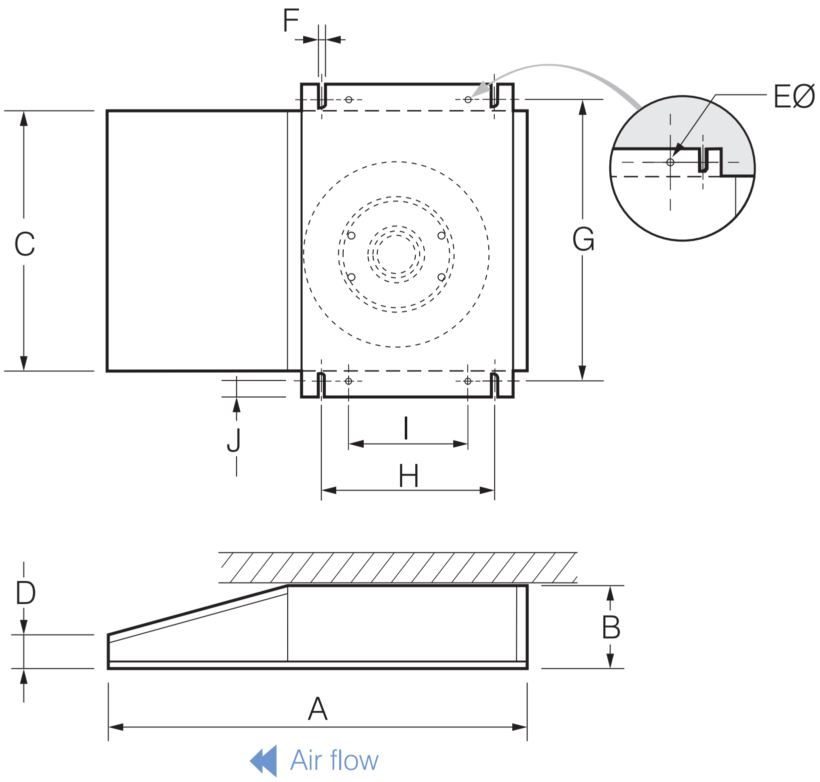
Product Code	Fan Speed		Thrust Rating		Car park Installed Noise Levels		Free-field Noise Rating		Power Rating		Control Types	
	r/s		N		dB(A)#		dB(A) @ 3m		kW		2-Speed	Analogue
	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	Relay (See Page 27)	VSD (See Page 28)
JISU-CPC-50N	23	15	50	25	78	69	69	60	1.42	0.45*	✗	✓
JISU-CPC-100N	21	14	100	50	77	68	68	59	2.6	0.75*	✗	✓

Car park installed noise levels apply 8m away from the fan with multiple fans operating. Contact your nearest Fantech office to confirm if this is applicable to your installation.

* Estimated power consumption.

Table 3. JetVent JISU series technical data

Dimensional Drawings



Product Code	A	Vertical Height B	C	D	EØ	F	G	H	I	J	Approx. Weight kg
JISU-CPC-50N	1262	250	790	102	30	16	890	607	427	60	85
JISU-CPC-100N	1832	320	1150	69	30	16	1240	600	450	50	184

Dimensions in mm

Note:

- High/Low speeds selected through VSD control of fans to listed speed.
- Lower noise levels achievable with further speed reduction.
- When VSDs are used with these models, sinusoidal filters are required in the power supply to these fans.
- Electrical supply - 415V, three-phase, 50Hz.

2.4 JIU-CPCEC Series - Digital EC JetVent Fans

The JIU-CPCEC series of JetVent Fans represents a new step forward in car park ventilation systems. They feature efficient EC motor technology with integrated speed control, doing away with VSDs, current overloads and motor phase protection. It even simplifies electrical connections between fans in the car park. However, the truly revolutionary feature of this system is ComLink digital communication between fan units and the matching Digital JetVent Zone Controller, which results in a very simple control wiring scheme while providing the ultimate in energy efficiency and JetVent System Monitoring.

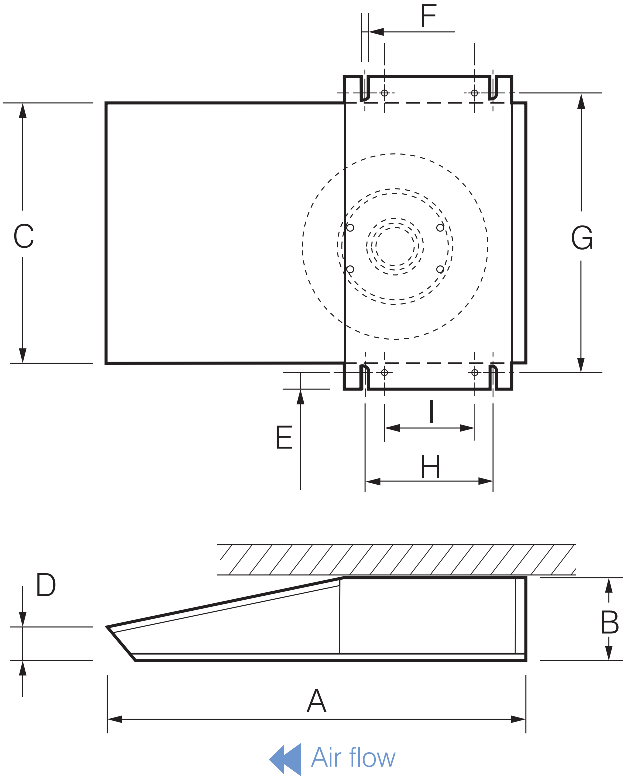
Product Code	Fan Speed		Thrust Rating		Car park Installed Noise Levels		Free-field Noise Rating		Power consumption		Control Types	
	r/s		N		dB(A)#		dB(A) @ 3m		kW		Digital	Analogue
	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	EC Control *(See Page 29)*	EC Control *(See Page 28)*
JIU-CPCEC-55N	25.8	20.8	55	35	70	65	61	57	1.08	0.58*	✓	✓

Car park installed noise levels apply 8m away from the fan with multiple fans operating. Contact your nearest Fantech office to confirm if this is applicable to your installation.

* Estimated power consumption.

Table 4. JetVent JIU-CPCEC series technical data

Dimensional Drawings



Product Code	A	Vertical Height B	C	D	E	F	G	H	I	Approx. Weight kg
JIU-CPCEC-55N	1788	369	900	64	60	16	1040	600	415	75

Dimensions in mm

Note:
- Lower noise levels achievable with further speed reduction.
- Electrical supply - 415V, three-phase, 50Hz.

3.0 System Layouts & Applications

3.1 Linear flow

A linear flow system uses JetVent Fans pointing in the same general direction to move air from one end of a car park to the other. This system is similar to a traditional mechanically ducted system, the main difference is that the JetVent Fans direct air flow from a single supply point to a single exhaust point. For this scheme to work effectively, the exhaust and supply points should be located on opposing ends of the car park across its longest dimensions (refer to Figure 3). If this is not the case, units arranged for circular mixing may be a better solution (refer to Section 3.2).

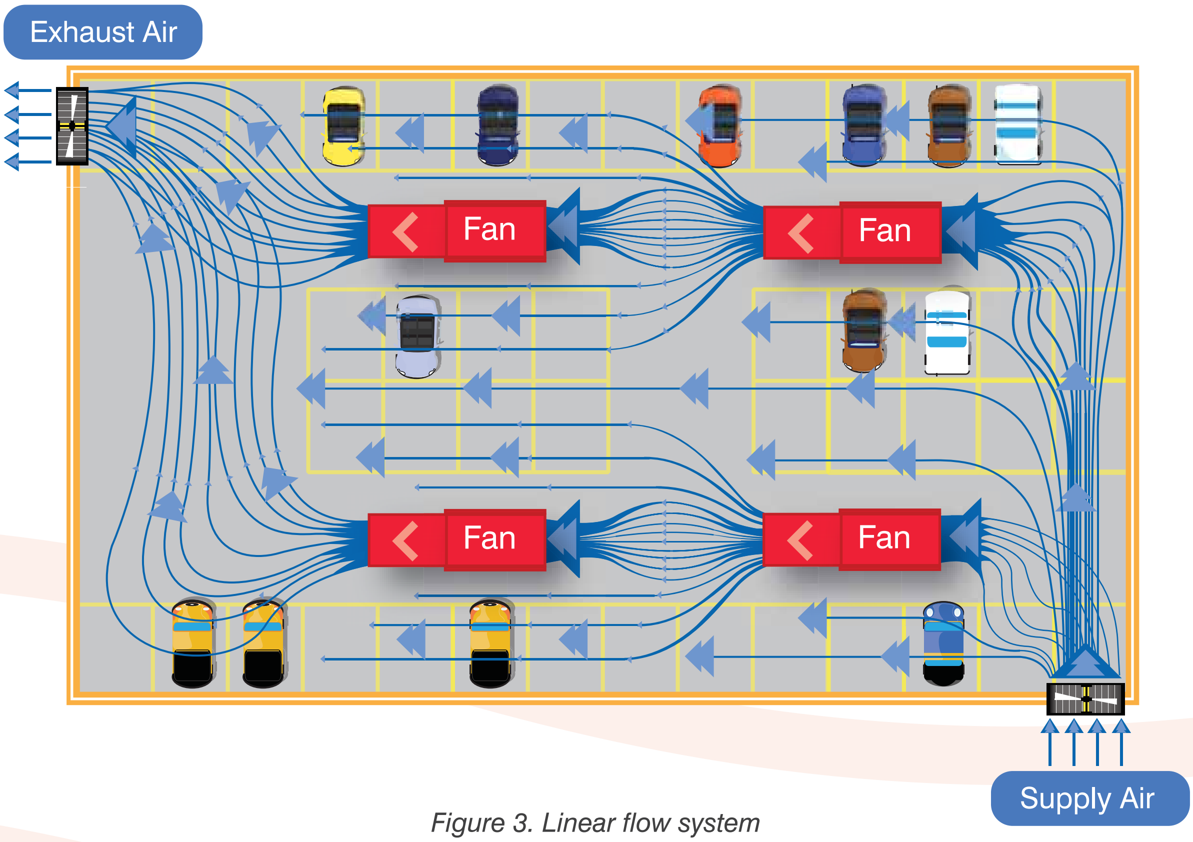


Figure 3. Linear flow system

3.2 Circular mixing

JetVent Fans can be positioned around the car park to generate air movement in a circular pattern. The result is that air gets mixed and stirred throughout the entire area, which provides greater dilution of pollutants within the car park. Figure 4 gives an example of this system layout and shows the direction of air flow from supply to exhaust. Circular mixing is suitable for smaller car parks where the length and width of the car park is less than 50m. This system also provides added flexibility when positioning supply and exhaust points. Unlike a linear flow system, a circular mixing system does not require exhaust and supply points to be on opposite sides of the car park.

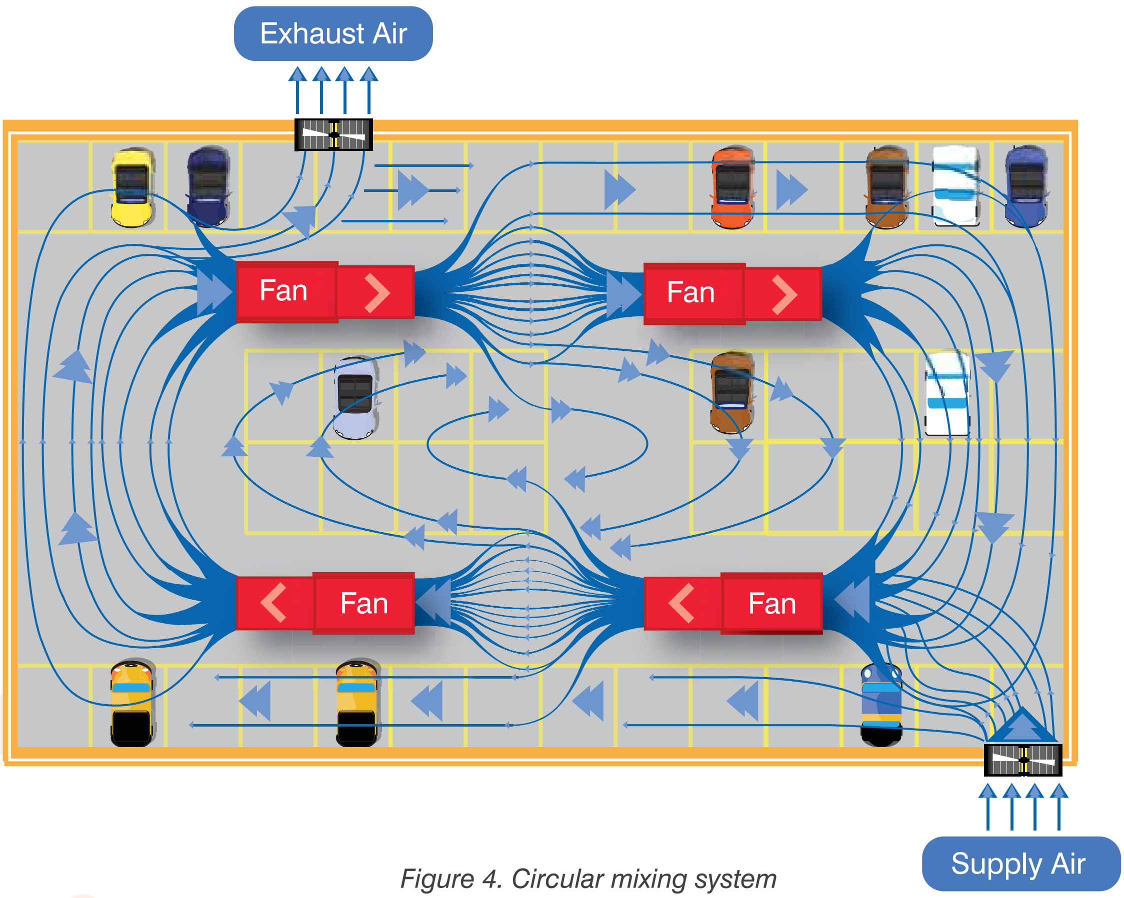


Figure 4. Circular mixing system

System Layouts & Applications

3.3 Assisted Natural Flow/ Augmented Ducted System

AS/NZS1668.2:2002 states that where exhaust air intakes or any relief openings are further than 40m away from supply air outlets or any make up air openings, consideration should be given to potentially harmful effects of short circuiting, stack effect, wind forces and interaction with other systems. Where the distance is greater than 75m, the ability of a ventilation system to effectively dilute polluted air in all parts of the car park should be demonstrated (C7.5.2 in the aforementioned standard). JetVent Fans can be used to maintain constant air movement in these car parks to remove the effects of air stagnation and the resulting build up of pollutants. In large open car parks, JetVent Fans can be used to create a large pressure difference between supply and exhaust, hence boosting air flow in and out of the car park as shown in Figure 5(a).

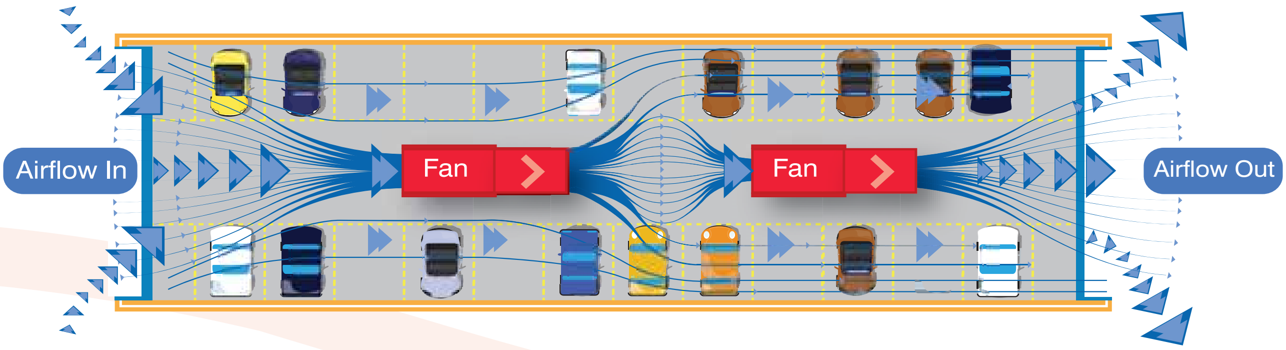


Figure 5(a). Assisted natural system

Figure 5(b). Typical installation of a JISU-CPC-100N JetVent Fan in an assisted natural flow system

System Layouts & Applications

4.0 Designing & Implementing the

Estimating fan quantities

For the purpose of estimating costs, the steps below may be bypassed. Allow 5N of thrust per 100m² of car park floor area to approximate the number of fans required.

The following steps are sufficient to create an initial impulse ventilation system design. A Computational Fluid Dynamics (CFD) analysis is often required to prove and further refine the design. Fans may need to be re-orientated, or in some cases, added or removed.

An impulse ventilation system can be tailored to suit virtually any car park. Before considering fan locations, the system layout will need to be identified. Refer to the previous section for information relating to system arrangements and their suitability for particular car parks.

4.1 Step 1 - Assessing Car Park Geometry

Firstly, identify the supply and exhaust points in the car park. A system that complements the natural air path and is able to circulate or move air effectively within the car park should be chosen. Certain layout features may assist the effectiveness of a particular layout as shown below:

(a) 'Natural air path' in car park

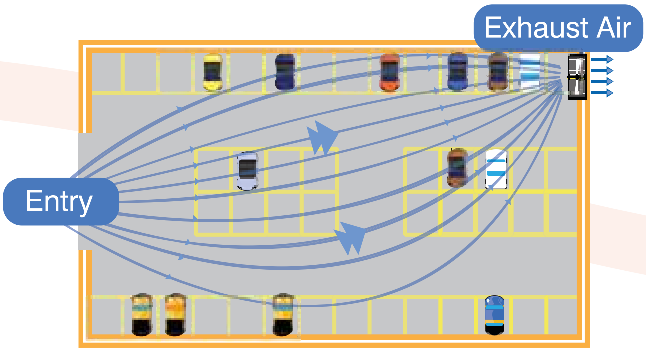


Figure 6(a). Preferred natural air path

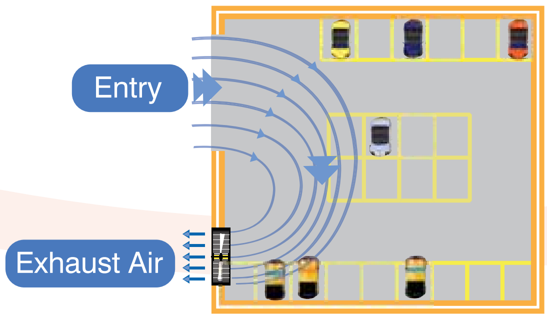


Figure 6(b). Natural air path to be avoided

- For 'Linear Flow Systems', supply and exhaust points should be spaced across the length of a car park.
- 'Circular Mixing Systems' are more tolerant of closely placed supply and exhaust points, but it is advisable to have a good amount of separation.
- Supply air points should include access ramps to outside.
- The impulse ventilation system layout should complement the natural air path from supply to exhaust points.

(b) Ceiling features

To make the system more effective, position JetVent Fans in-line with supporting ceiling beams as illustrated in Figure 7(a). If this is not possible, the system becomes less effective and more fans may be needed.

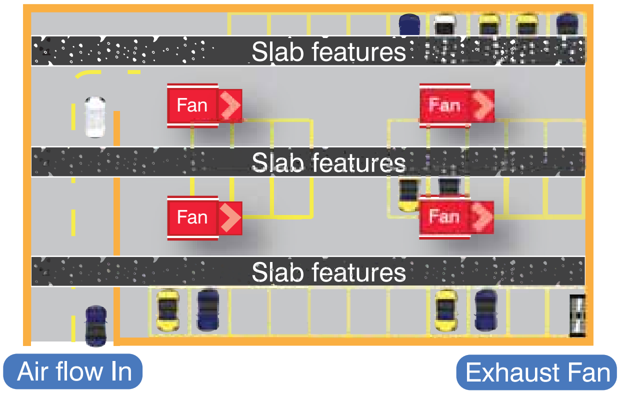


Figure 7(a).
Fans discharge parallel to beams:
most effective

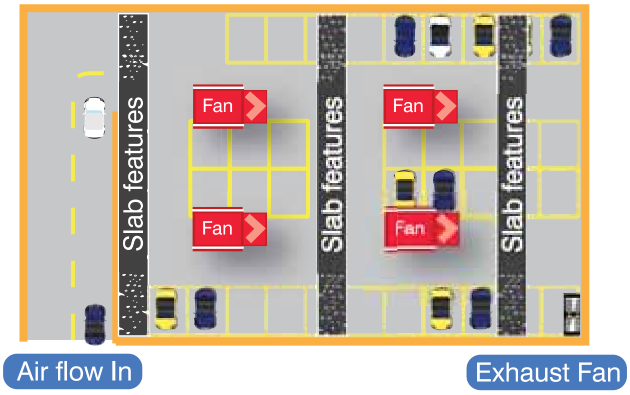


Figure 7(b).
Fans discharge perpendicular to beams:
less effecitve

(c) Vertical clearance

- Sufficient vertical clearance ensures maximum flexibility in system design.
- JetVent Fans may be recessed between ceiling beams to minimise the height of the system.

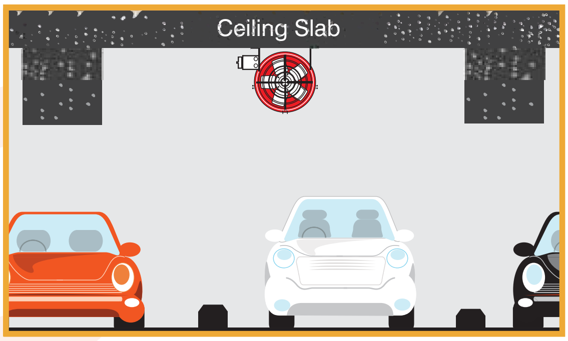


Figure 8(a). Sufficient clearance

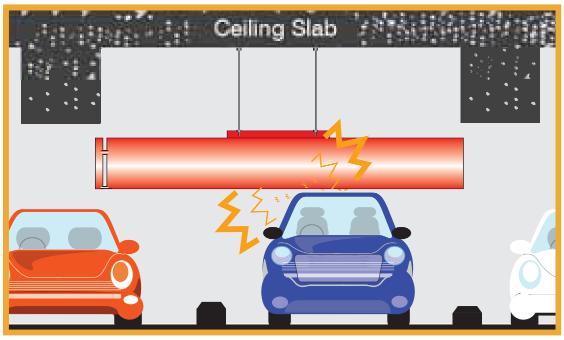


Figure 8(b). Insufficient clearance

(d) Obstructions

If there is no option but for the JetVent Fans to blow across ceiling beams, they must be positioned a distance away from the obstruction as illustrated in Figure 9(b). A horizontal separation eight times (8x) the height of the obstruction is generally sufficient. Nozzles on the units are specially designed and angled downwards for this purpose.

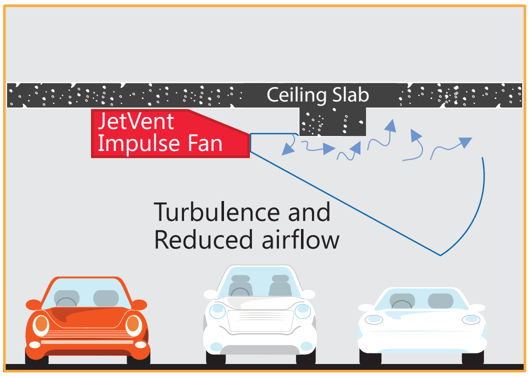


Figure 9(a). Obstruction too close

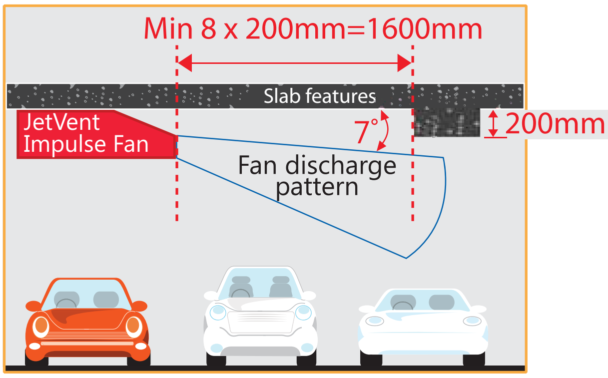


Figure 9(b). Obstruction out of the way

(e) Clashes with other services

Place components of mechanical services, such as sprinklers exit signs and pipework out of the discharge area of the JetVent Fans. Some examples of these clashes are shown below.

Figure 10(a). One way of avoiding clashing with pipework

Figure 10(b). Warning signs can impede fan throw

Figure 10(c). Clashes with sprinkler heads can impede fan throw

Figure 10(d). Pipe work can impede fan throw

4.2 Step 2 - Identify Fan Selection and Spacing

Table 5 shows the maximum and recommended spacings between JetVent Fans for different levels of fan thrust. These spacing distances are guidelines for fans placed in series. Using these spacings, air velocities in most of the ventilated areas should be greater than 1m/s. Analysis will determine whether this is achieved in a particular car park design. In some ideal cases, designs using the maximum distances have been effective. Fan thrust depends on the operating speed of a particular fan unit and its thrust rating. See section 2.0 for the thrust ratings of various fan models at different speeds.

Operating fan thrust	Recommended fan to fan spacing distance	Maximum fan to fan spacing distance	Approximate coverage area
50N	45m	60m	1000m^2
25N	30m	40m	500m^2
12N	12m	20m	250m^2

Table 5. Fan spacing and coverage

After a preliminary fan layout is completed using the spacing distances above, the layout may be checked for total installed thrust. Successful designs typically have approximately 5N of thrust per 100m^2 of car park floor area. This thrust ratio also works well for estimating purposes.

Note that using fewer numbers of higher rated fans is generally desirable as it makes the system more cost effective. However, to effectively ventilate car parks with unusual or irregularly shaped geometries, selecting more fans with smaller thrust ratings may be necessary.

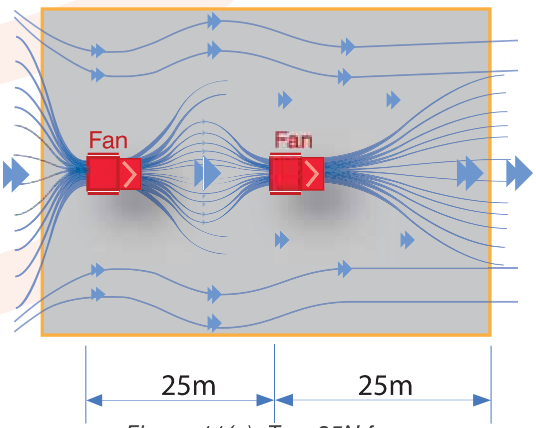


Figure 11(a). Two 25N fans

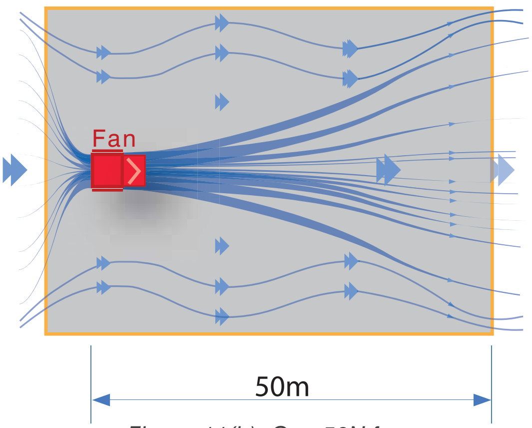


Figure 11(b). One 50N fan

Designing & Implementing

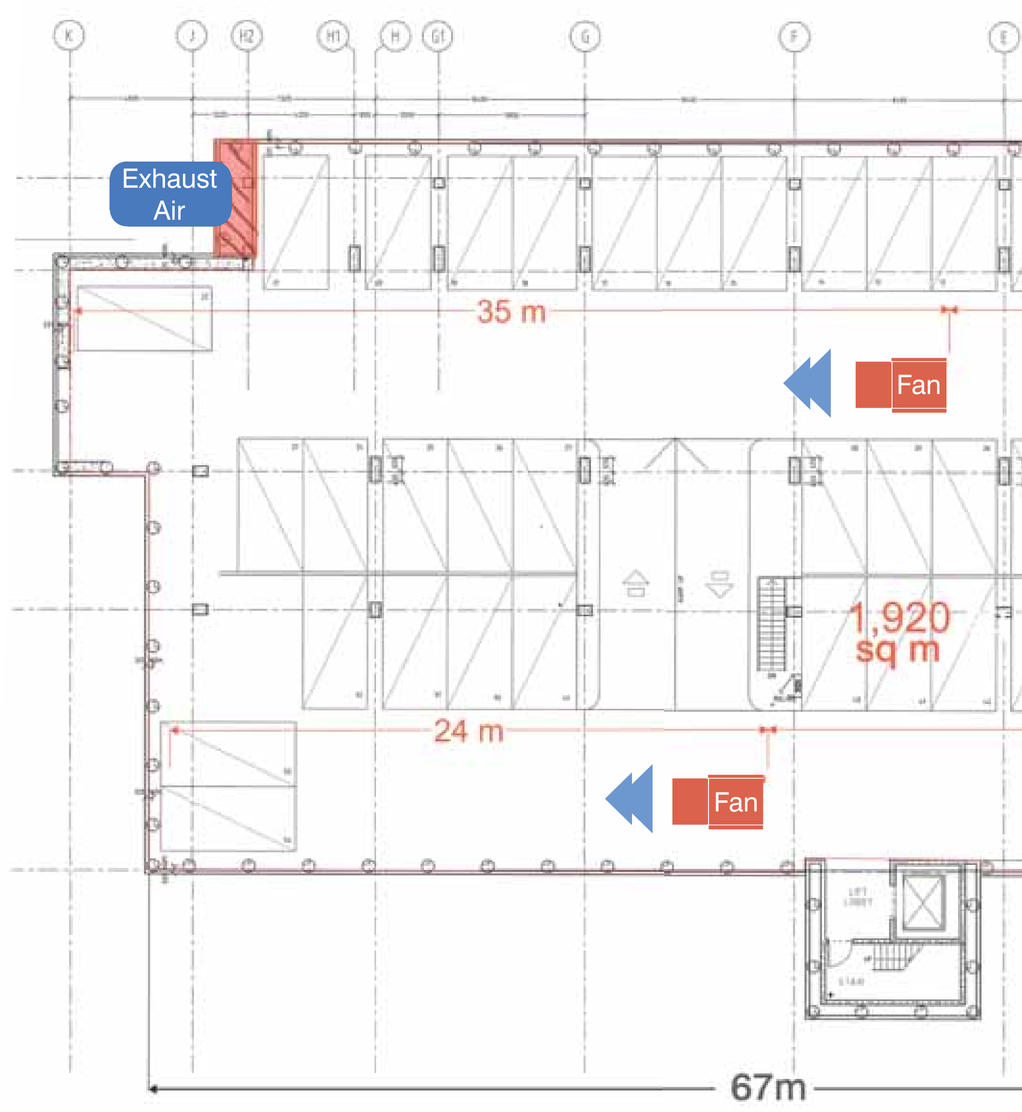
4.3 Step 3 - Design Example

Estimating fan quantities

For the purpose of estimating costs, the steps below may be bypassed. Allow 5N of thrust per 100m² of car park floor area to approximate the number of fans required.

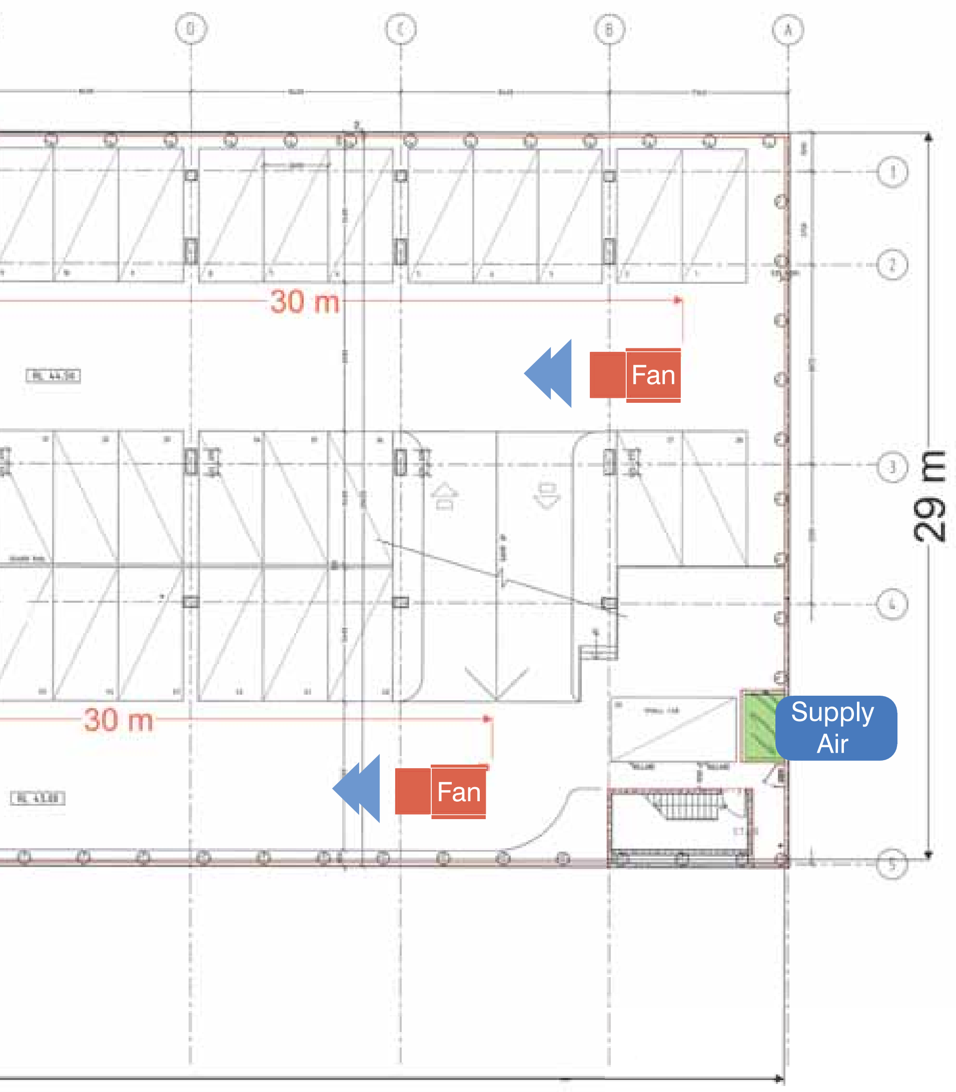
Fans should be placed in the laneways with the air blowing along them. This will ensure that the high air velocities close to the outlet nozzle do not significantly disturb pedestrian traffic as velocities will be lower at the lane edges. Also, ensure that the throw pattern of the selected fan is long enough to reach the next impulse fan.

Figure 12 shows an example of how fans are sized and placed based on floor area.



Design parameters;

- Based on 5N per 100m² floor area, minimum total fan thrust = car park floor area x 5N/100m²
  = 1920m² x 5N/100m²
  = 96N
- Minimum thrust criteria can be achieved with 4 x JISU-CPC-50N fans on low speed (operating thrust 25N), total fan thrust= 25N x 4= 100N.
- Fans are spaced within the 30m spacing recommendation for 25N thrust.
- Final fan to wall spacing under 40m maximum spacing guidelines for 25N fan thrust. This is because the exhaust point is an area of low pressure, making it likely to enhance the fan throw distance.



Car park floor area = 1920m²

Figure 12. Fan sizing and placement example

4.4 Step 4 - Calculate Supply & Exhaust Rates

Section 7 of AS/NZS1668.2:1991 details requirements for ventilating car parks. In particular, sub-section 4.4.2 of the standard outlines calculations of exhaust rates. In any of the two cases below, the exhaust air flow rate for a car park is taken as the **greatest of the following calculations**:

Calculation of exhaust air flow rates	
Car parks with more than 50 spaces	**Car parks with less than 50 spaces**
a) 3000 Litres/s (minimum air quantity for one operating car) b) P x 1.2 x (100 x n_1 + n_1 x d_1 + n_2 x d_3) Litres/s (minimum air quantity necessary to dilute CO during the peak hour for car park exit movements) c) P x 0.4 x (100 x n_1 + n_1 x d_2 + n_2 x d_4) Litres/s (minimum air quantity necessary to dilute CO during the peak hour for car park entry movements) d) 3.5 x A Litres/s (minimum air quantity based on area of car park)	a) 3000 Litres/s b) 3.5 x A Litres/s c) 500 n_1 x P Litres/s

Supply air flows should range from 75% to 100% of the exhaust air quantity. This is based on the pressurisation of the car park, which should be 12Pa maximum.

Reference information for the calculation of exhaust air flow rates in the table above:

n_1 = the number of parking spaces in the zone or level under consideration

d_1 = the average driving distance, in metres, within the zone or level under consideration for the exit of a car parked there

d_2 = the average driving distance, in metres, within the zone or level under consideration for the entry of a car parked there

n_2 = the lesser of:
(i) the number of parking spaces situated in other parts of the car park, the entry or exit routes which pass through the zone or level under consideration; and
(ii) When used in b): (250/P) parking spaces per exit lane
When used in c): (250/P) parking spaces per entry lane

d_3 = the average driving distance, in metres, within the zone or level under consideration for the exit of a car whose exit route passes through the zone or level, but excluding any part of the exit route designated as queuing area and ventilated in accordance with Clause 4.5

d_4 = the average driving distance, in metres, within the zone or level under consideration for the entry of a car whose entry route passes through the zone or level, but excluding any part of the entry route designated as queuing area and ventilated in accordance with Clause 4.5

P = the car park usage factor (Related car park zoning e.g. residential) Refer to Appendix A1 – A3 on pages 39 and 40 for relevant factors

A = the area, in square metres, of the zone or level

4.5 Step 5 - Control Systems

a) Typical Control System Operation

It is highly recommended that JetVent Fans work in conjunction with a control system to reduce ventilation rates during periods of low vehicle activity. The benefit of this is a reduction in the power consumed and noise levels generated during these times.

Typically, the electronic controls for a JetVent Impulse Ventilation System will vary the operating speeds of individual fan units according to Carbon Monoxide (CO) levels in the car park. CO levels are monitored by a network of electronic CO sensors, each typically monitoring an area of 400m^2. Fan speed changes are achieved through the use of a VSD or relays (used for two-speed motors) depending on the model of fan used. The fan speeds are usually the same for all of the fans within a particular zone or control group. On more intricate control systems, a single car park floor is divided into multiple control zones to precisely control fan speeds independently of activity in other areas.

The controls can also be connected to the fire systems in the building to manage the automatic starting/stopping of the fans when a fire is detected (depending on fire/smoke management strategies), and manual speed control for the fans at the Fire Indicator Panel (FIP). Some buildings also require links from the main Building Management System (BMS), usually to monitor the operation of the JetVent system in the car park.

Because the requirements of different buildings vary significantly, a JetVent control system may use any number of the inputs and outputs listed below to function effectively:

Inputs	Outputs
CO / NO_x or other pollutant sensors	JetVent Fans Speed/Switching (VSD or Relays)
Fire Status (FIP/Sensors)	Main car park exhaust fan speed
Fan run / health status	Main car park supply fan speed
BMS Supervisory Instructions	Fault Signals/Status
	BMS Monitoring Parameters

Table 5. Car park JetVent Control System input/output listing

Note:
Australian Standards AS/NZS1668.1:1998 and AS/NZS1668.2:1991/2002 offer insight into the functional characteristics of a car park control system.

4.5 Step 5 – Control Systems

b) Fantech Control Solutions - Overview

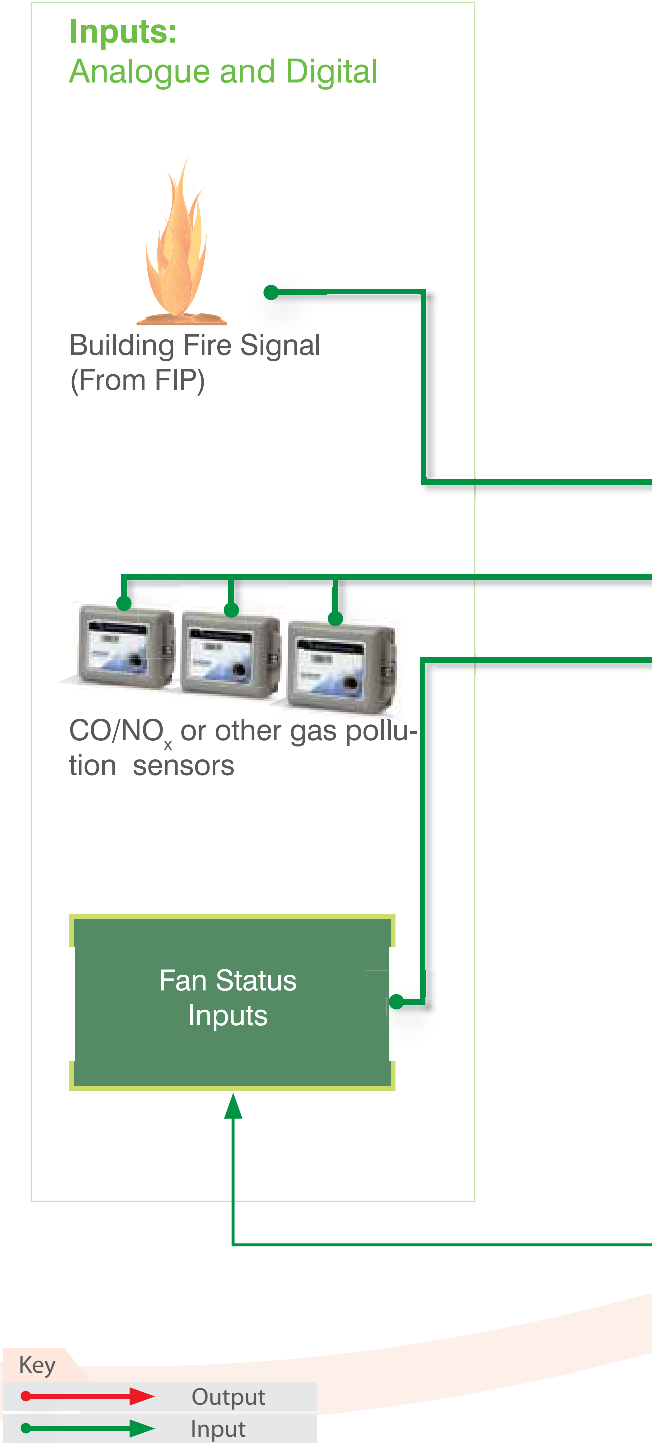
As part of supplying a complete JetVent Impulse Ventilation System package, Fantech can also supply a control system to control JetVent Fan operation.

To suit both large and small car parks, this control system is built on a modular concept. Each individual JetVent Zone Controller monitors a single zone of the car park, which may typically be sized up to 5000m². Car parks requiring more than one zone of control will have multiple controllers, of which a virtually unlimited quantity can be linked together through the whole building.

Each controller comes programmed with parameters suitable for a JetVent Impulse Ventilation System. This removes the trouble of having to configure a separate control system. Ease of use and flexibility are built into this system without sacrificing features needed for integration into complex Building Management Systems.

Specifications of a single Fantech JetVent Zone Controller are as follows:

- 10 x analogue inputs for CO or other pollutant sensors. (0-20mA, 0-5V and 0-10V input available).
- 16 x digital inputs for fan run/fault status.
- 1 x emergency alarm (i.e. fire) digital signal inputs.
- MODBUS, BACnet and other protocols for supervisory connection with BMS system.
- 3 x analogue outputs available to speed control groups of JetVent Fans, central car park exhaust fan or supply fan.
- 3 x digital outputs to drive speed control relays (for 2 speed fans) or other systems according to pollutant concentration.



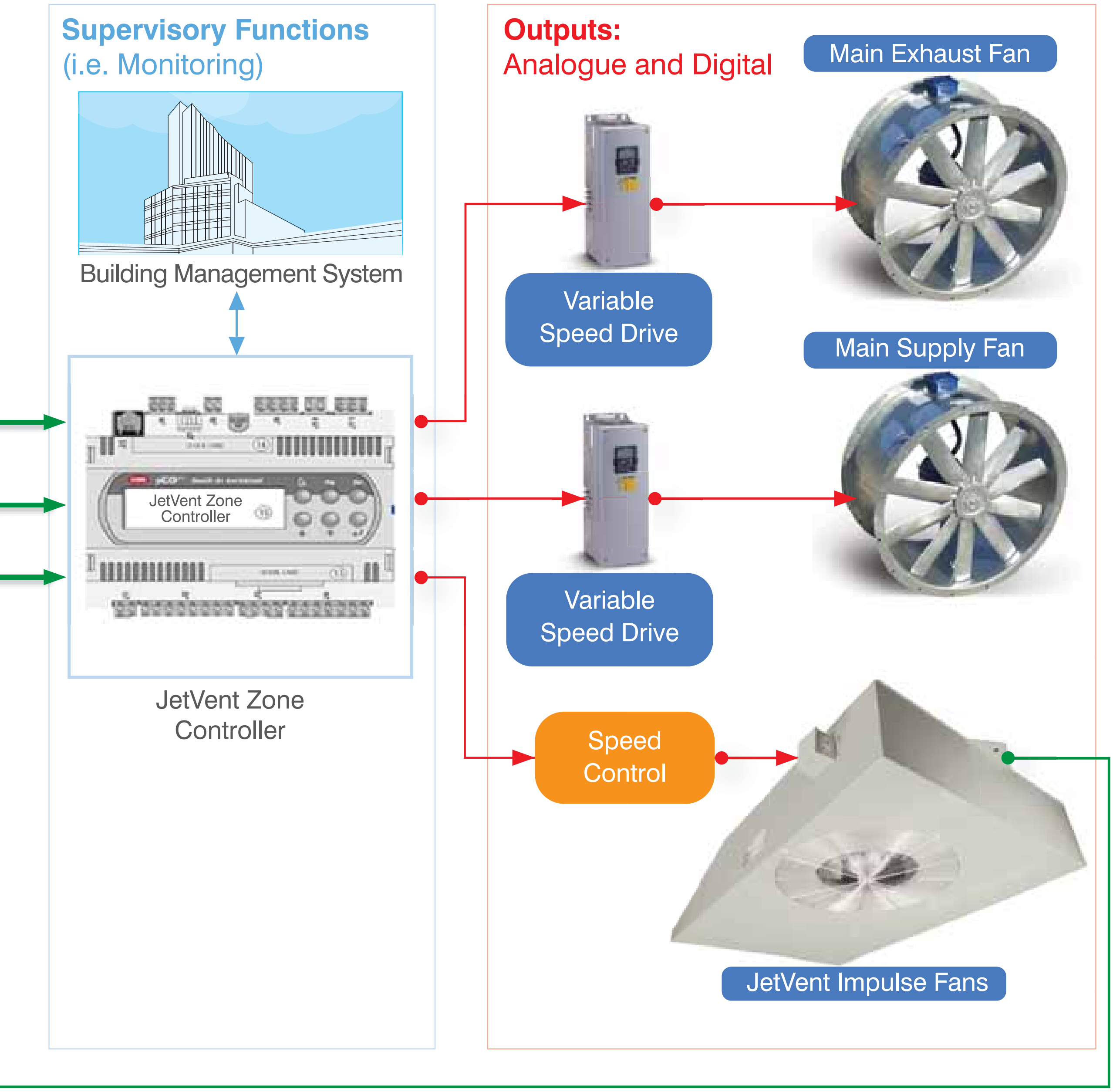


Figure 13(a). JetVent Control System conceptual layout

Note: See Sections 4.5 d) to f) for fan model specific setups

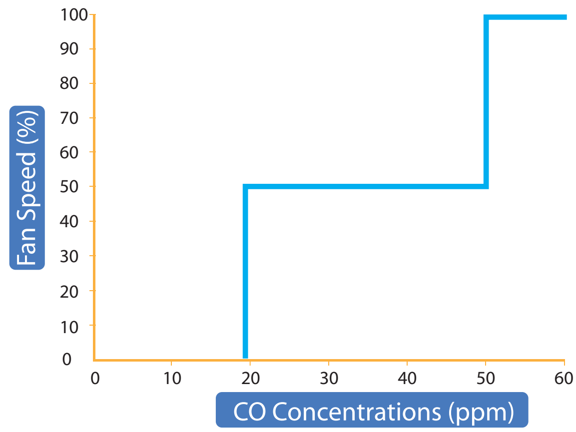
c) Speed Control Strategies

Choosing a Method of Control

There are several ways of controlling JetVent Fans in a car park. These fall into two categories. The first is a stepped approach (i.e. high/low speed) and the other is a ramped control of speed, i.e. with variable speed control. Here are some points regarding the control methods available:

Two-Speed Control

Two-speed control involves setting the fans into off, low or high speeds through a two-speed motor and relays. The relays are switched by a controller at various set levels or 'setpoints' corresponding to CO sensor readings in the car park. This is a simple and low cost way of achieving basic speed control of the JetVent Fans in a car park.

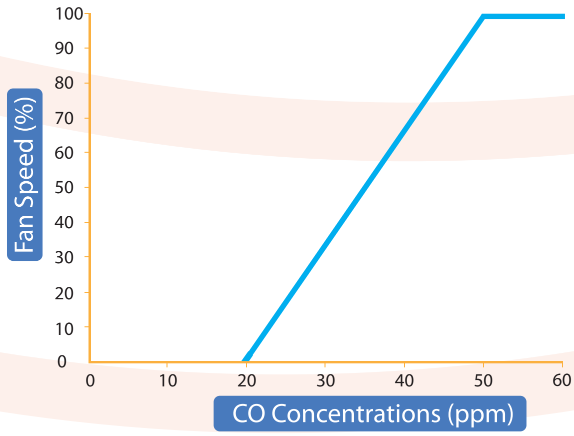


Analogue Variable Speed Control

Analogue variable speed control involves controlling the speed of the fans proportionally to CO levels in the car park. This is done with an electronic controller (usually a PLC control) interfacing with a speed controlling device (usually a VSD) over 0-10V or 4-20mA analogue signals. This system of speed control is more expensive than a simple two-speed approach but is more efficient by providing more precise control of fan speed against pollution levels.

Digital Variable Speed Control

High efficiency EC technology motors also have more advanced control methods and interfaces. The speed of the fans are again proportionally controlled against CO levels in the car park, but in this case the electronic controller uses digital protocols such as MODBUS to control the speed of the fan directly. Diagnostic information can also be transmitted from the fans to the controller in the same way. As a package, this system is very simple as all speed control components are part of the fan unit and all that is required to complete the system are the controllers and pollution (CO/NO_x) sensors.



d) Two-Speed Setup

Applicable Fans Series: JV-CPA, JIU-CPC2, JIU-CPMF

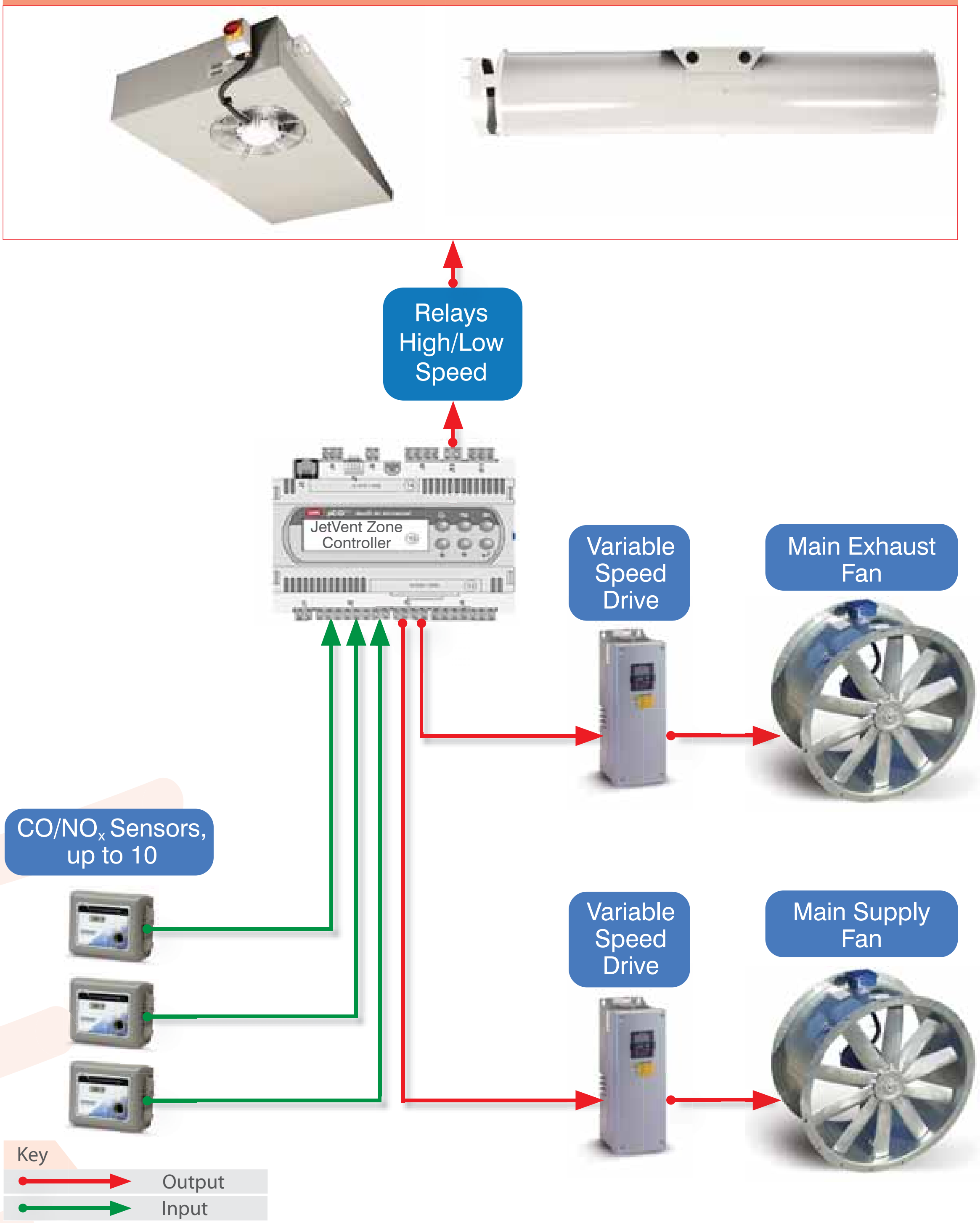


Figure 13(b). Two-speed fan control - conceptual layout

4.5 Step 5 – Control Systems

e) Analogue Variable Speed Setup

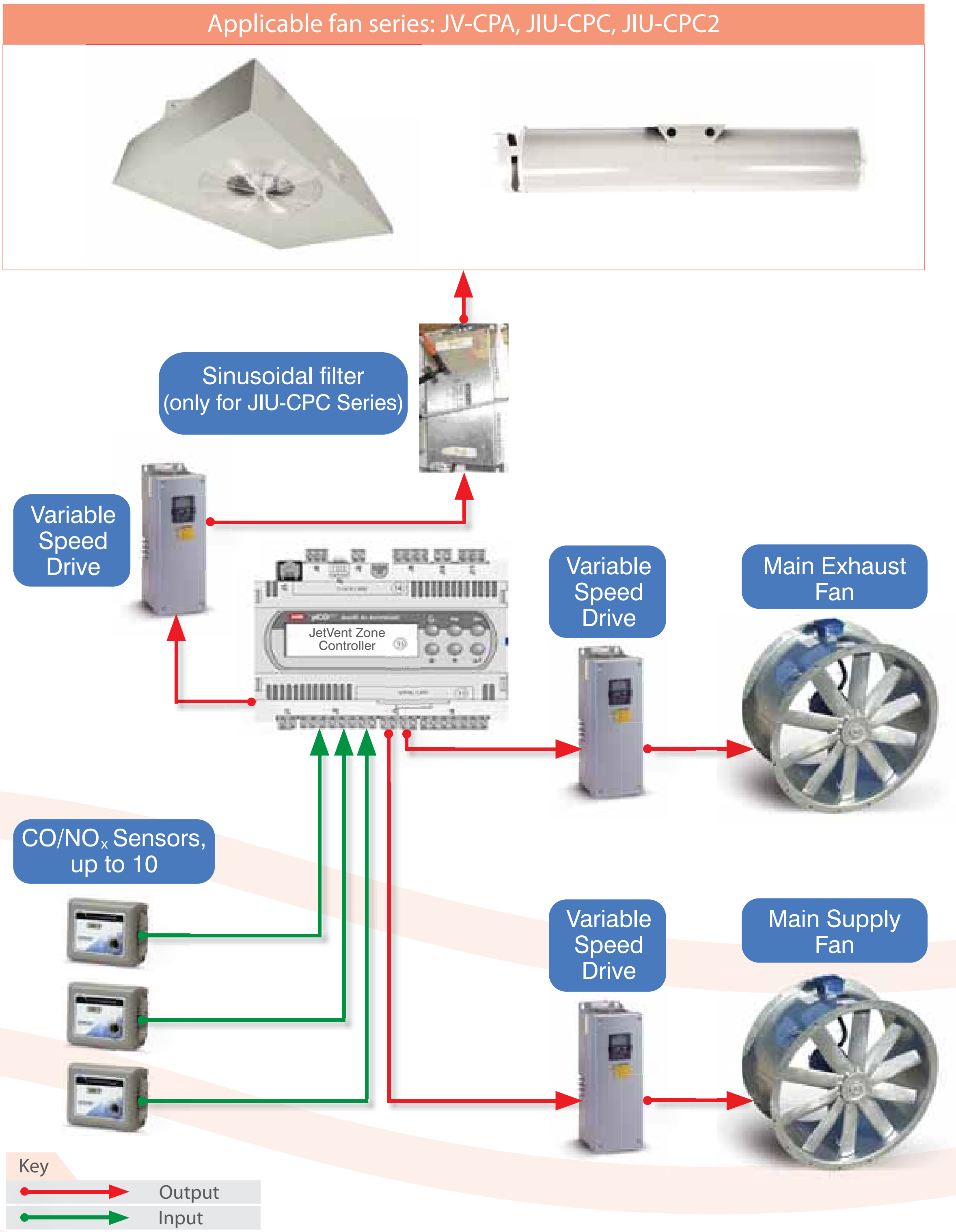


Figure 13(c). Analogue variable speed fan control - conceptual layout

f) Digital Variable Speed Setup

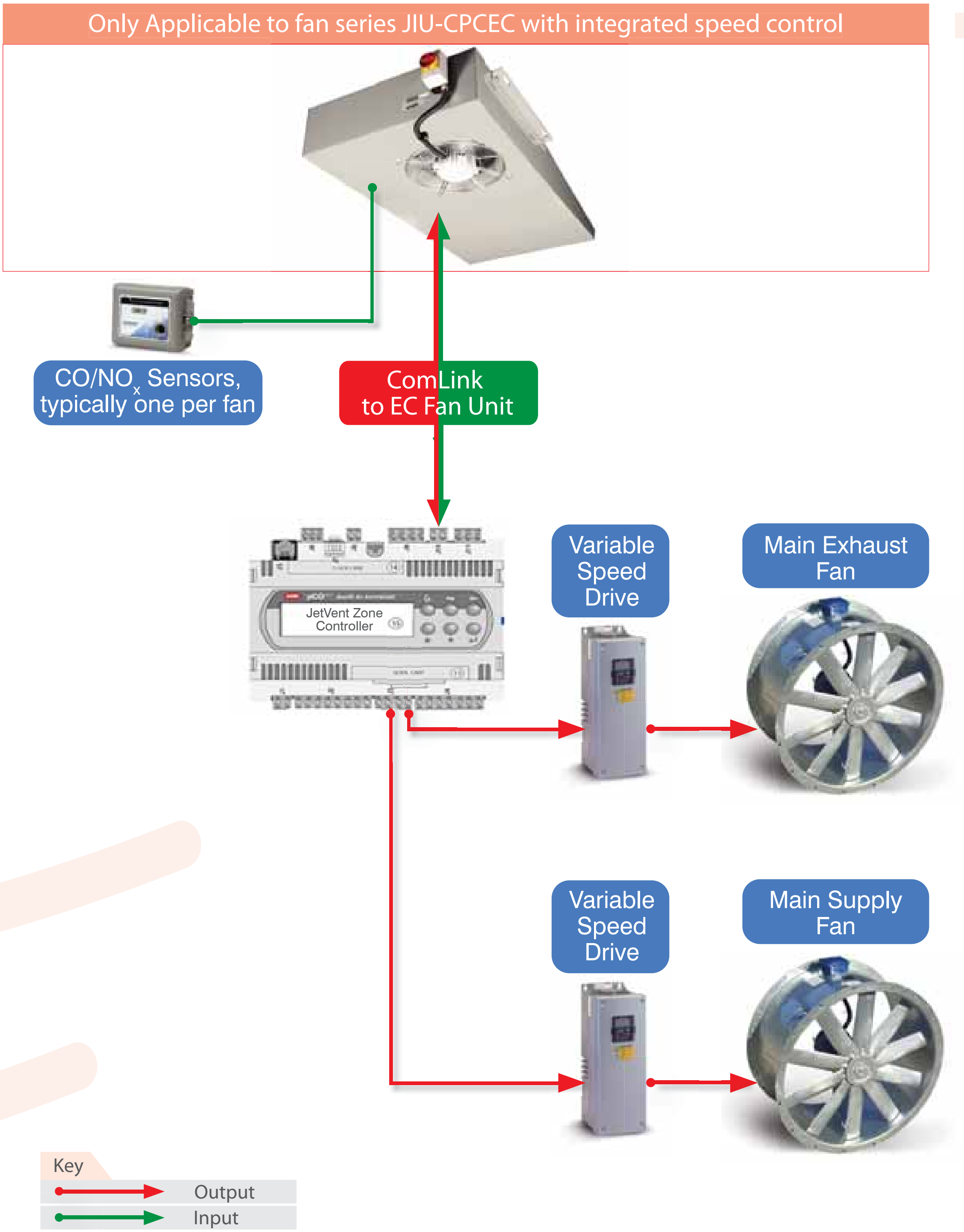


Figure 13(d). Digital EC fan control - conceptual layout

Designing & Implementing

4.6 Step 6 – Installation

JetVent Fans are typically hard mounted to the concrete ceiling using 8mm fixing bolts. In some cases, fans may be set off the ceiling through the use of brackets and anti-vibration mounts. This may be the case if there are unavoidable obstructions near the discharge air stream. To maintain the building's structural integrity, methods of affixing fans may need to be approved by a structural engineer.

In general, vibration isolation is not required when installing JetVent Fans in retail or commercial office car parks. However, anti-vibration mounts may be required for installations underneath residential buildings or floor structures that are flexible or vibration sensitive. An isolation efficiency of 90%, or as otherwise specified by the design consultant, would be recommended. The images below show typical JetVent Fan units on site.

Figure 14(a).
Typical unit installation

Figure 14(b).
Optional rubber mount installed

4.7 Step 7 – Commissioning the System

The following points are guidelines given regarding the procedure for commissioning a JetVent Impulse Ventilation system:

1. Check each fan's rotation when the fan is first started. When the direction of rotation is incorrect, immediately advise the electrical contractor so that wiring at the motor terminals can be changed.

2. The following individual elements are then measured:
   - Air flow and running current for each of the JetVent Fans to verify their performance in the field.
   - The running current and fan pressures for all the main exhaust fans should be checked and noted. Main exhaust and supply fan should be commissioned for air flow as usual.

3. Check individual CO/NO_x sensor operation using supplier's recommendations. This may also include sensor calibration.

4. Check CO/NO_x sensor naming/numbering in accordance to the control strategies.

CO/NO_x sensor, standard housing

CO/NO_x sensor, watertight housing

Continues on the following page

5. Optionally, overall performance/clearance may be checked by using cold smoke. A cold smoke test is considered a practical way of representing the air flow in a fully enclosed car park. The main objective of the cold smoke test is to visually confirm good air distribution in the car park, and ensure that 'dead spots' are not present.

Start, Approx 8.0m visibility

+5 min., 12m visibility

18 min., 40m visibility

32 min., +60m visibility

6. Once the car park is open for public use, and sufficient vehicles are present, observe system operation to ensure it is operating as expected. Also make sure that additional signs or other services have not been installed in such a way that they impede with the air movement of the system.

4.8 Step 8 – Maintenance

1. Due to differing periods of operation, recommended inspection and maintenance periods may vary. It is suggested that inspection and, if necessary, fan cleaning (with non-abrasive cleaner) is carried out at regular intervals of 5000 running hours or 12 months, whichever comes first.

2. All mounting fasteners, should be checked for tightness within 4-6 weeks of commissioning and periodically thereafter.

3. Bearings are a 'sealed-for-life' type and hence will not need re-greasing. The motor's cleanliness must be checked to ensure overheating from dirt and dust buildup does not occur.

4. If possible, also visually check to make sure that the fans rotating components are not touching any other parts of the fan.

5.0 System Compliance

5.1 BCA Framework

In order to comply with the Building Codes of Australia (BCA), a building solution must satisfy the performance requirements as outlined in Section A.05. This can be achieved by:

a) Complying with the "Deemed-to-Satisfy" provisions in the BCA.

b) Formulating an alternative solution that complies with performance requirements or is shown to be equivalent to the Deemed-to-Satisfy provisions in the BCA.

For car park ventilation, the "Deemed-to-Satisfy" requirements as outlined in the BCA requires a ducted ventilation system complying with AS/NZS1668.2:1991 or an adequate system of permanent natural ventilation (Section F4.11).

The impulse ventilation system differs to a conventional ducted system and is therefore an alternative solution under the legislative structure outlined above. At the time of publication of this guide, such ventilation systems must be approved as a "Performance Based" solution under the BCA. Sections A0.8 to A0.10 of the BCA outline the requirements for alternative solutions and the relevant assessment methods and performance requirements for the system to be a BCA compliant solution.

5.2 Australian Standard Requirements (AS/NZS1668.2)

AS/NZS1668.2:1991 is the Standard relevant to ventilation of buildings as referenced in the BCA. As per this standard, the target of a car park ventilation system is to limit Carbon Monoxide (CO) concentrations to levels specified in Worksafe and National Health and Medical Research Criteria (NHMRC). However, there is very little information in this standard that actually outlines the car park traffic scenarios for these pollution levels to be assessed. Information that may be useful for this includes calculation routines for determining the number of cars driving in the car park at capacity.

A newer version of the Standard AS/NZS1668.2:2002 contains information that will assist in the formulation of an alternative design. While this Standard is not referenced in the BCA, it is accepted as a standard of good quality and is a good basis for an alternative design. In order for the impulse ventilation system to be approved as an alternative design solution under AS1668.2:2002, it will need to be demonstrated that CO concentration levels between 900mm and 2500mm above the floor are limited to:

i) 60ppm 1hr maximum average
ii) 100ppm peak value; and
iii) 30ppm Time-Weighted Average (TWA) over 8hrs

These guidelines are derived from section 7.2.2 of AS1668.2:2002. The 60ppm 1hr maximum average is taken to be the significant design criteria. This is because guidelines in AS1668.2:2002 regarding the pollution levels of cars and maximum traffic scenarios work on the basis of a 'worst case condition' of one hour in duration. Also, if this is met, it is safe to say that CO levels will be well under the 100ppm peak values allowed in the standard.

The 30ppm time weighted average appears to apply to car parks where people work within the confines of the car park without having separate ventilation systems for their work area. Examples of this include car parks with a car wash inside or parking attendant booths with no other sources of ventilation. In most cases, the third CO concentration criteria will not apply to the car park due to the lack of these features.

Having defined the scenario for assessing the performance of the car park system, there are a number of ways of proving that the ventilation design performs adequately. The most comprehensive way of demonstrating this is by building a Computation Fluid Dynamics (CFD) Model of the car park. The model has to simulate pollution and air flow movement within the car park to ensure that Carbon Monoxide levels meet the requirements outlined above. While this approach is precise and ensures that the designed system works throughout the car park, it may be unnecessary for smaller car parks and those partially served by natural ventilation. In these cases, 'expert judgement' or knowledge gained from projects completed previously may indicate that a proposed car park ventilation design using JetVent Fans will be adequate.

6.0 Computational Fluid Dynamics

Computational Fluid Dynamics (CFD) is the use of computer-generated models to simulate the aerodynamic behavior around objects within a space. When alternative systems are proposed, as outlined in section 5.0 of this guide, a CFD analysis is a good method to demonstrate to approving authorities that the system is likely to perform satisfactorily. In order to successfully perform a CFD analysis, the following information is required:

1. Mechanical and architectural drawings are required in AutoCAD format with the locations of any obstructions to air flow, such as support columns, included. These drawings must also display plan views and elevations with detailed cross-sections to illustrate floor and ceiling heights.

2. Exhaust and supply air flow rate calculations provided by the consulting engineer.

3. Exhaust and supply air outlets/inlets are clearly marked on the drawings with all relevant dimensions and details shown.

4. Parameters for CO calculation are to be supplied correctly as per Section 7.5.4.1 of AS/NZS1668.2:2002. This includes the number of cars, traffic paths and relevant parameters as per the standard (see page 39-40 for reference). Another option is for the consulting engineer to clearly state an alternative international standard to be used for calculation purposes.

5. The JetVent Fan type, model and control method is clearly stated and indicated.

6. The target criteria for the CFD model are to be confirmed, e.g. 60ppm 1hr maximum average as per Australian Standards, along with the steps in the methodology.

7. Any additional views or plots required by the analysis are noted for inclusion in the CFD report.

The final CFD report includes a description of the car park, as well the ventilation system, with placements of JetVent Fans illustrated on the drawings. The design criteria and objectives of the analysis are to be clearly detailed at the beginning of the report. The report should also include the scenarios investigated along with air velocity and CO plots. These results closely reflect what would occur in the car park during real life situations. Figures 15 and 16 provide examples of typical CFD plots for air velocities and CO concentration levels respectively. Fantech are able to facilitate a CFD analysis with costing provided on application. The cost of a CFD analysis is generally expected to be minimal in comparison with the potential cost savings associated with implementing the Impulse Ventilation system. The time required to perform the analysis and present the report varies greatly but is usually between 2-6 weeks.

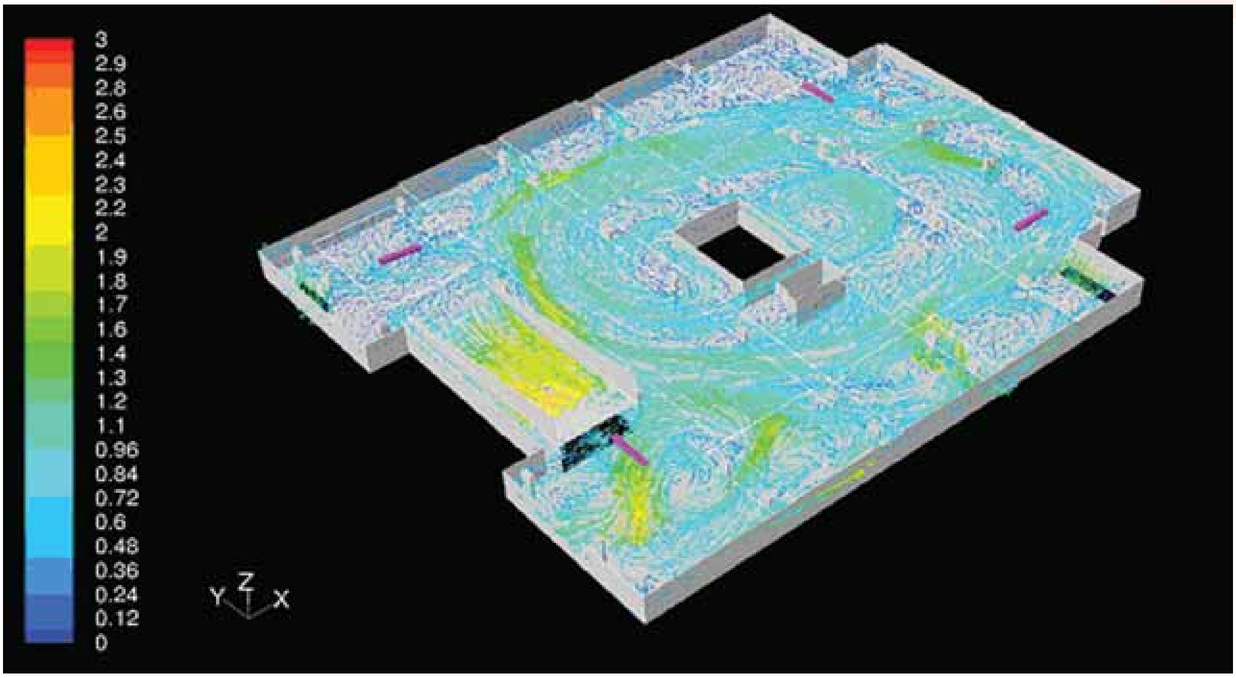


Figure 15. CFD plot with velocity vectors, scale in m/s

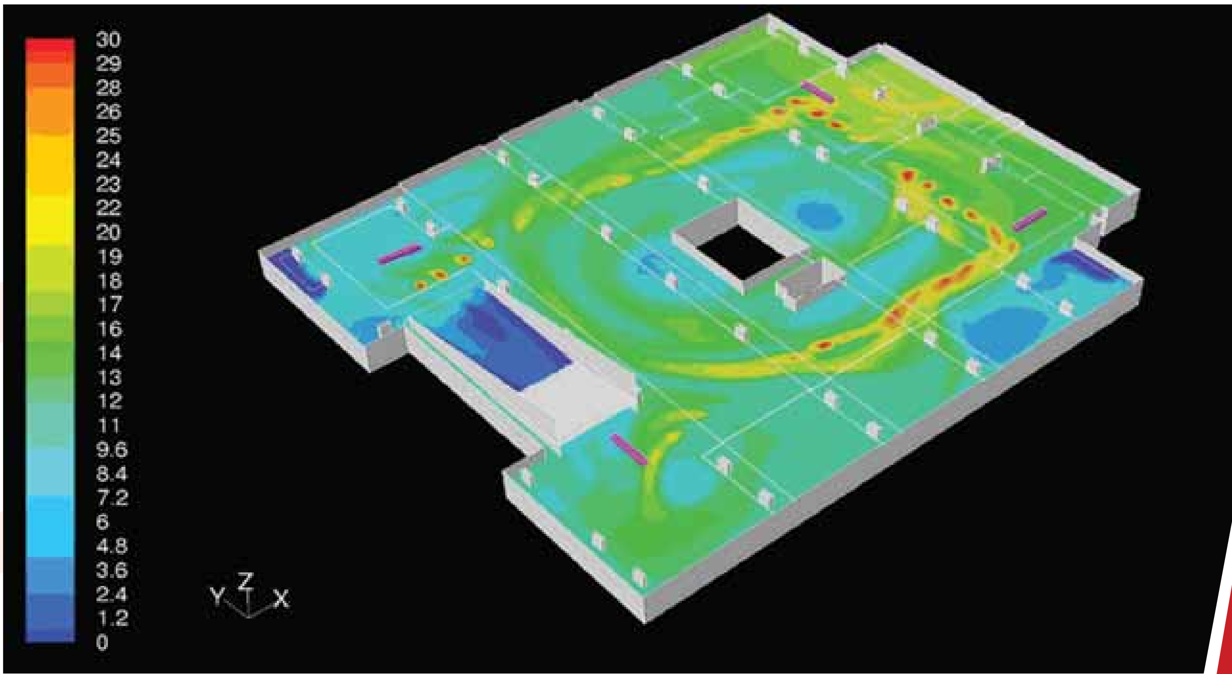


Figure 16. CFD plot of CO concentration levels, scale in ppm

7.0 References

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- Standards Association of Australia 1999, *The use of ventilation and air-conditioning in buildings. Part 2: Ventilation design for indoor air contaminant control* (AS 1668.2 – 1991), Standards Australia, Sydney.
- Standards Association of Australia 2002, *The use of ventilation and air-conditioning in buildings Part 2: Ventilation design for indoor air contaminant control* (AS 1668.2 – 2002), Standards Australia, Sydney.

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AS/NZS1668.2 - 2002 Calculation Factors

1. Parking Usage Factor (P)

Use of car park	Parking usage factor (P)
Residential	0.3
Commercial	0.5
Retail/food and drink services	0.7
Entertainment/sports centres	1.0
Vehicle Depots	2.4

2. Vehicle Type Factor (T)

Use of car park	Vehicle type factor (T)
No special vehicle population	1.0
Diesel vehicles	2.4
LPG vehicles	1.0
CNG vehicles	1.0
Electric powered vehicles	0.1
Motorcycles	0.25

8.0 Appendix

3. Staff Usage/Exposure Factor (E & F)

Parking procedure	Staff exposure factor (E)	Staff usage factor (F)
No special procedures, self parking, any staff in separate enclosure ventilated in accordance with Clause 7.12 in AS/NZS1668.2-2002	1	1
Self parking stack parking, any staff in separate enclosure ventilated in accordance to Clause 7.12 in AS/NZS1668.2-2002	1	2 + 0.1 x car spaces not adjacent to driveway
No special procedures, self parking, staff located in car parking enclosure	1.8	2
Self parking stack parking, staff located in car parking enclosure	1.8	4 + 0.25 x car spaces not adjacent to driveway
Attendant parking, no stack parking	1.8	2.5 x No. of attendants
Attendant parking, stack parking	1.8	3.5 x No. of attendants
Mechanical stack parking	1.8	2 x No. of car engines simultaneously running

Notes

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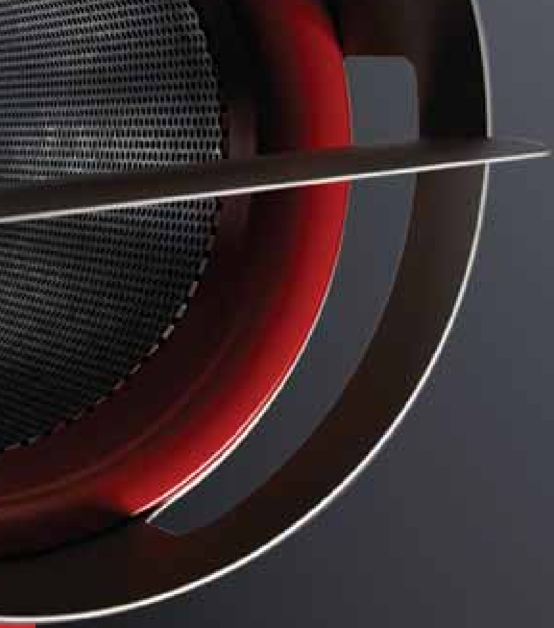

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