



# Car Park Ventilation (CPV)

Full Scale 'Live' Smoke Tests

# Full Scale Live Smoke Tests

## Impulse & Induction system outperformed traditional ducted system

### SUMMARY

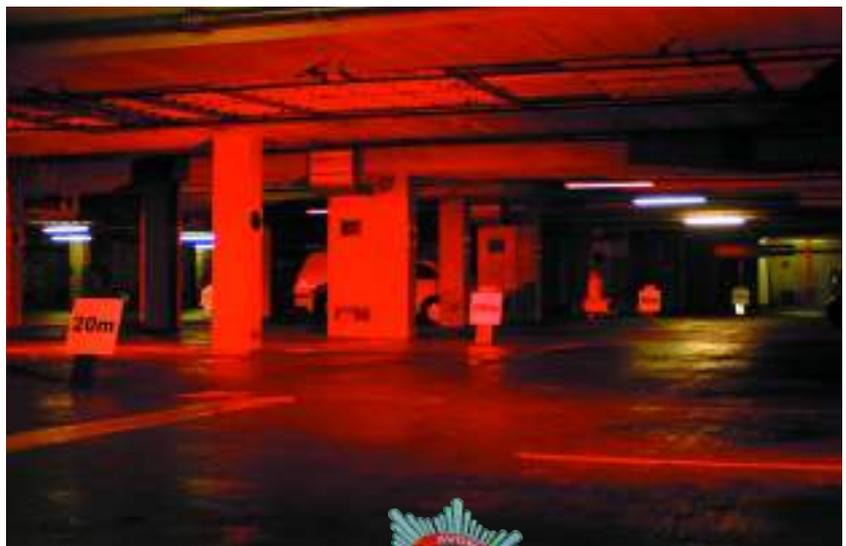
A series of full scale demonstrations to investigate the effectiveness of mechanical extract systems were carried out in an existing underground car park in Bristol.

The demonstrations involved filling the car park with warm smoke and measuring the time taken to regain visibility and substantially smoke free conditions.

Three ventilation systems were tested: the existing traditional ducted system in compliance with Approved Document B 2000 edition (ADB), an impulse ventilation system and an induction ventilation system.

The aim was to investigate the performance of a traditional ducted system in compliance with ADB and to compare the performance with the new impulse and induction systems.

It was found that the compliant system took 40 to 45 minutes to clear the smoke and the impulse and induction systems took 25 to 35 minutes. Impulse and induction systems are, therefore, at least equivalent to mechanical extract systems as described in ADB.



The demonstrations were carried out at the car park of Avon Fire and Rescue Service HQ, Temple Back, Bristol by courtesy of the Chief Fire Officer.

We would like to express our thanks to Community Fire Safety Officer Graham Blight and his colleagues for their co-operation and assistance in setting up and running these demonstrations.

## THE SETTING

Approved Document B 2000 edition (ADB) to the Building Regulations sets out recommended methods for the ventilation of car parks in the event of fire. Three options are provided:

- Open sided car parks with ventilation openings equal to 5% of the floor area
- Naturally ventilated car parks with ventilation openings equal to 2.5% of the floor area
- Mechanically ventilated car parks with an extract rate of 10 air changes per hour (ACH)

Where car parks are underground they are invariably mechanically ventilated.

The ventilation system is also usually used to provide day to day ventilation for control of exhaust and petrol fumes in accordance with Approved Document F.

Mechanically ventilated car parks require a distributed ductwork system within the car park to ensure that there are no stagnant areas where smoke or petrol and exhaust fumes could collect. The ductwork is also required to extract equally from high and low level.

This ductwork is often difficult to design and install due to the restricted headroom in underground car parks and creates significant additional resistance for the extract fans to work against, increasing the power consumption and running costs for the ventilation system.

The impulse fan system was developed to replace the ductwork, the intent being to provide a system equivalent to the mechanical extract system described in ADB. The effectiveness of these systems is often demonstrated using CFD analysis or smoke tests but no tests have previously been carried out directly comparing the systems.

Note: Impulse fan systems may also be used to control smoke and keep areas of the car park smoke free during fire conditions. Such systems provide a level of performance far in excess of Building Regulations requirements and fell outside the scope of these demonstrations.



# Full Scale Live Smoke Tests

## THE DEMONSTRATIONS

The specific objectives of the demonstrations were:

- to demonstrate the effectiveness of a traditional mechanical extract system compliant with ADB.
- to demonstrate the effectiveness of impulse and induction ventilation systems in the same car park under the same conditions.
- to compare the effectiveness between systems to show whether impulse systems truly are equivalent to traditional systems.



A team of engineers from Colt International Limited carried out four full sets of demonstrations during September and October 2004. Two sets of these were carried out in front of an invited audience of consultants, architects, fire officers and building control officers.

## THE CAR PARK

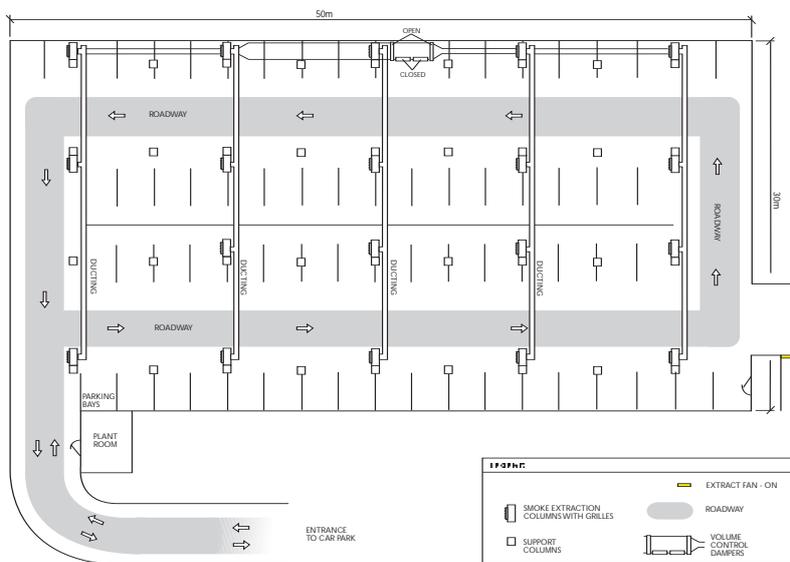
The car park was built in the 1960's and is a typical underground car park with a floor area of 1600 m<sup>2</sup> and an average height of 3m. The ceiling has concrete downstand beams running across the 32m width at column centres of 5m. The car park is fitted with a traditional mechanical extract system with ducts providing extract from points evenly distributed through the car park. At each extract point grilles are provided at high and low level.

The ductwork was modified slightly by

adding shut off dampers to allow the extract to be provided either via the distribution ductwork or via a single extract point for use with the impulse and induction fans.

Under test the extract system failed to achieve 10 ACH. Additional extract was therefore provided to make up the shortfall by means of a fan mounted in a fire escape doorway. This additional fan provided 20% of the total extract.

During the demonstrations the car park was typically 15% occupied by cars, randomly parked as left by their users.



TEST 1

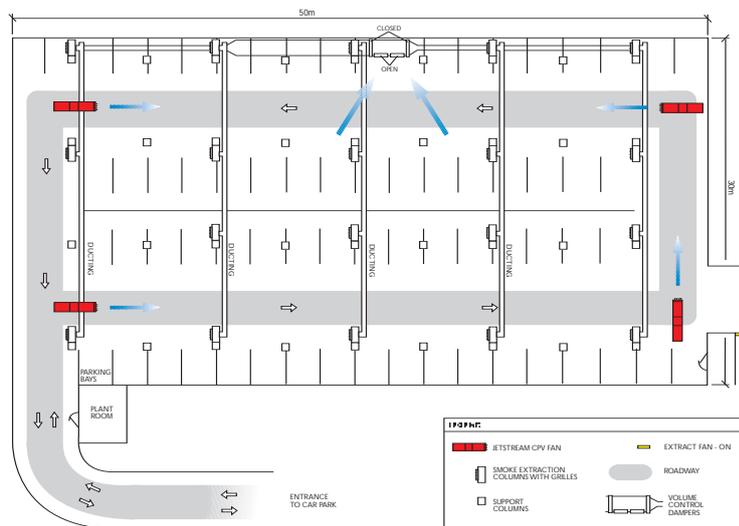
### THE IMPULSE AND INDUCTION SYSTEMS

For these systems, the required extract rate is unchanged at 10 ACH, however the extract is usually taken from a single point without any distribution ductwork. In these demonstrations the main extract was taken from the point where the ductwork leaves the car park. The additional extract fan in the escape door was also utilised.

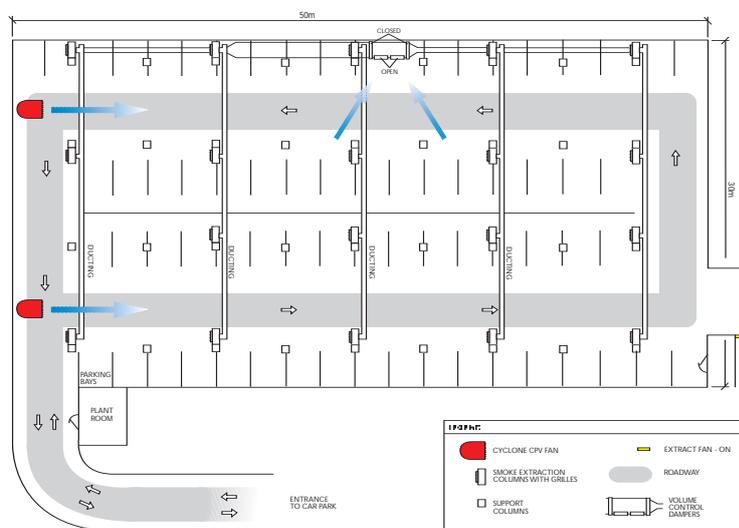
For the impulse system the extract was supplemented by 4 Colt Jetstream impulse fans mounted in the four corners of the car park, blowing down the roadways. This would be a typical design for this car park.

For the induction system the extract was supplemented by 2 Colt Cyclone induction fans mounted to blow down the roadways from the ramp end of the car park.

The purpose of the impulse and induction fans is to effectively mix and distribute the air and smoke in the car park, ensuring that there are no stagnant areas and generally guiding the smoke towards the extract point.



TEST 2



TEST 3

# Full Scale Live Smoke Tests

## THE PROCEDURE

The procedure was identical for all demonstrations.

All fans were switched off and the car park was smoke logged by operating 4 smoke generators for a period of 4 minutes. Smoke distribution was aided by entraining the smoke into the airstream of

4 portable propane heaters. This also added some heat and buoyancy to the smoke. At the end of this period the car park was evenly smoke logged with visibility of approximately 10m.

The selected ventilation system was then started and the system left for the period required to clear the smoke. Distance boards were placed at 10m intervals along

both roadways so that the time taken for visibility to increase in 10m increments could be measured. The time taken to substantially clear the smoke was assessed subjectively, but the consistency of assessed time through the demonstrations indicated that the subjective assessment was reasonably reliable.



Photographs 1-6 show car park clearing after being fully smoke logged

Video footage of all the tests are available from Colt International Ltd

# Impulse & Induction systems are more effective at smoke clearance

## THE RESULTS

Table 1 shows the range of times taken in the demonstrations to achieve visibility distances and for the car park to become clear of smoke.

It was noticeable during the demonstrations that the impulse and induction systems provided more homogenous control of visibility. When the traditional system was in use the effect of the air inlet air stream from the ramp meant that some areas cleared quickly while others remained smoke logged much longer. With the impulse and induction systems the inlet was no longer dominant and the whole car park cleared at an even rate.



The Deputy Chief Fire Officer of Avon Fire & Rescue, Jerry O'Brien commented

"The speed that the new products cleared the smoke compared to the old ducted system that we and maybe some others are using, is just remarkable. It is very impressive"

Visibility	System		
	Traditional	Impulse	Induction
10 metres	At start	1 minute	1.5 minutes
20 metres	3.5 minutes	8 minutes	6 minutes
30 metres	13 minutes	13 minutes	9.5 minutes
40 metres	23 minutes	16 minutes	12.5 minutes
Rear wall details	27 minutes	18.5 minutes	16.5 minutes
Clear of smoke	41.5 minutes	32.5 minutes	28 minutes

## CONCLUSIONS

The results of these demonstrations confirmed that the mechanical extract system described in ADB is only sufficient for smoke clearance and could not be expected to provide control of smoke during a fire. The system typically took 40 - 45 minutes to substantially clear the car park of smoke, although even at this time there was still some dilute smoke hanging under the ceiling between the downstand beams.

The demonstrations also showed that impulse and induction systems are more effective at smoke clearance, taking typically 25 to 35 minutes to clear the car park of smoke.

It is therefore clear that impulse and induction systems are suitable as equivalent alternatives to the ventilation systems described in ADB.

#### THE COLT PACKAGE

Colt can offer the complete package, including the design, supply and installation of:

**CPV fans**

**Ductwork (extract)**

**Extract ventilators**

**Control system**

**CO and smoke detectors**

**Strobe lighting and sounders (if required)**

**Wiring**

**CFD analysis**

**Commissioning**

**Service and Maintenance**

Also, for traditional systems Colt can offer louvres for natural cross-flow ventilation.

#### COLT SERVICE

Part of the Colt Group of companies, Colt Service offers a comprehensive range of maintenance packages incorporating the maintenance and repair of all building services equipment including non Colt products.

Colt Service provide a 24 hour, 365 day emergency cover as standard.

#### MAINTENANCE

Maintenance of a smoke control system is essential. Regular maintenance protects your investment and brings peace of mind that the system will operate effectively in an emergency.

The British Standard, BS 7346 recommends that smoke control systems should be serviced at least once a year and tested weekly.



A Member of the British Parking Association



Architectural Solutions

Climate Control

Smoke Control

Service and Maintenance

**Colt International Limited**

New Lane Havant

Hampshire PO9 2LY

Tel +44(0)23 9245 1111

Fax +44(0)23 9245 4220

info@coltgroup.com

www.coltgroup.com