# Colt International Ltd

## Car Park Ventilation

## CPD Technical Seminar 2020

# CPD Accreditation

Colt International Limited

CIBSE CPD

## Certification

**of CPD course provision**

This is to certify that

Colt International Ltd

has been registered as a CPD Course Provider by
The Chartered Institution of Building Services Engineers (CIBSE)

Accredited from 1 June 2019 to 31 May 2021

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CIBSE CPD

Colt have a number of CPD accredited topics including:

- Car park ventilation
- The general principles of smoke control
- Pressurisation
- Smoke shafts
- Overheating common corridors
- Smoke and fire curtains
- Louvre
- Evaporative cooling

# A brief history of Colt

Colt International Limited


Founded in

**1931**

2019 UK turnover

**£38.4 million**

2019 Group turnover

**£180.4 million**

Manufacturing facilities in

**UK, Holland & Germany**

# Accreditations and Memberships

Colt International Limited

## Accreditations

- CHAS
- Construction Line
- Safe Contractor
- Worksafe Contractor
- RoSPA

PPQ still required by clients

Chas Accredited

Constructionline
Part of Capita plc

IFC certification
CERTIFICATED INSTALLER OF ACTIVE FIRE PROTECTION

safecontractor APPROVED

smas worksafe contractor
www.smasltd.com
as recognised by
SSIP SAFETY SCHEMES IN PROCUREMENT

QUALITY SYSTEM CERTIFICATION
DNV·GL
ISO 9001

ENVIRONMENTAL SYSTEM CERTIFICATION
DNV·GL
ISO 14001

SAFETY SYSTEM CERTIFICATION
DNV·GL
ISO 45001

## Memberships

BSRIA

CIBSE PATRONS

ASFP
www.asfp.org.uk

CIBSE CPD

FETA

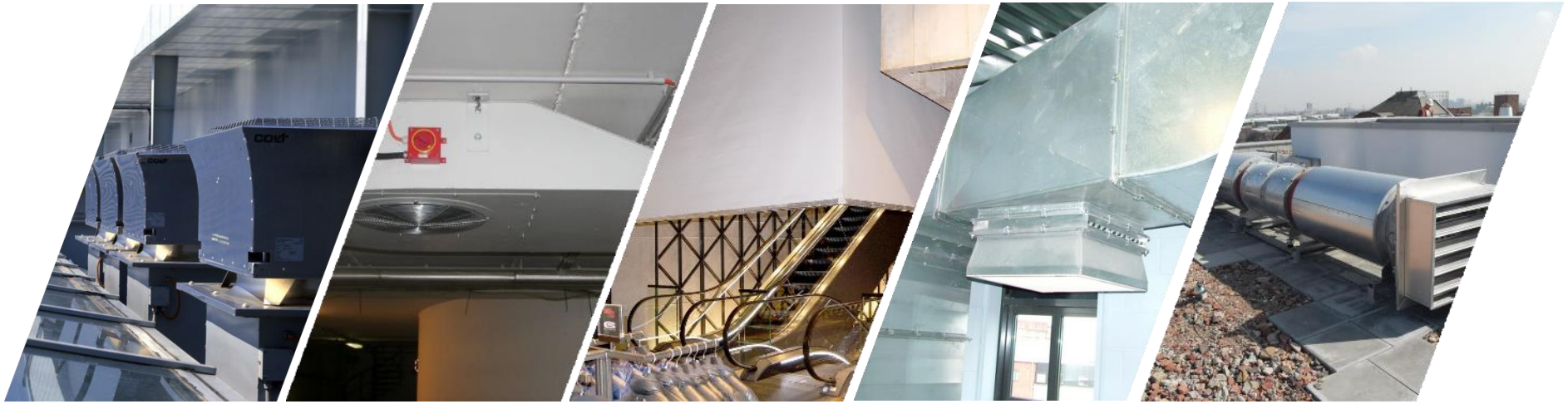
Smoke Control

Climate Control

Louvre & Shading

Service

## Smoke Control



SHEVS
Smoke and Heat
Exhaust Systems

Car Park
Ventilation

Smoke
Containment

Pressurisation
Systems

Smoke Shaft
Systems

## Climate control

Natural Ventilation

Mechanical Ventilation / HVAC

Evaporative Cooling

Industrial Heating

## Louvre

Screening | Ventilation & Rain Defence | Shading | Acoustic

## Service


24 hour call out

Nationwide Coverage

Spare Parts

Surveys


P603 ERV
P210 KGW


colt

# Approved Documents B & F - Summary

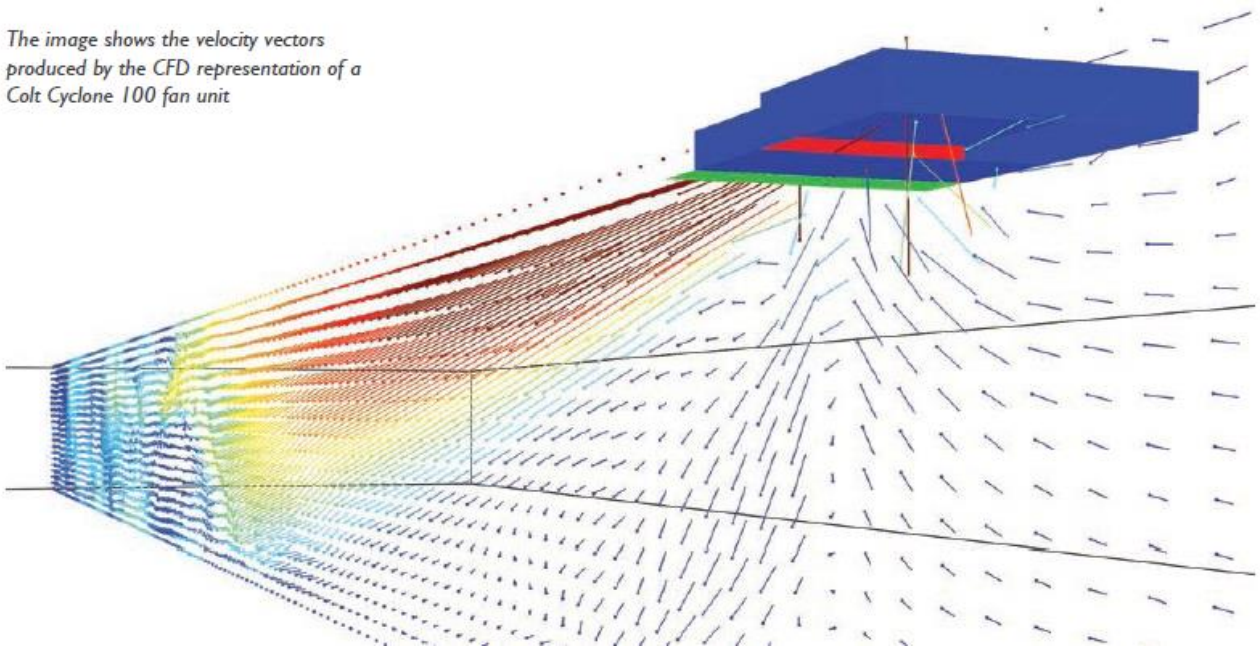
Car Park Ventilation 2020

| | Car park type | | |
|---|---|---|---|
| | Open sided | Naturally ventilated | Mechanically ventilated |
| ADB<br>Fire Safety | 5%* | 2.5%* | 10ACH |
| ADF<br>General Vent | 5% | 2.5% + 3ACH | 6ACH |

* Of which at least 50% should be split equally between two opposing walls to provide crossflow ventilation

ADF limits CO concentrations to 30ppm over 8 hours and 90ppm over 15 minutes

It is a method of providing ventilation in a Car Park by adding momentum to the air, by installing small unit fans under the ceiling to generate thrust. The impulse fans remove the need for large runs of ductwork as they push smoke/fumes to a central extract.



*The image shows the velocity vectors produced by the CFD representation of a Colt Cyclone 100 fan unit*

A fan has a throw of approximately 20 - 30m at full speed

One fan covers approximately 400m$^2$

These figures can be significantly reduced by downstand beams

Dimensions:  Typically 2800mm long x 450mm deep

50N thrust, rated at 300$^o$C for 1 hour

The Cyclone was developed specifically for use in larger car parks

Two Sizes

- Cyclone 100: 1457 long x 291mm deep
- Cyclone 50:  1206 long x 235mm deep

Rated at 300°C for 1 hour.

Effects of downstand beams reduced

Could save 100mm of excavation per level

Main Extract Fans Require:

- Temperature Rated to 300degC for 60 minutes.
- Back-up Power Supply.
- Minimum 2 fans at 50% each.
- Sound Attenuation
  - Intake NR55
  - Exhaust 55dB(A) at 3m (typical)

**Benefits**

Impulse Ventilation removes the need for ductwork and low level intakes**,** giving:

- Safer, lighter environment
- Improved security for CCTV
- Potential increase in number of parking bays
- Easier and quicker installation – less storage required on site
- Fewer clashes with other work packages
- Lower power consumption due to less resistance on main extract fans
- Lower height constraints leading to possible reduced ‘dig out’ costs

**Main Guidance for Car Park Ventilation**

Approved Document B - Fire Safety (ADB)

Approved Document F – Ventilation (ADF)

BS 7346 Part 7 – 2nd edition published August 2013

(Includes design parameters for impulse systems, including smoke control systems.)

**Upcoming European Standard:** 12101-11 - Horizontal ventilation systems for enclosed car parks

**Approved Document F** requires the area of natural openings to be the equivalent area:

*"A measure of aerodynamic performance of a ventilator. It is the area of a sharp edged orifice which air would pass at the same volume flow rate, under an identical applied pressure difference, as the opening under comparison."*

If the openings used to provide this equivalent area are plain openings with no grilles, louvres, railings or other obstructions then, by definition, the equivalent area is the same as the measured area of the openings.

Therefore any obstructions, such as louvres, need to be taken into account.

**Approved Document B** Requires that:

- System be designed to run in two parts each capable of extracting 50% of the required extract rate
- Each part have an independent power supply to operate in the event of mains power failure
- Extract points be arranged such that 50% are at high level, 50% at low level
- Fans be rated to run at 300ºC for a minimum of 60 minutes and ductwork to have a melting point not less than 800ºC

**Ductwork sizing**

- limitations on height
- ductwork passing underneath downstand beams

**Low level inlets**

- impede parking bays
- require barriers for protection

**Two basic design approaches:**

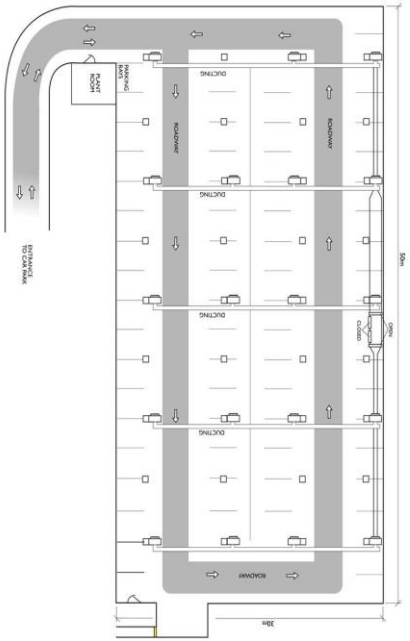
1. Smoke **Clearance** Systems
2. Smoke **Control** Systems

1. **Smoke Clearance Systems**

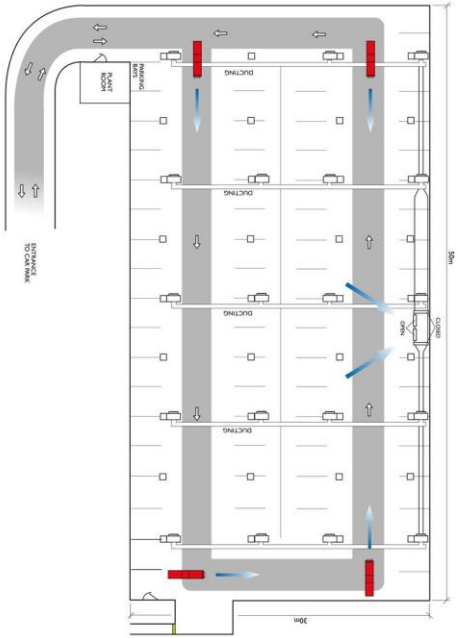
Meets the requirements of Approved Document B, allows the fire fighter to clear smoke from an enclosed car park once the fire has been tackled.

- Provides an air change rate, taking no account of potential fire size or fire location.
- Does NOT aid escape
- Does NOT compensate for extended escape distances
- Does NOT compensate for omitting sprinklers
- Extract is sized to provide 6 ACH to all levels and 10 ACH to the largest level
- Fans are located over roadways and laid out to ensure no stagnant areas.
- Car Park is usually modelled using Computational Fluid Dynamics (CFD) to confirm performance
- Systems based on air change rates can only offer smoke clearance.

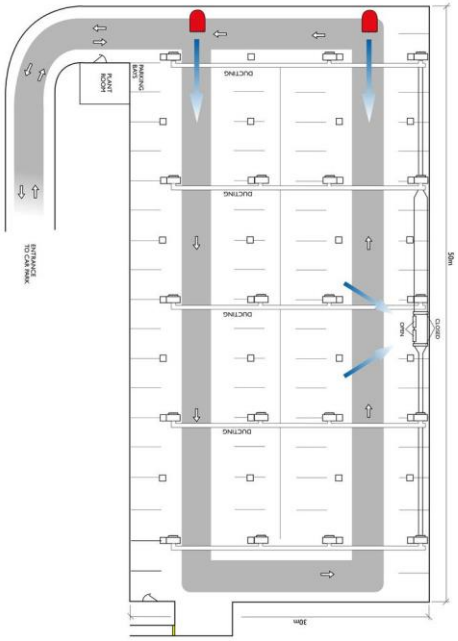
A series of tests to demonstrate the effectiveness of systems intended to comply with Approved Document B carried out at the Headquarters of Avon Fire and Rescue Service in October 2004.



**Test 1**



**Test 2**



**Test 3**

# Smoke Clearance Systems: The Bristol Car Park Tests

Car Park Ventilation 2020

| System | Time to see end wall | Time to clearance |
|---|---|---|
| Traditional | 27 Minutes | 42 Minutes |
| Jetstream | 19 Minutes | 33 Minutes |
| Cyclone | 17 Minutes | 28 Minutes |

## 2. Smoke Control Systems

Specifically designed to achieve the **CONTROL** of smoke movement. Usually requires additional extract over and above the basic clearance requirement.

Can be designed to:

- Aid escape and therefore extend safe escape distances
- Assist fire fighting as an alternative to sprinklers
- Control smoke as a alternative to compartmentation
- Trade-off against lobby ventilation in basement or stairs that serve upper levels

In the UK, sprinklers are generally not required in car parks, except in certain applications, such as shopping centres or larger projects in London and Scotland.

**Design Fire Sizes - From BS 7346 Part 7:**

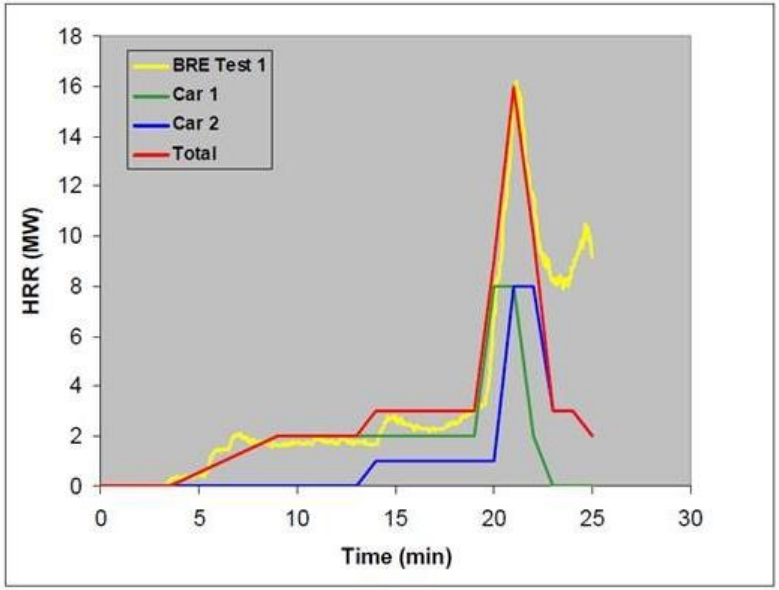
Sprinklered: 14m Perimeter 4000 kW

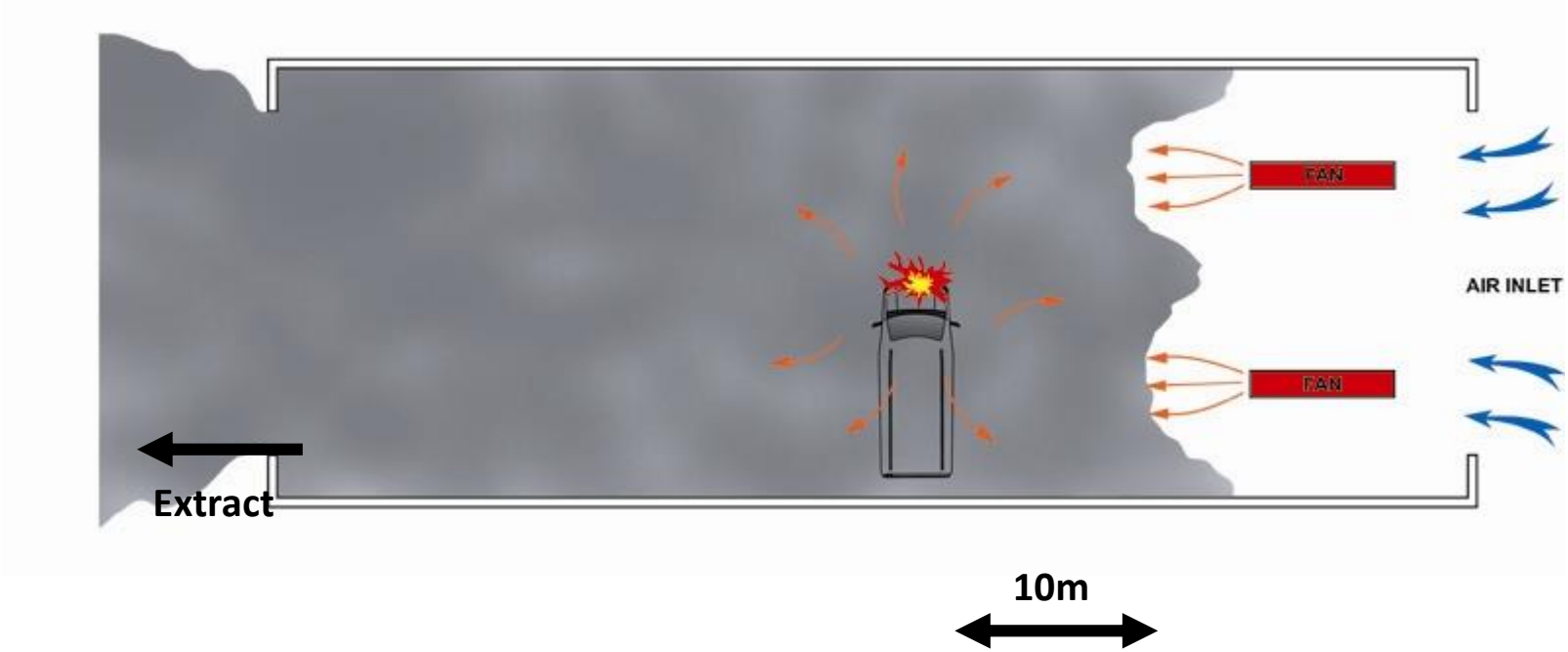
Unsprinklered: 20m Perimeter 8000 kW

Sprinklered 2 tier stack: 14m perimeter 6000kW

Smoke Control systems require calculation of the ceiling jet velocity and opposing this velocity with Jetstream/Cyclone fans to move the smoke in a particular direction, keeping the upstream location free of smoke.

Main extract fans need to remove the bulk air volume being moved down the car park so that smoke does not circulate behind Jetstream/Cyclone fans – can be much larger than a notional air change rate.






Smaller car parks – to assist fire fighting, smoke is pushed away from fire fighting access, allowing clear approach to within 10m of the fire.

**Single Zone Systems**

**To stop the flow of smoke:**

1. It is necessary to achieve the required velocity across the whole cross-sectional area

2. The extract rate must equal the bulk air movement, not 10 or 12 ACH.

   For wide car parks the flow rates become impractical with mechanical systems.

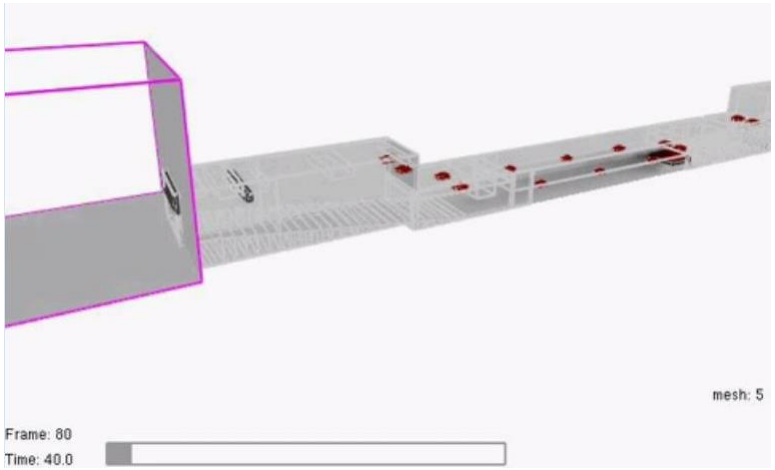
   Zoning becomes essential to overcome this.

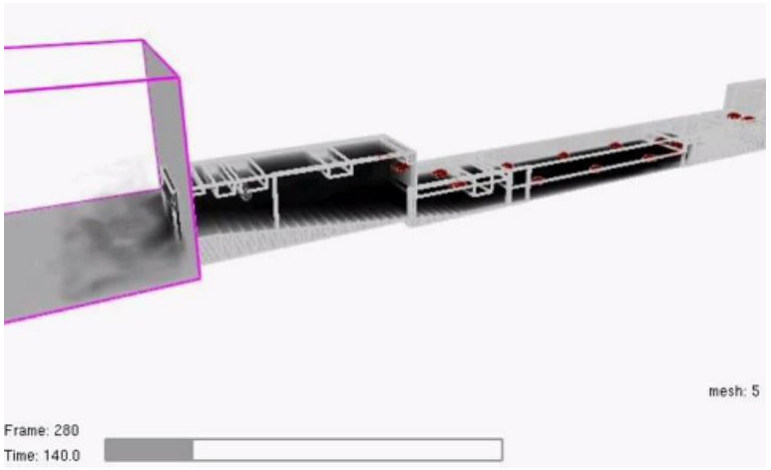
**The Shires Road Tunnel:**

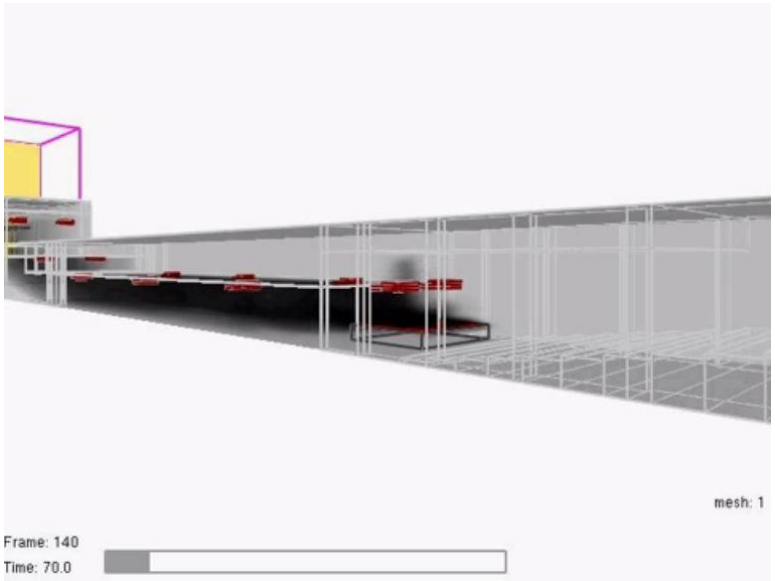
- Single direction traffic flow
- Cars only – 2 car fire = 8000kW
- Ventilation system uses Cyclones only to push smoke in direction of traffic flow, even in adverse wind.
- Directs smoke in one direction, allowing those trapped behind fire to evacuate on foot in safety
- No extract plant required

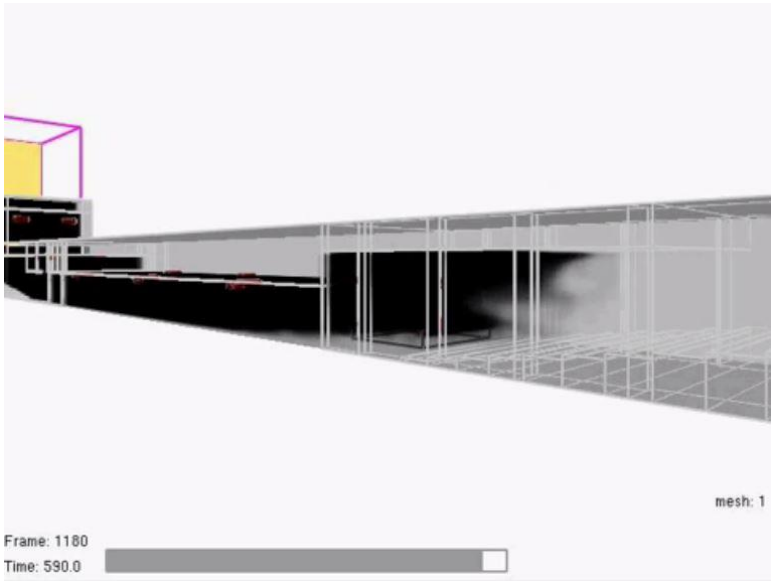
# Smoke Control Systems: Single Zone systems

Car Park Ventilation 2020



**Zonal Systems**

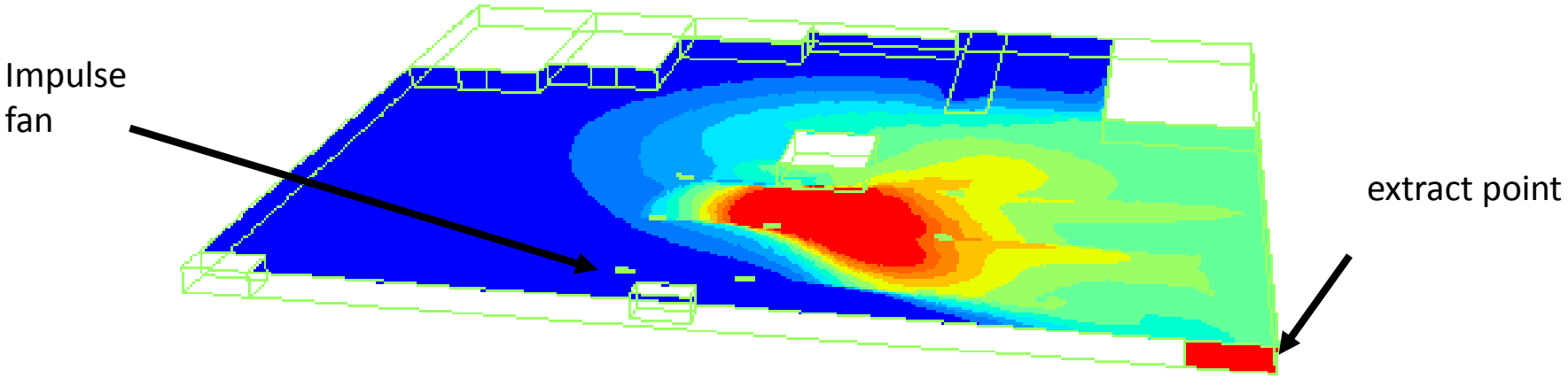
Larger projects must use a **'zonal' system** - In a fire, the use of selective fans upstream of the fire forces the smoke towards the extract point

**To stop the flow of smoke:**

1. It is necessary to achieve the required velocity across the cross-sectional area of the zone – some lateral spread should be expected.
2. The extract rate must equal the bulk air movement, not 10 or 12ACH.
3. The system must be linked to a zoned fire detection system so only the zone containing the fire activates.
4. Maximum zone size between 2 and 3,000m$^2$.
5. If fire fighting, limit smoke to maintain 10m visibility until within 10m of fire, if aiding escape, ensure available safe escape time exceeds the time that it takes for everyone to evacuate the car park.

# Smoke Control Systems: Zonal System

Car Park Ventilation 2020



# Smoke Control Systems: Case History

Car Park Ventilation 2020

**Liverpool One –** 4 Storey Enclosed Car Park

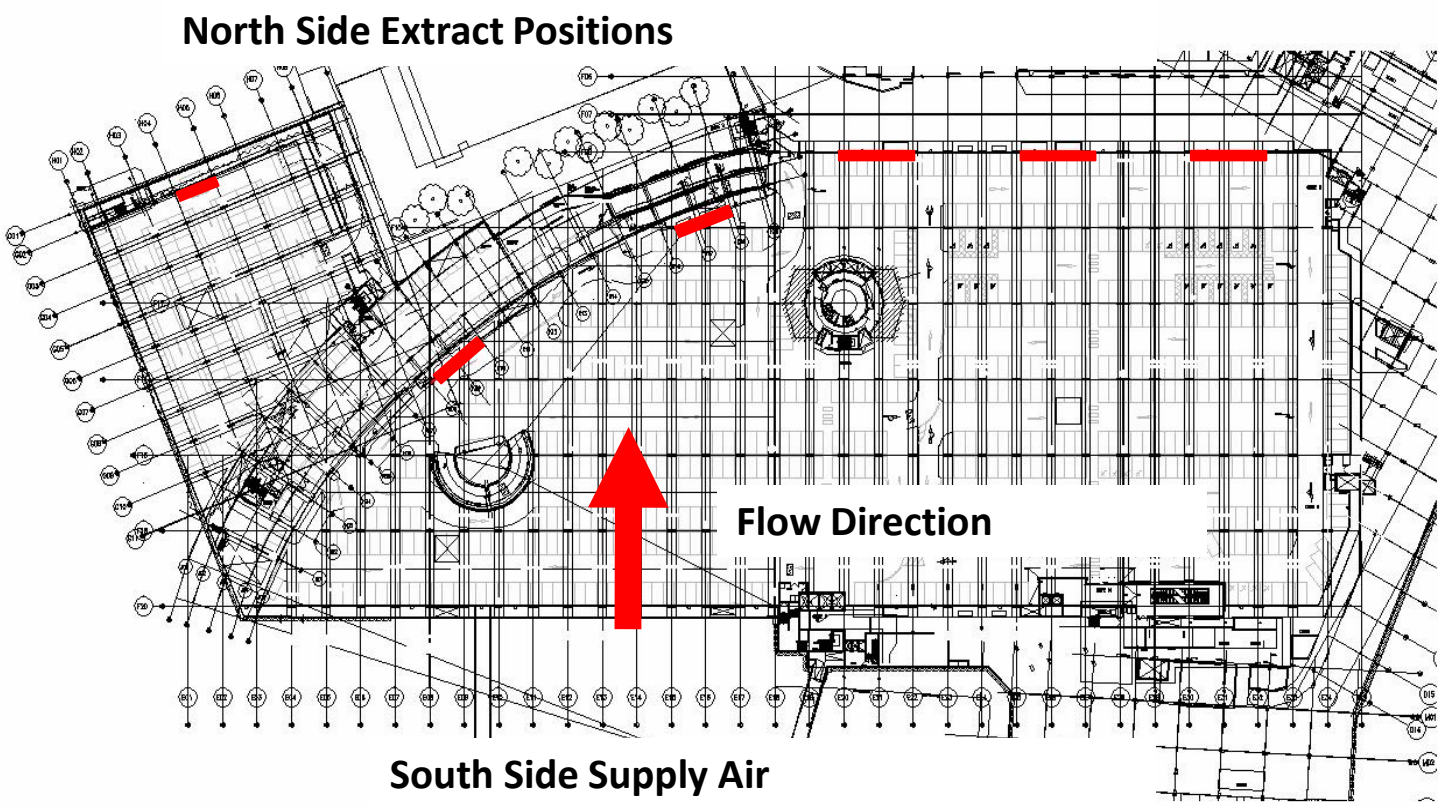
Due to the constraints of the site location, this car park did not meet current legislation for evacuation travel distances.

Colt provided a smoke control system with mechanical extract and supply, combined with induction fans to control smoke movement and assist escape and fire fighting, as well as providing general ventilation in normal conditions.

**Project Details**

- 4 levels of car parking, 2 of which measure approximately 300m x 100m with 30 Cyclones per level.
- 6 No Extract Points on North side of Car Park - controllable with a maximum of 200m$^3$/s.
- Supply air on South Side of Car Park – fixed locations with a maximum supply volume of 286m$^3$/s to all levels.
- Note: 10 ACH would have been around 150m$^3$/s.

## **Liverpool One -** The Project



**Liverpool One –** The Project

**Design Objectives**

**Escape Phase (0 to 10 minutes):**

A zonal system is used to control the smoke movement to a maximum zone width of 50m and a plan area of 2-3,000m$^2$ ensuring that extended travel distances do not compromise safety.

**Fire Fighting Phase (10 to 30 minutes):**

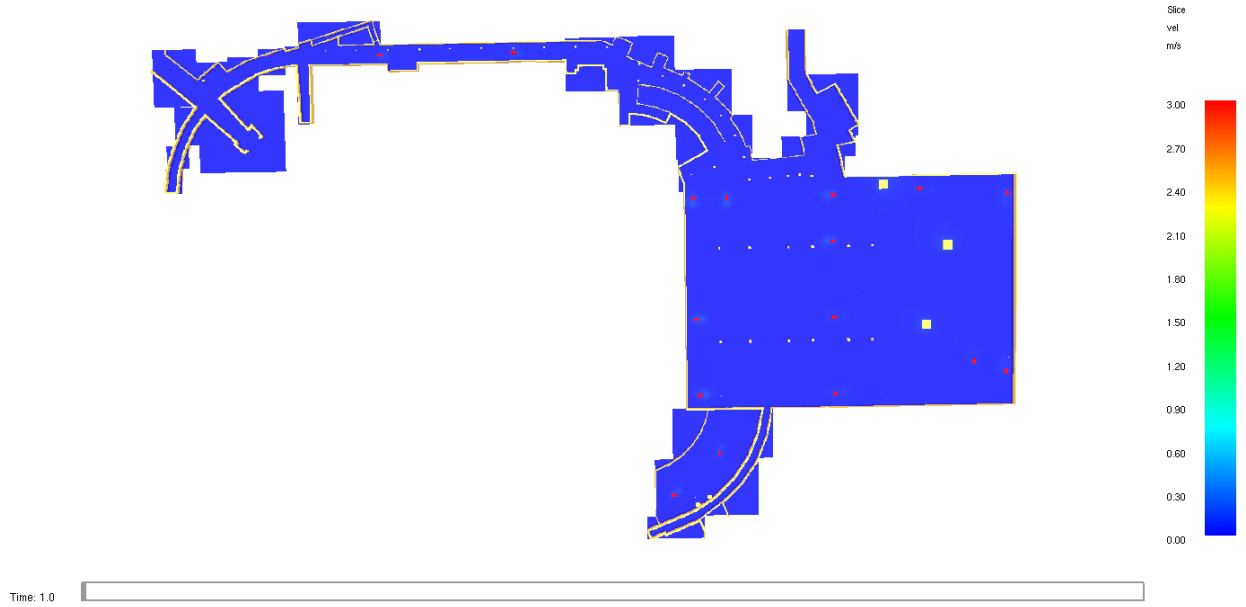
The zonal system ensures that fire can be approached from South Side in relatively clear conditions to within 10m of fire position, to assist fire fighting in lieu of sprinklers.

## **Liverpool One –** Using CFD

### CFD Case Study

Smoke flows in the car park were modelled using Computational Fluid Dynamics (CFD) to predict smoke flow from a number of fire scenarios.

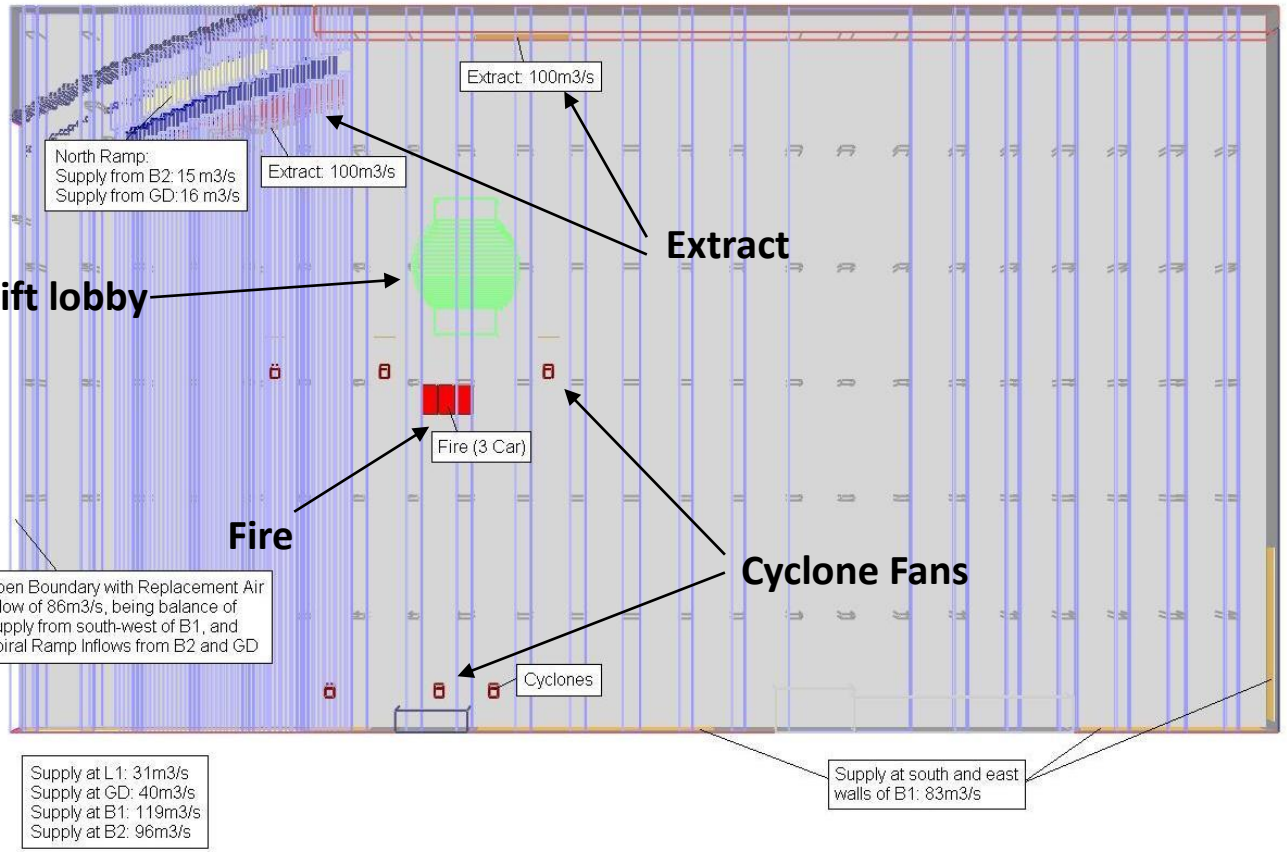
CFD is a complex computer model which in this case predicts smoke movement and temperatures through out the car park.



## **Liverpool One -** CFD Study

Design Fire Size: Initially a single car growing up to 4MW, decaying, and then spreading to two adjacent cars peaking at 9MW after around 20 minutes.

**Typical Fire location**

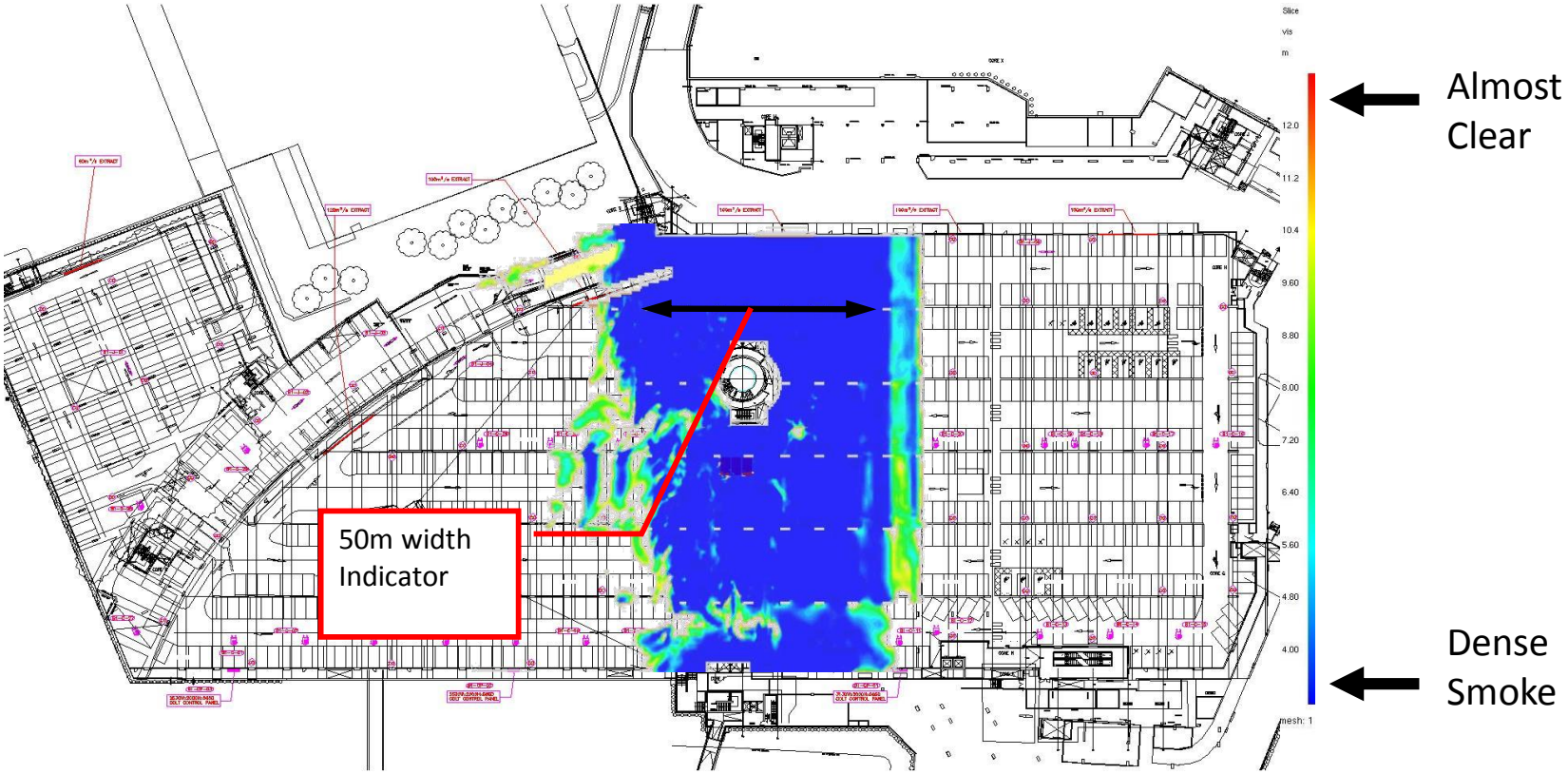


## **Liverpool One** - CFD Study

### Visibility at 10 minutes

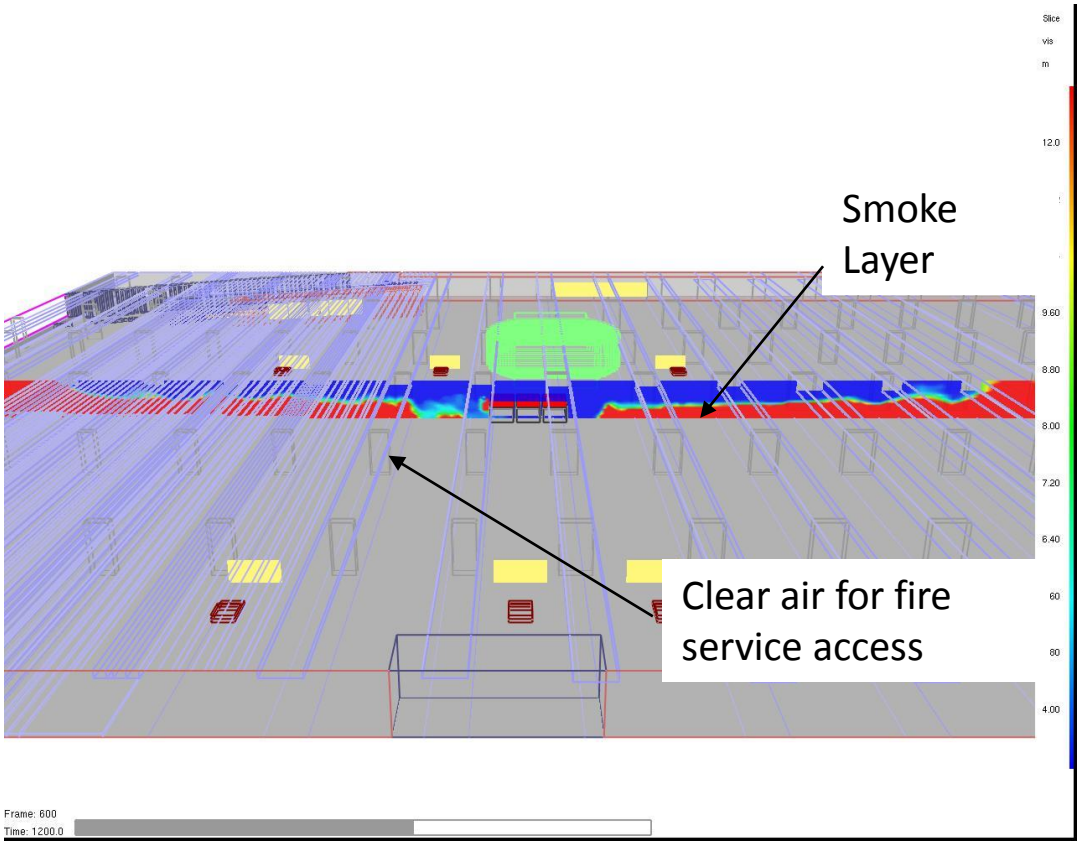
## **Liverpool One** - CFD Study

### Visibility at 20 minutes



**Liverpool One** - CFD Study

**Fire Position Four – Visibility Section at 20 minutes**



## Middlesbrough Fire Test

### Objectives

As part of the Liverpool One project real fire tests were carried out at a site in Middlesbrough:

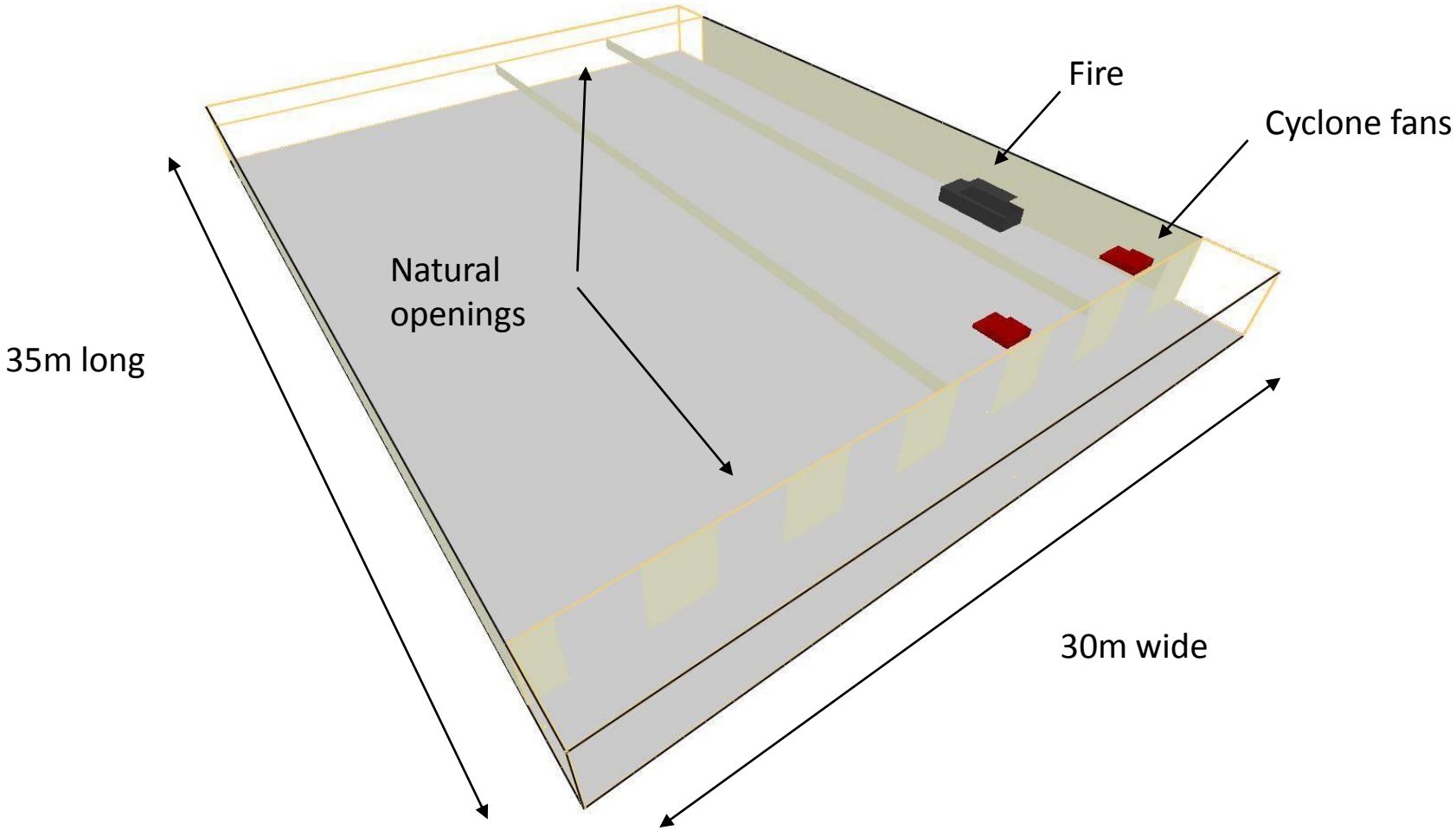
- To show that Induction fans can be used to control the spread of smoke, to assist both means of escape and fire-fighting.
- To demonstrate the effectiveness of CFD in predicting conditions in a car park with Induction fans.
- Fire Size scaled to 1MW

The tests were conducted by the Building Research Establishment (BRE), who constructed a scaffold test rig on an open air site in Middlesbrough.

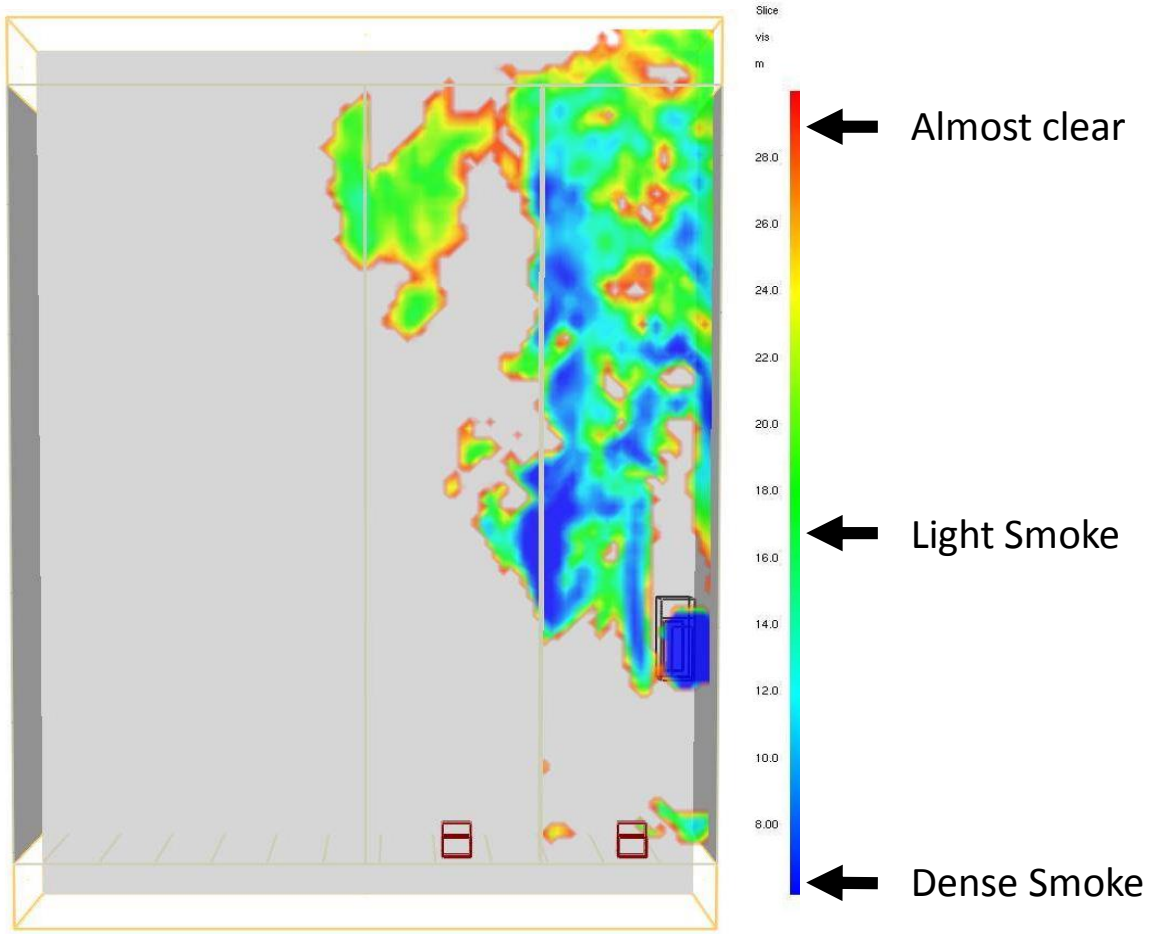
The rig had natural openings at either end which caused problems during the tests with changing wind directions - in one test, the wind was able to reverse the flow against the thrust of the Cyclone fans.

This clearly demonstrated the importance of careful attention to possible adverse wind pressures when designing smoke control systems.

## Middlesbrough Fire Test

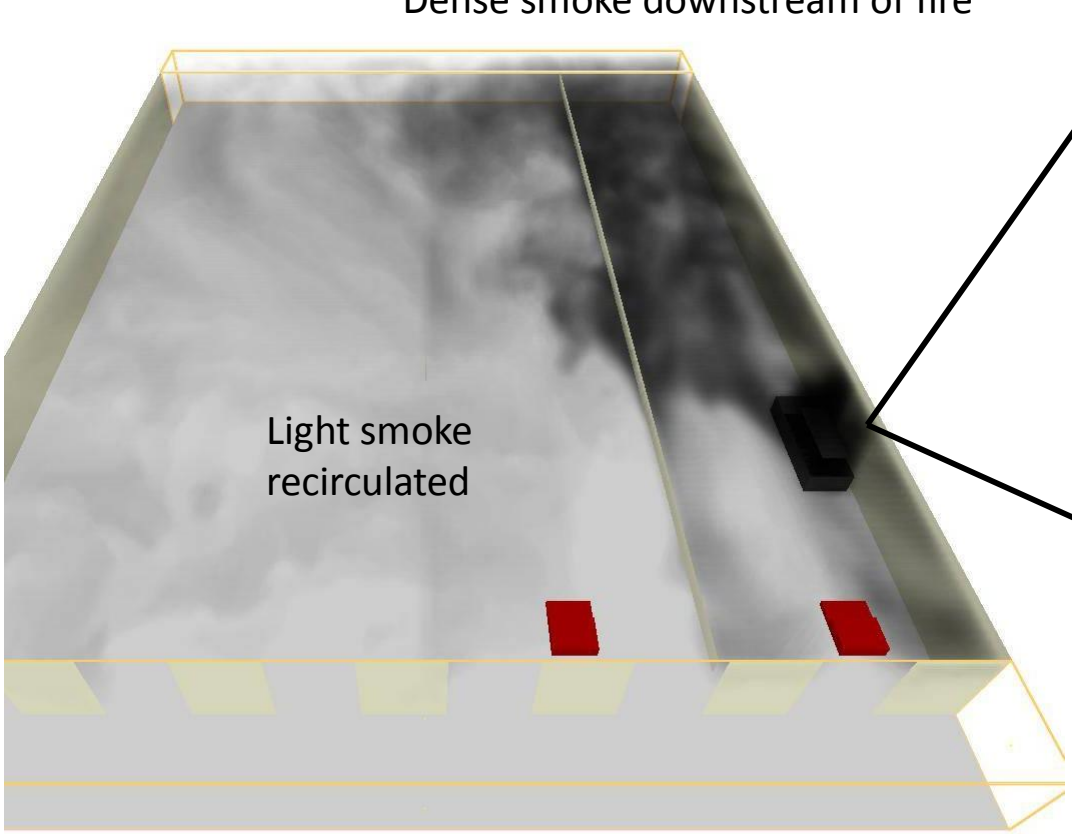


**Middlesbrough Fire Test**: Visibility at a height of 2m



**Middlesbrough Fire Test:** 3D visualisation of soot density

Dense smoke downstream of fire





Light smoke upstream

## Controls

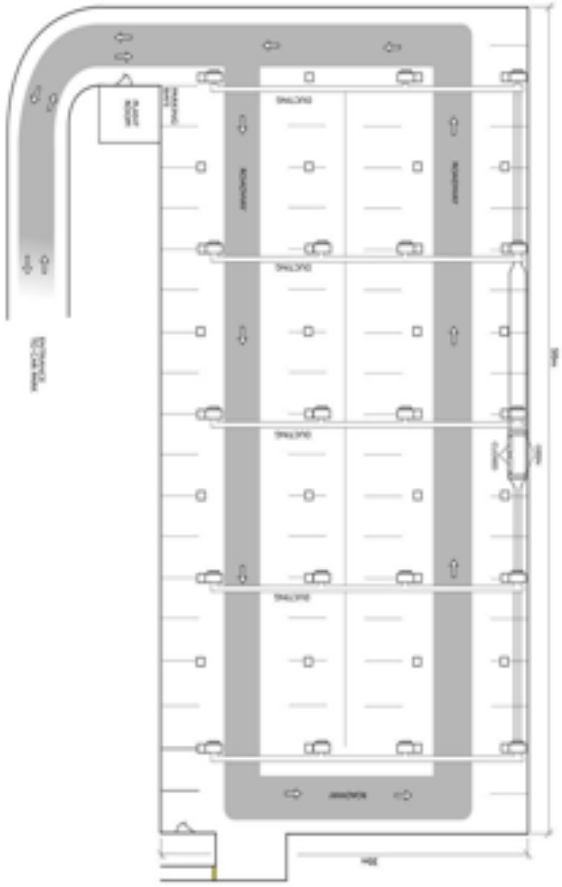
In general ventilation mode the system can be run continuously at 6ACH with the impulse fans at low speed, or linked into a CO detection system. This will allow the operation to be reduced during periods of low use, which can:

- Conserve energy consumption

- Reduce noise levels during periods of low activity.

## Air Changes

| | Main Extract Fans | Jetstream/Cyclone fans |
|---|---|---|
| Low CO (Below 15ppm) | 3 ACH | Off |
| Intermediate CO (15 to 30ppm) | 3 ACH | Low speed |
| High CO (30ppm and over) | 6 ACH | Low speed |



## Energy Efficiency

European Directives such as ErP are improving fan efficiencies, but could more be done?

Using the earlier example, let's suppose that removing the ducted system reduces the pressure drop by half – the power consumption of the extract fan goes down by almost 88%.

In comparison, both the Jestream (4 No) and the Cyclone solution (2 No) would add around 1.1kW at low speed

**Other ways to improve energy efficiency**

- Use dedicated high efficiency environmental fans for the fume ventilation rather than dual purpose smoke fans – would also allow use of EC motors

  - Requires increased space & investment, but costs less in the long run.

- Turn the fans off during periods of low occupancy

  - Currently ADF specifies the minimum vent rate of 3 ACH, but with CO monitoring & more attention on air quality this could be reduced. (e.g., temp, humidity, NOx)

- Increase the size of ducting and louvres to minimise pressure drops on extract fans

## Smoke Ventilation Controls

Smoke clearance systems will usually spread smoke across a large area of car park. It is usual, therefore, for the system to shut down on detection of fire for the initial escape period.

The system is usually re-started in fire mode automatically after a pre-determined time delay or manually by fire-fighter's override switch.

In fire mode extract fans and Cyclones/Jetstreams fans run at full speed.

The operation of smoke control systems will depend on the design objectives of the system and will be specific to the actual fire location.

## What's Next?

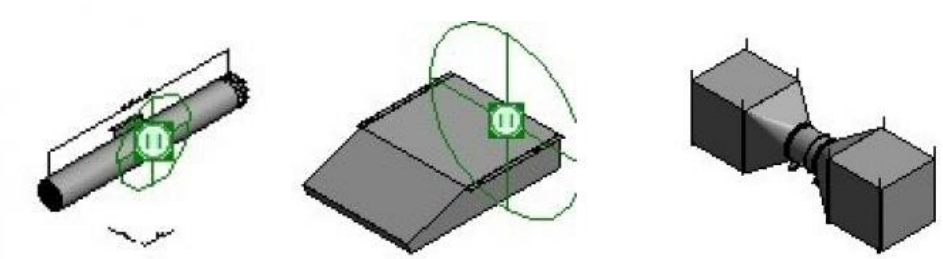
Traditional ducted ventilation systems have been almost completely replaced by Impulse or Induction type systems.

The advantages to all concerned using this method of ventilation is already being demonstrated in projects throughout the UK.

The design of these systems is becoming increasingly sophisticated, resulting in their use for means of escape as well as firefighting applications in the same way as other types of smoke control system have been used in the past.

**BIM**

Revit Models are available to download at www.coltinfo.co.uk/bim-download-area.html




**Whitepaper: Designing car park ventilation systems**

Download this and more at:

blog.coltinfo.co.uk/white-papers

# Q&A Session…