



Fläkt Woods
Academy of Excellence

Car Park Ventilation Using Thrust Fan Systems



Course Topics

- Introducing The Need For Car Park Ventilation
- Traditional Methods Vs Fläkt Woods Thrust Fan System
- The Benefits of Enhanced Design
- Product Range



Introducing The Need For Car Park Ventilation



Learning Objectives

- Recognise the Types of Car Park
- Understand the Regulations Behind Car Park Ventilation
- Appreciate Increased Design Requirements on Some Systems



Introducing The Need For Car Park Ventilation

- Above Ground Car Parks
- Below Ground Car Parks
- Loading Bays & Service Roads
- Short, Complex Tunnels

Introducing The Need For Car Park Ventilation

- Above Ground Car Parks



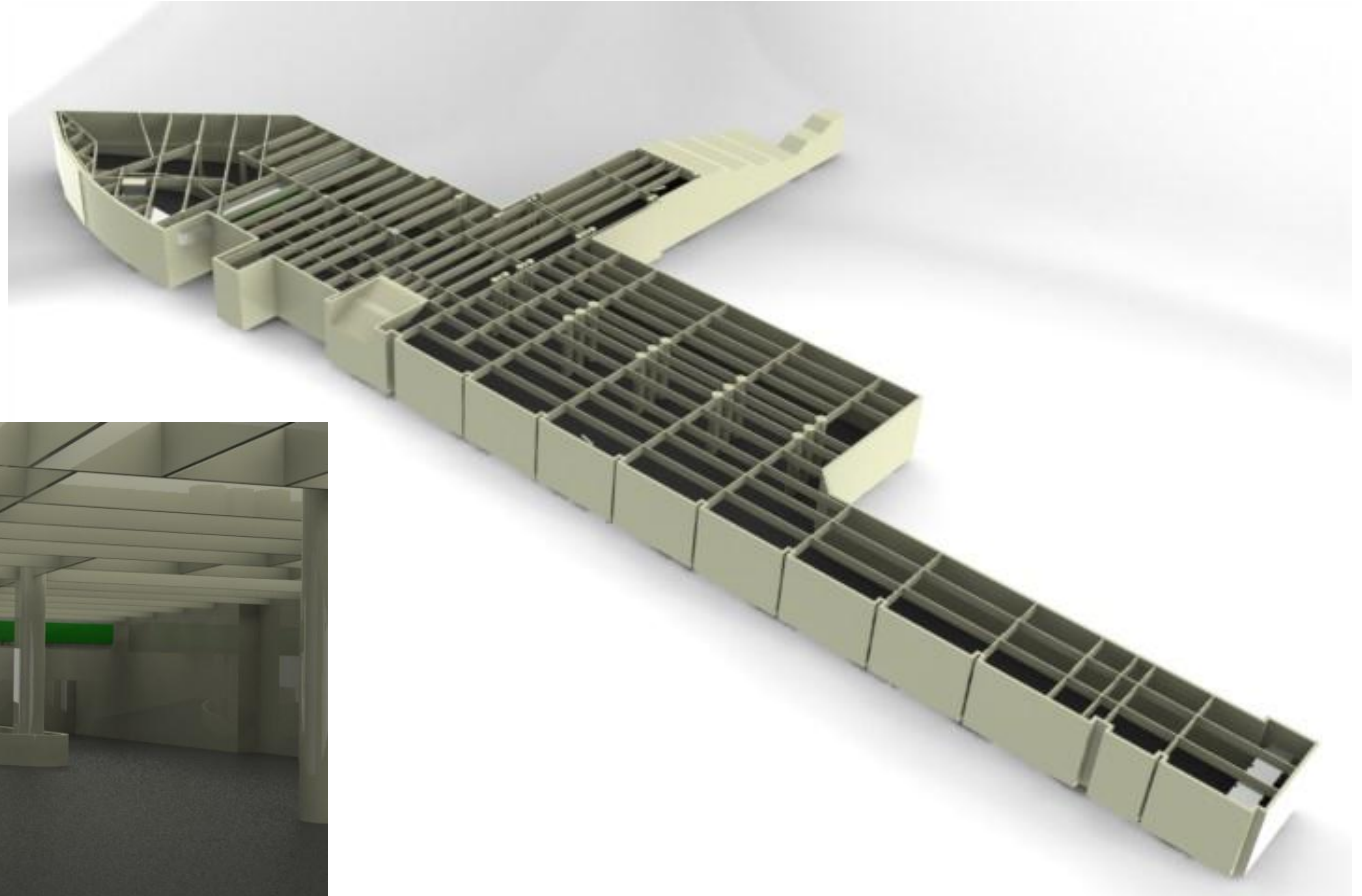
Introducing The Need For Car Park Ventilation

- Below Ground Car Parks



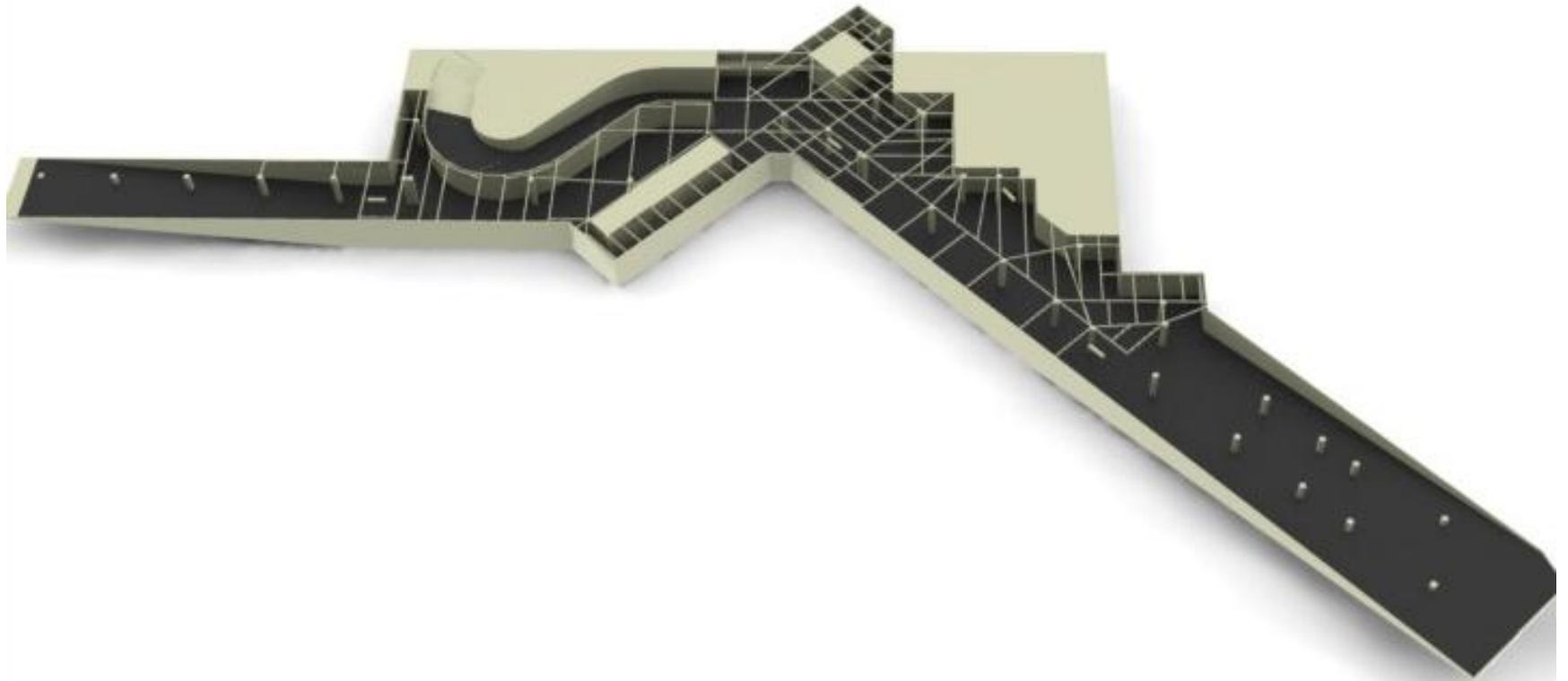
Introducing The Need For Car Park Ventilation

- Loading Bays & Service Roads



Introducing The Need For Car Park Ventilation

- Short, Complex Tunnels





Introducing The Need For Car Park Ventilation

UK Regulations:

- Approved Document B: Fire Safety
- Approved Document F: Ventilation
- BS 7346 Part 7, 2006



Introducing The Need For Car Park Ventilation

Approved Document B: Fire Safety

- Ventilation based on volume of space, 10 Air Changes Per Hour [AC/H]
- Fans rated 300 Deg C 60 minutes
- Extract volume divided between at least 2 fans
- Ductwork rated 800 Deg C
- Or on provision of natural openings:
 - 1/40th floor area split across 2 opposite faces, or in the ceiling.



Introducing The Need For Car Park Ventilation

Approved Document F: Ventilation

- Ventilation based on volume of space, 6 AC/H
- Or on provision of natural openings:
- 1/40th floor area split across at-least 2 opposite faces + 3AC/H extract
- 1/20th floor area split across at-least 2 opposite faces



Introducing The Need For Car Park Ventilation

BS 7346 Part 7, 2006

- Ventilation based on volume of space, 10 AC/H
- Or based on the smoke release rate from a design fire [4 or 8 MW]
- Used for increased life-safety, fire-fighter access, or where sprinklers are not provided



Topic Summary

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Traditional Methods Vs Fläkt Woods Thrust Fan System

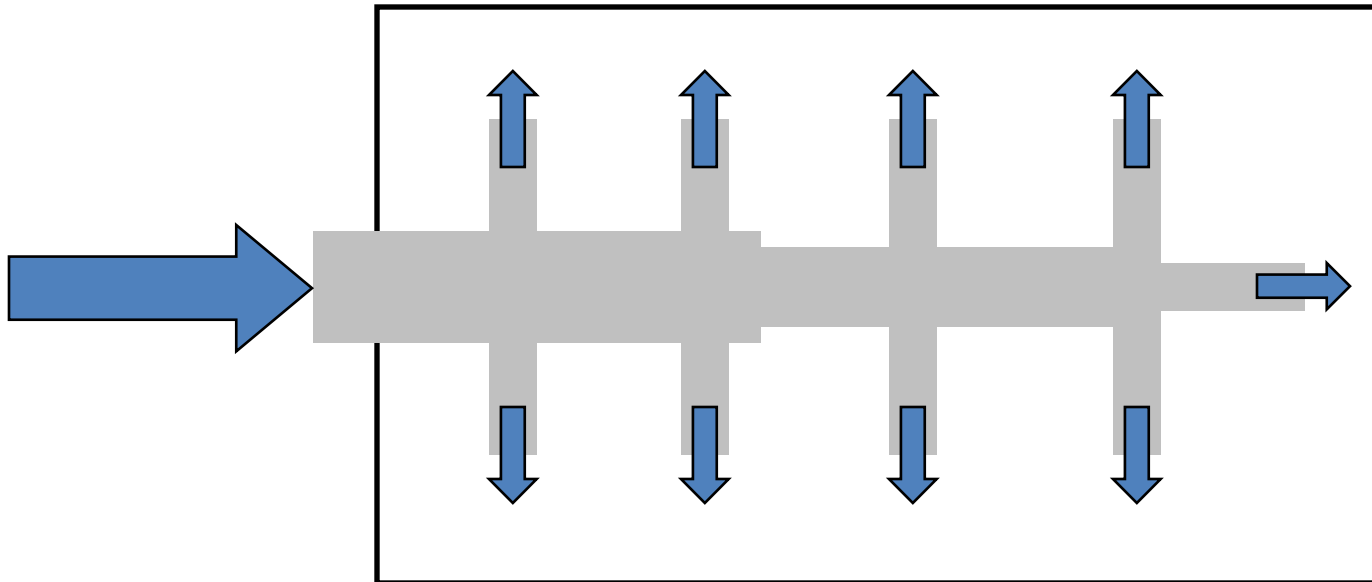


Learning Objectives

- Understand the Limitations of Ducted Systems
- Design Uni-Direction Thrust Fan Systems
- Introduce Truly Reversible Thrust Fan Systems
- Review of Systems Available

Traditional Methods Vs Fläkt Woods Thrust Fan System

Traditional supply ducting (NOT car parks):



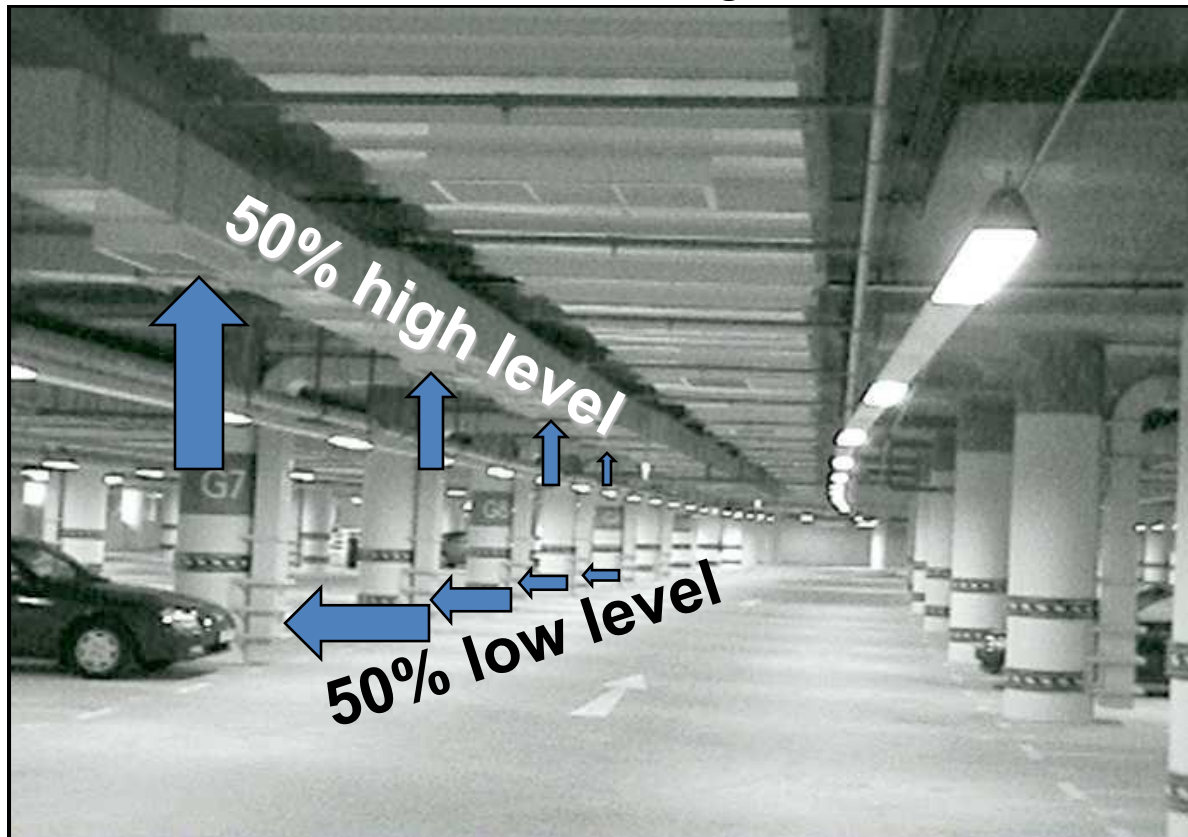
air is *supplied* in a controlled manner

to where it is required

Traditional Methods Vs Fläkt Woods Thrust Fan System

Traditional ducted car park system:

air is EXTRACTED through the ducts



air supply is *uncontrolled*

Traditional Methods Vs Fläkt Woods Thrust Fan System

Problems With Traditional Duct-work:





Traditional Methods Vs Fläkt Woods Thrust Fan System

Fläkt Woods Thrust Fan car park system:

- Main extract fans give air change rate
- Supplied air from entrance/exit ramps, fresh air openings or supply fans.
- Jet Thrust Fans control supply air.

Traditional Methods Vs Fläkt Woods Thrust Fan System

Fläkt Woods Jet Thrust Fan car park system:

Main extract fans:



Two fans
extracting
50% each

Traditional Methods Vs Fläkt Woods Thrust Fan System

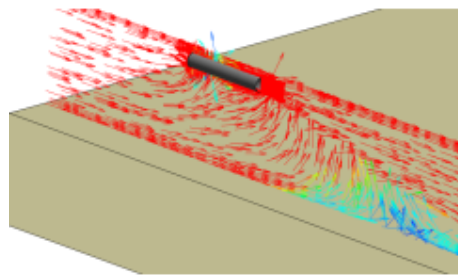
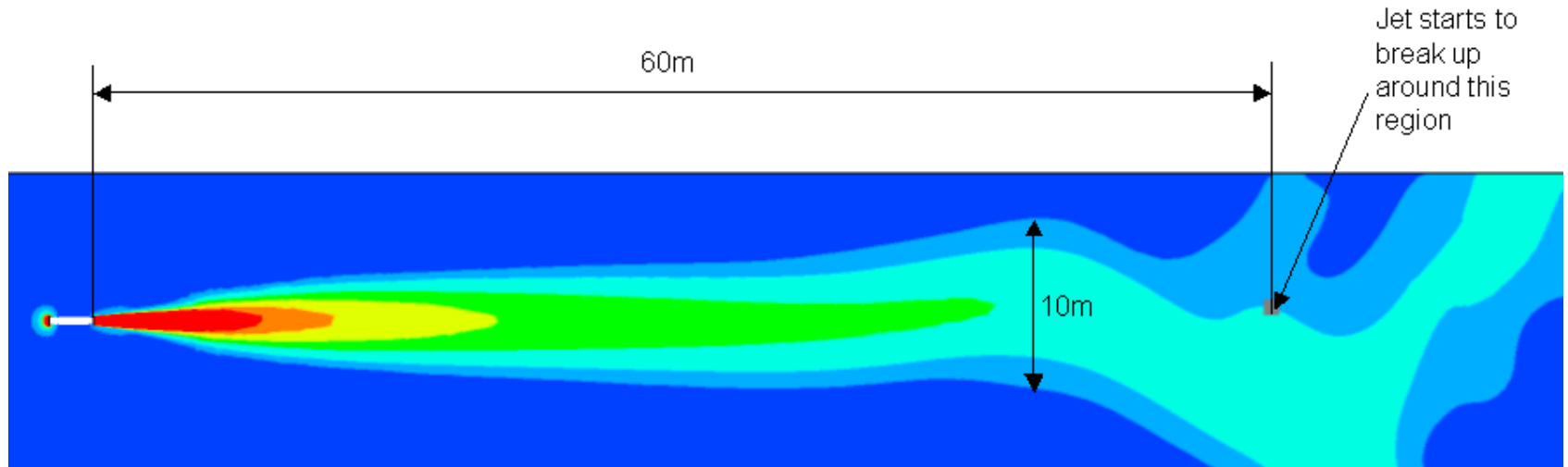
Fläkt Woods Thrust Fan car park system:



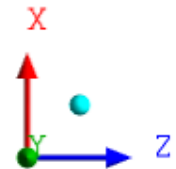
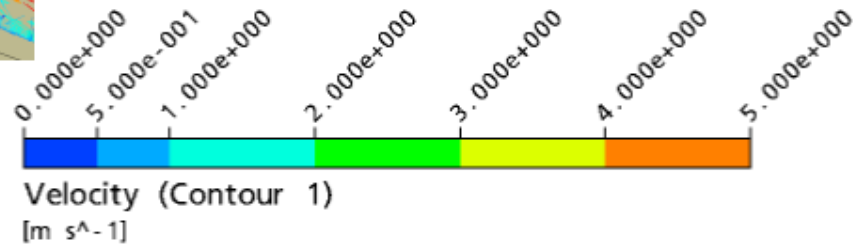
Jet Thrust Fan

Traditional Methods Vs Fläkt Woods Thrust Fan System

Fläkt Woods Jet Thrust Fan car park system:



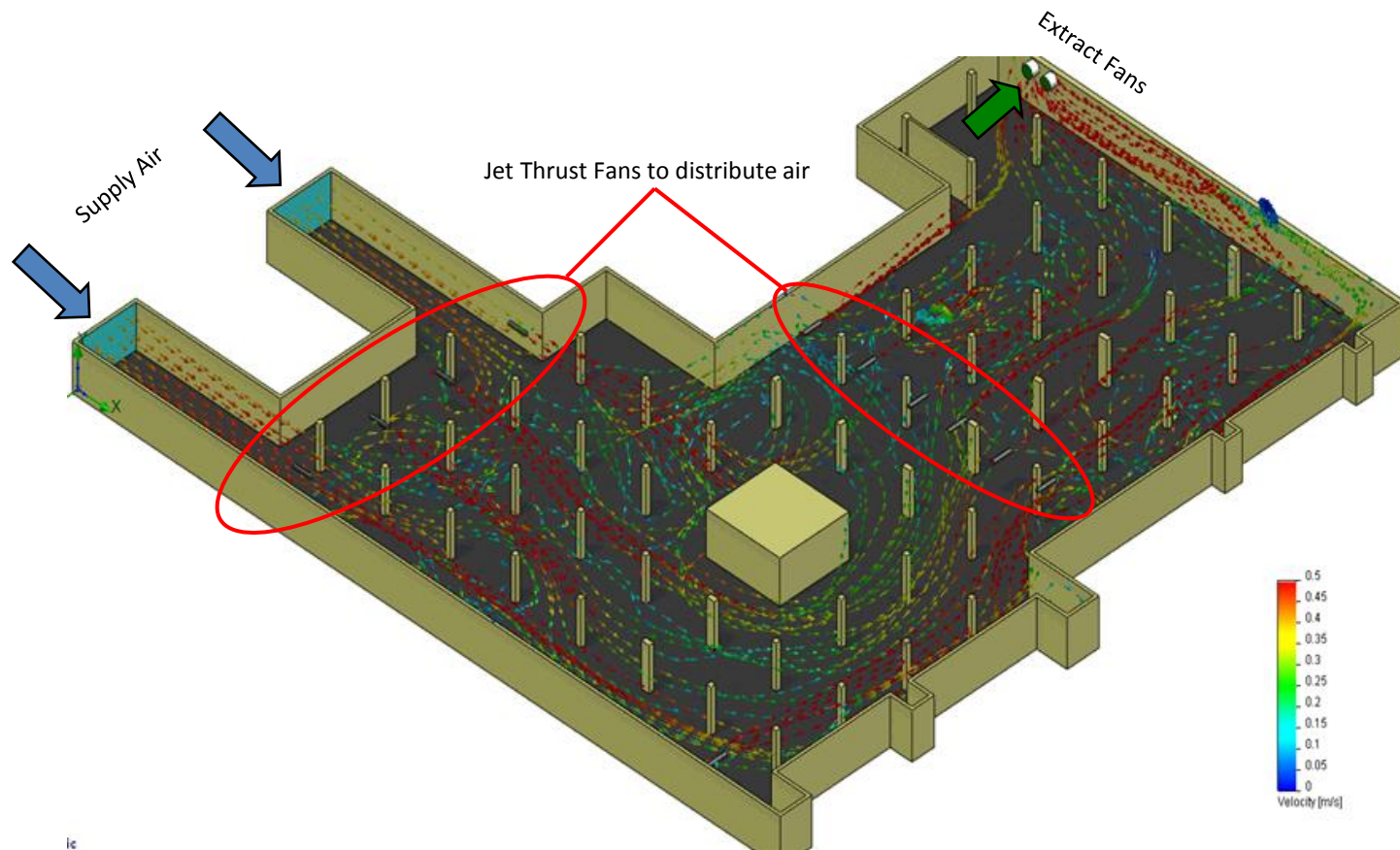
Velocity vectors through fan centreline – showing entrainment from low level



Jet Thrust Fan - air entrainment

Traditional Methods Vs Fläkt Woods Thrust Fan System

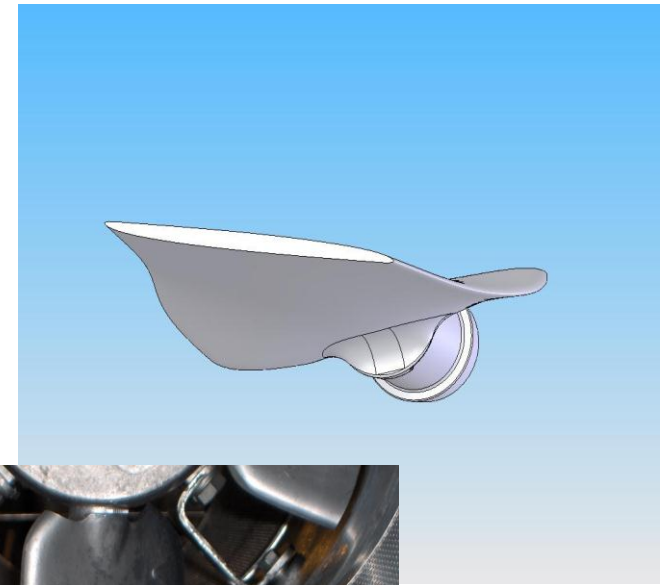
Fläkt Woods Jet Thrust Fan car park system:



ic

Traditional Methods Vs Fläkt Woods Thrust Fan System

- Truly Symmetrical profile
- high efficiency impeller
 - fully reversible
- 100% thrust in both directions
- Unique to Fläkt Woods



Traditional Methods Vs Fläkt Woods Thrust Fan System



Uni-directional blade section

- can only operate at 67% efficiency in reverse



'TS' blade section

- can operate at 100% efficiency in reverse



Traditional Methods Vs Fläkt Woods Thrust Fan System

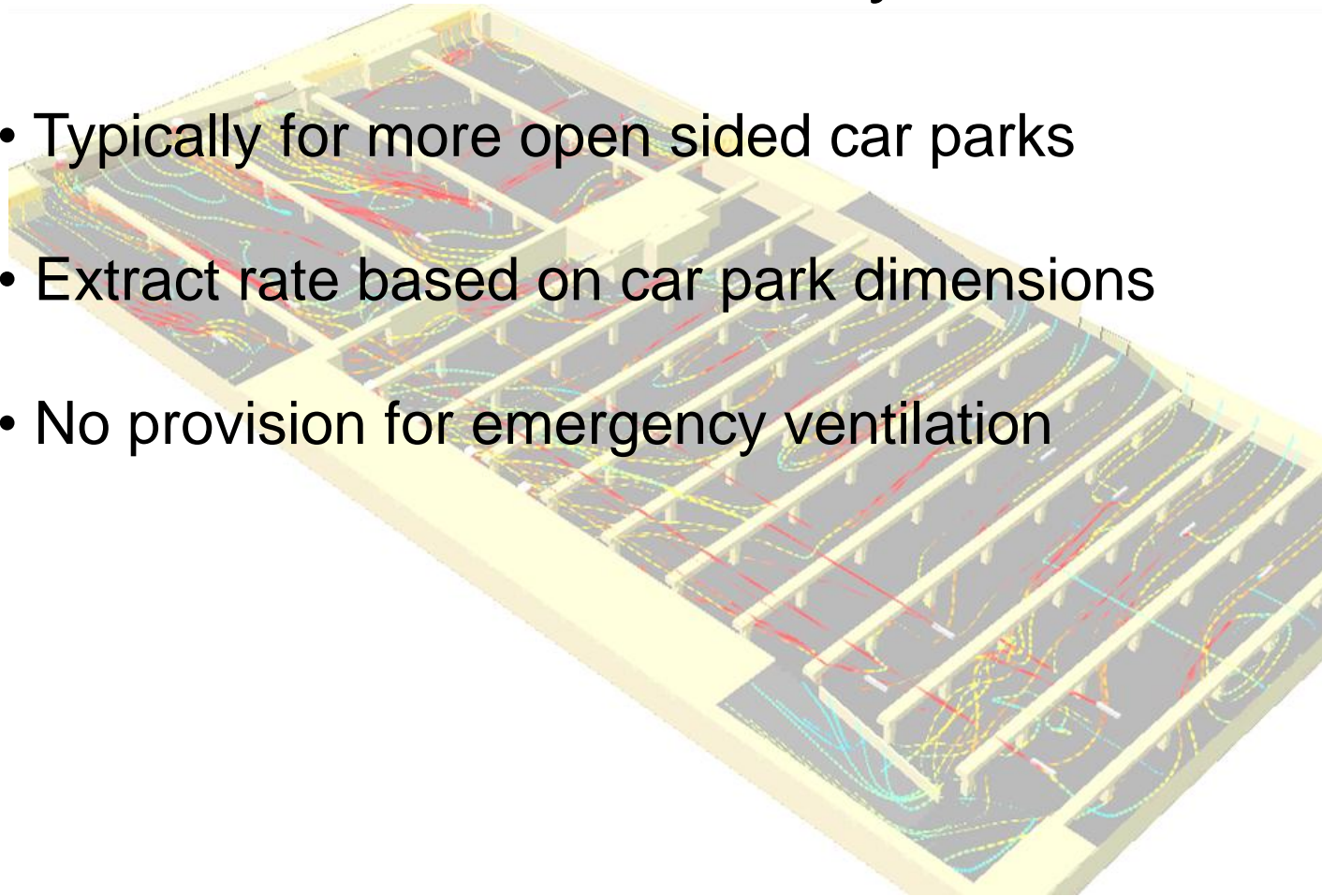
Types of systems

- Pollution only
- Smoke clearance / purging
- Smoke control

Traditional Methods Vs Fläkt Woods Thrust Fan System

Pollution Only

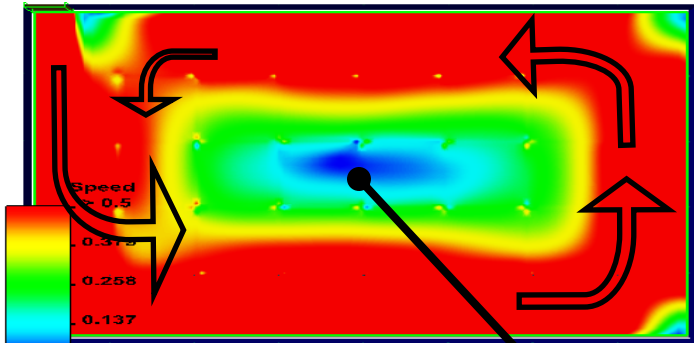
- Typically for more open sided car parks
- Extract rate based on car park dimensions
- No provision for emergency ventilation



Traditional Methods Vs Fläkt Woods Thrust Fan System

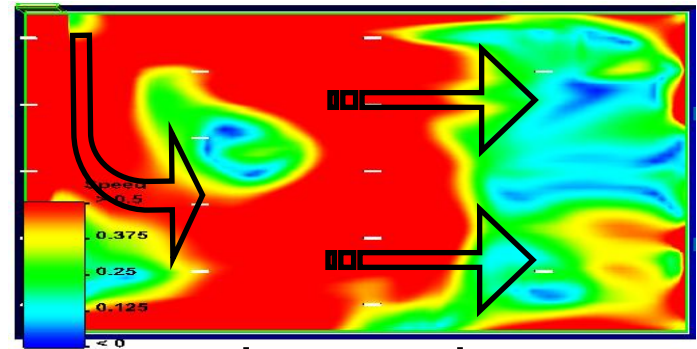
ducted system - 100 extract points

Jet Thrust System - 16 Jet Thrust Fans



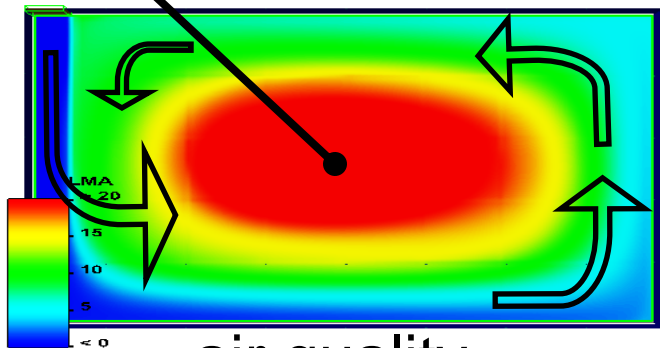
air speed

area of still air



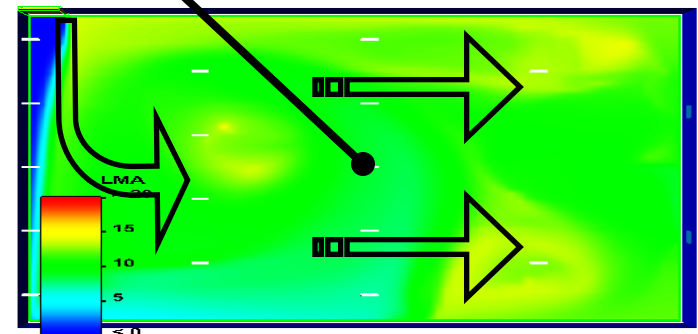
air speed

area of stagnant air



air quality

even distribution of clean air

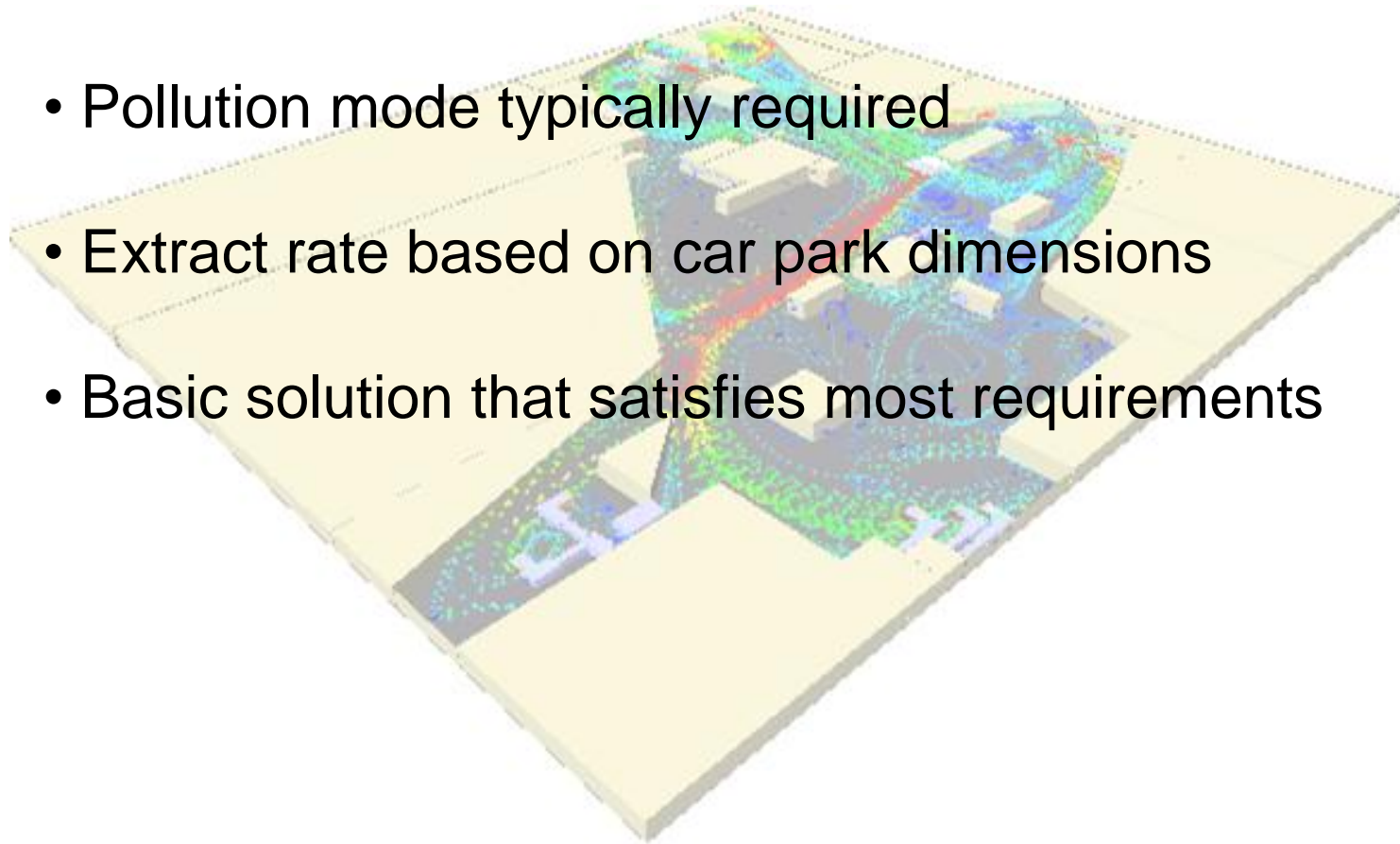


air quality

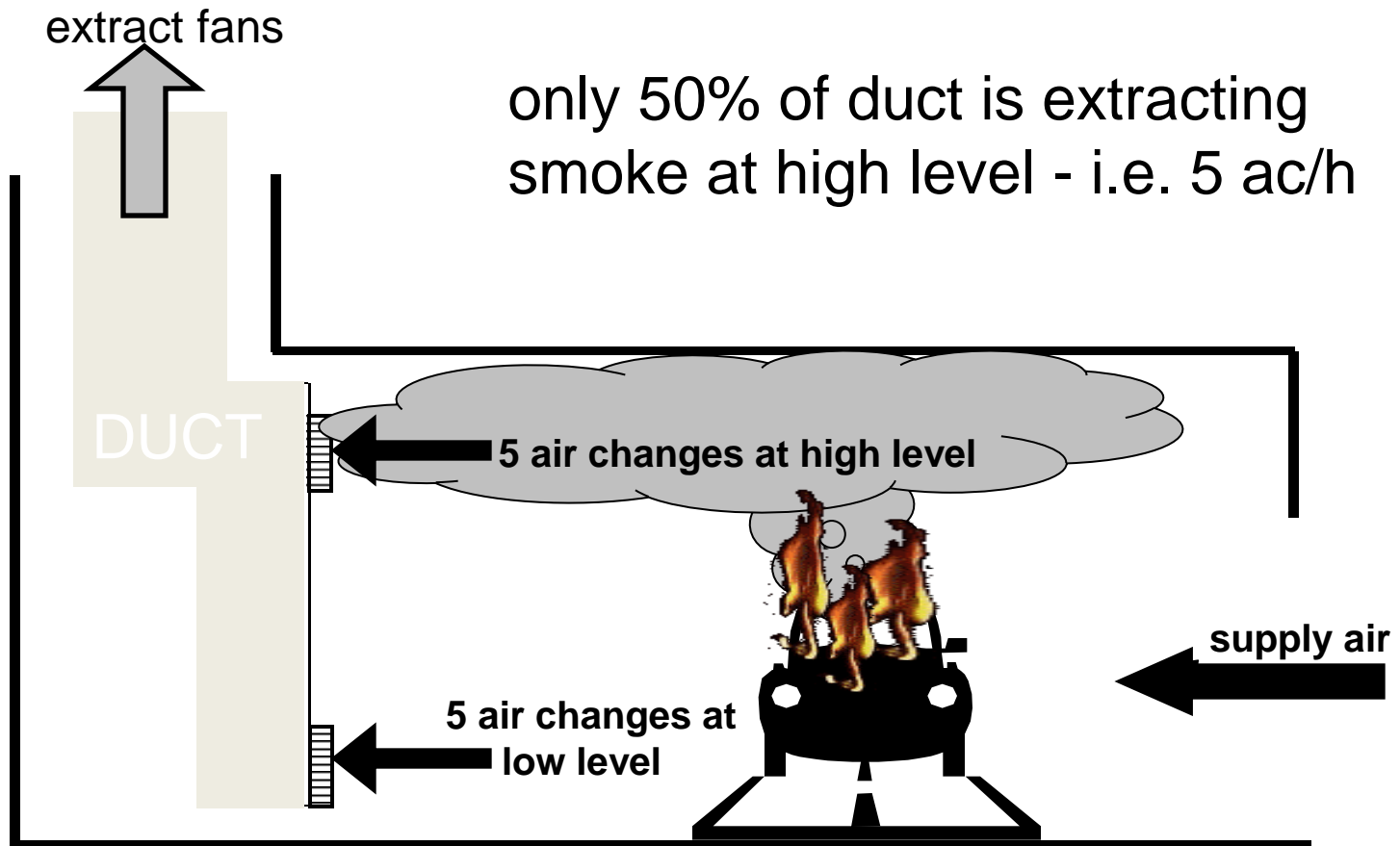
Traditional Methods Vs Fläkt Woods Thrust Fan System

Fire Smoke Purging (smoke clearance systems)

- Pollution mode typically required
- Extract rate based on car park dimensions
- Basic solution that satisfies most requirements

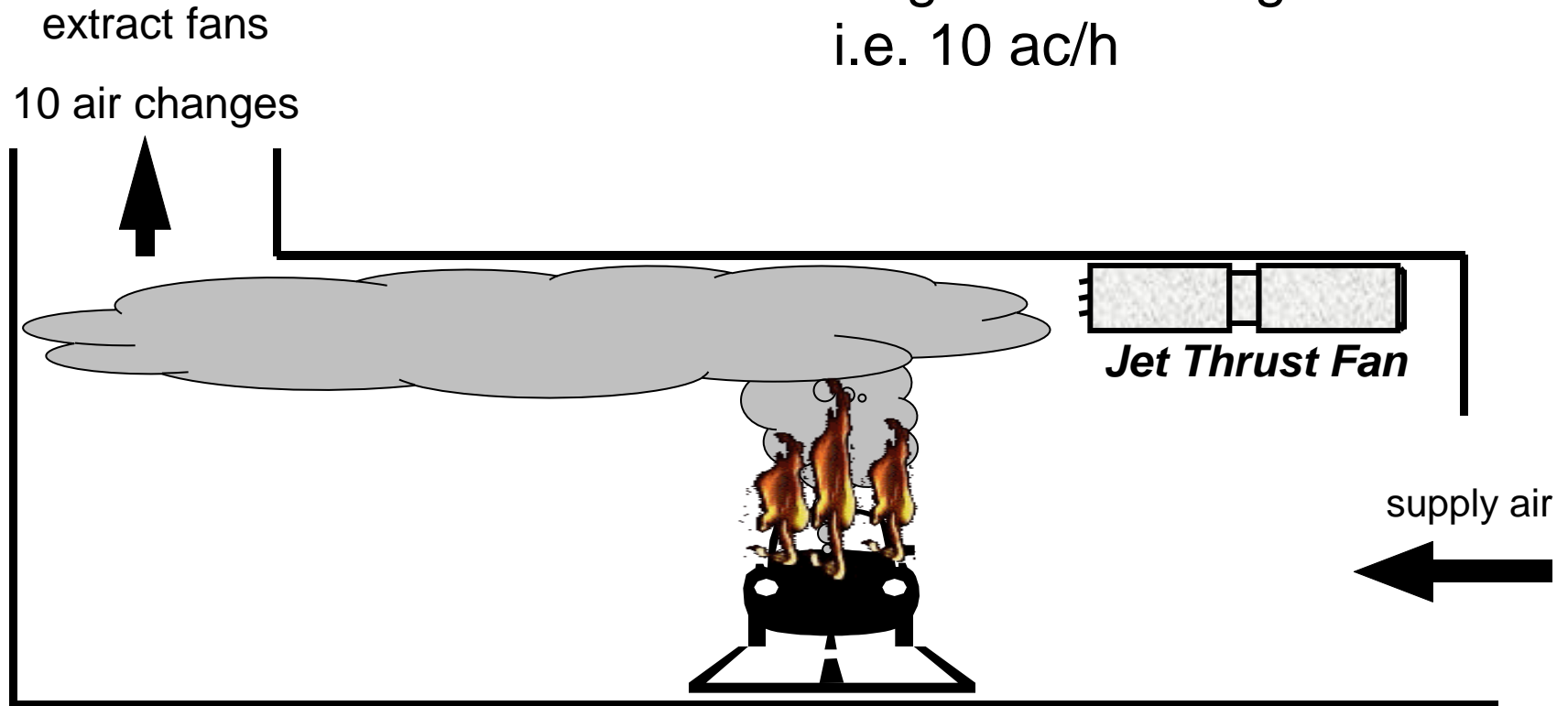


Traditional Methods Vs Fläkt Woods Thrust Fan System



Traditional Methods Vs Fläkt Woods Thrust Fan System

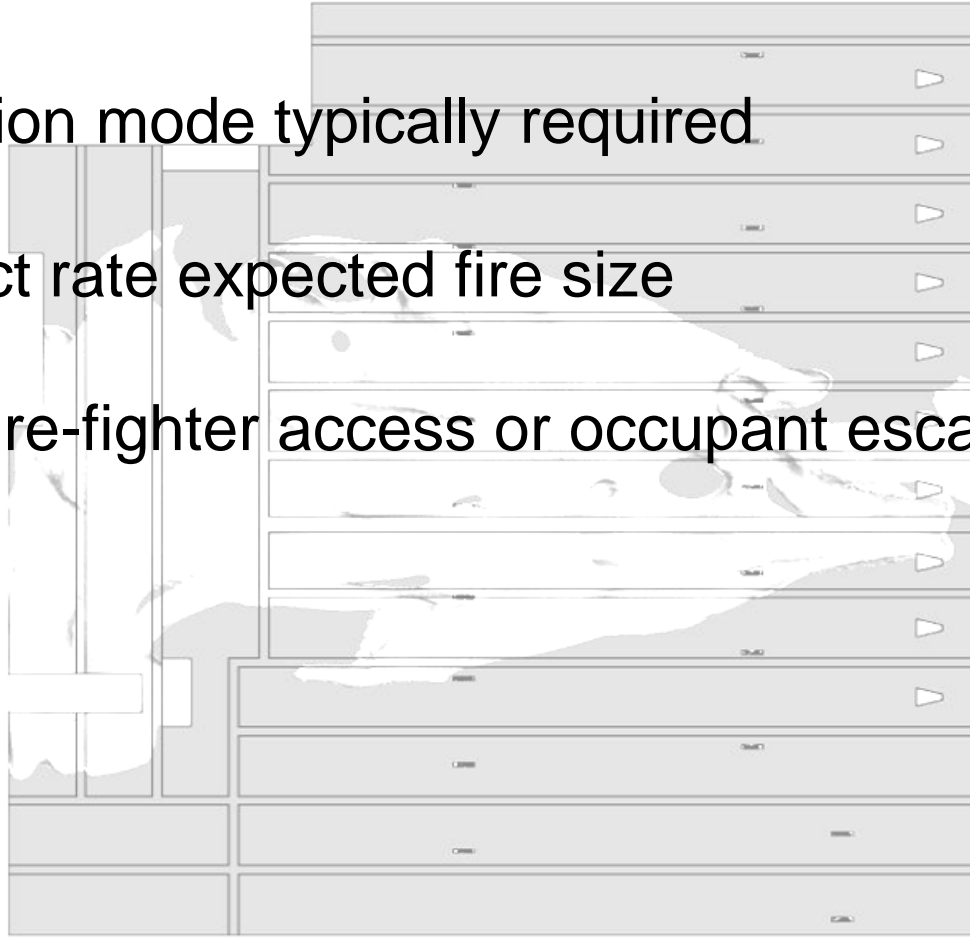
100% is extracting smoke at high level -
i.e. 10 ac/h



Traditional Methods Vs Fläkt Woods Thrust Fan System

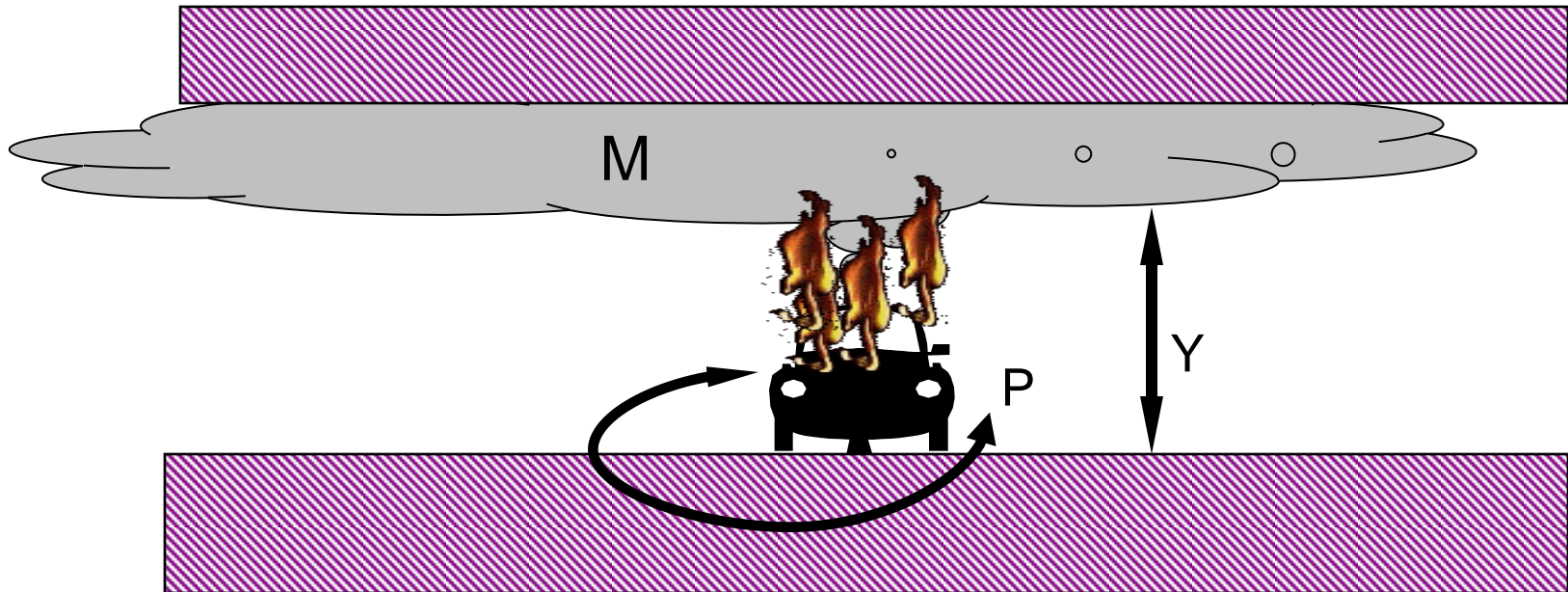
Fire Smoke Control

- Pollution mode typically required
- Extract rate expected fire size
- Aids fire-fighter access or occupant escape



Traditional Methods Vs Fläkt Woods Thrust Fan System

calculation of the rate of fire smoke production



where:

$$M = C_e P Y^{3/2}$$

M = Mass rate of smoke production.(kg/sec)

P = Perimeter of fire (m)

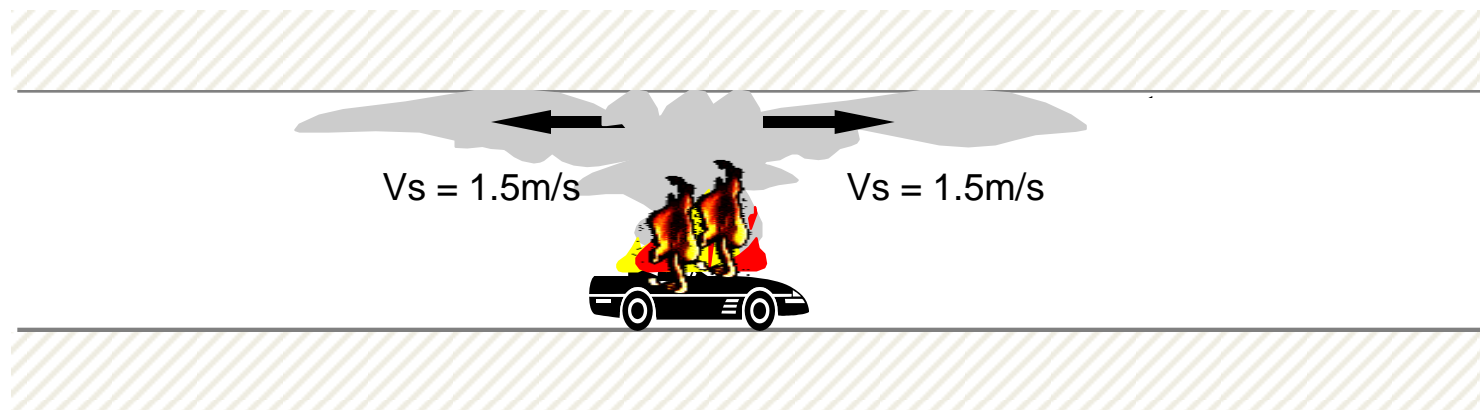
Y = Height of clear layer (m)

C_e = Constant

BRE 368

Traditional Methods Vs Fläkt Woods Thrust Fan System

SMOKE VELOCITY (V_s)

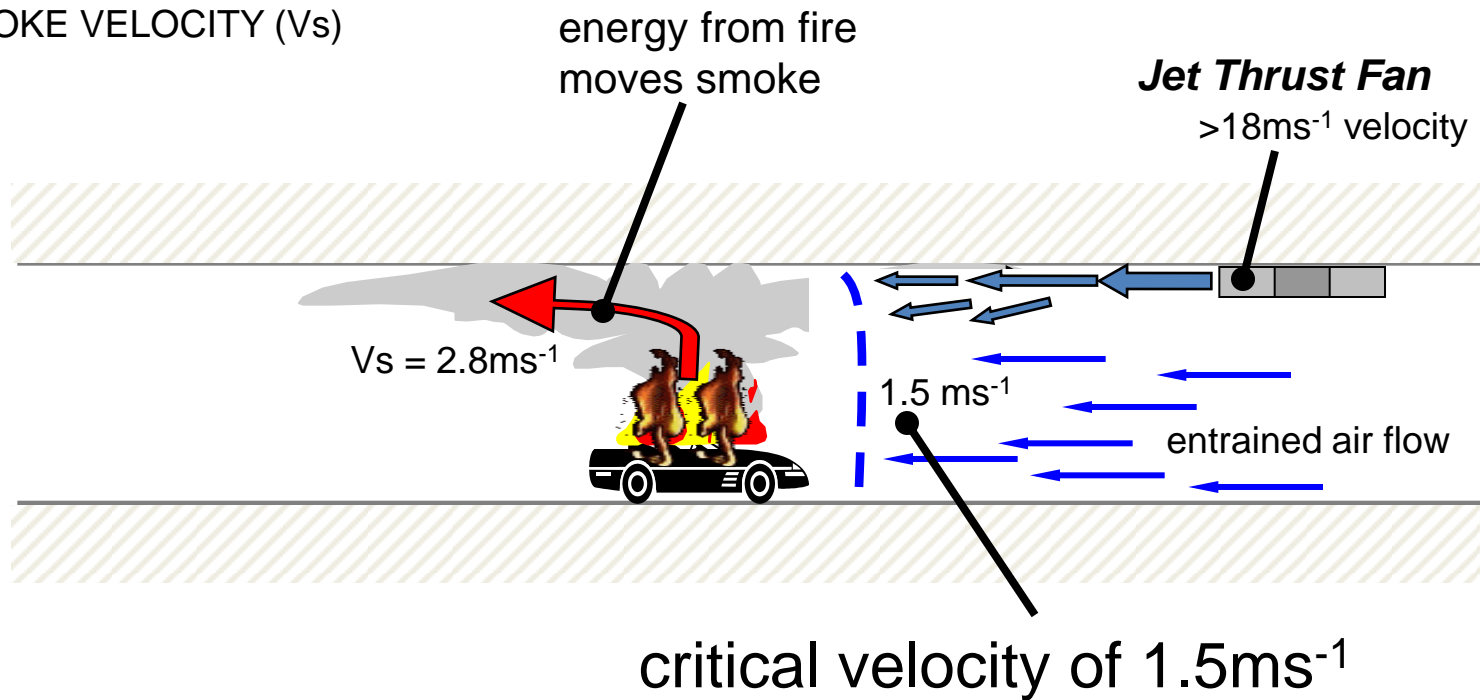


where: tunnel: 10m (w) x 5m (h)
car fire 8MW

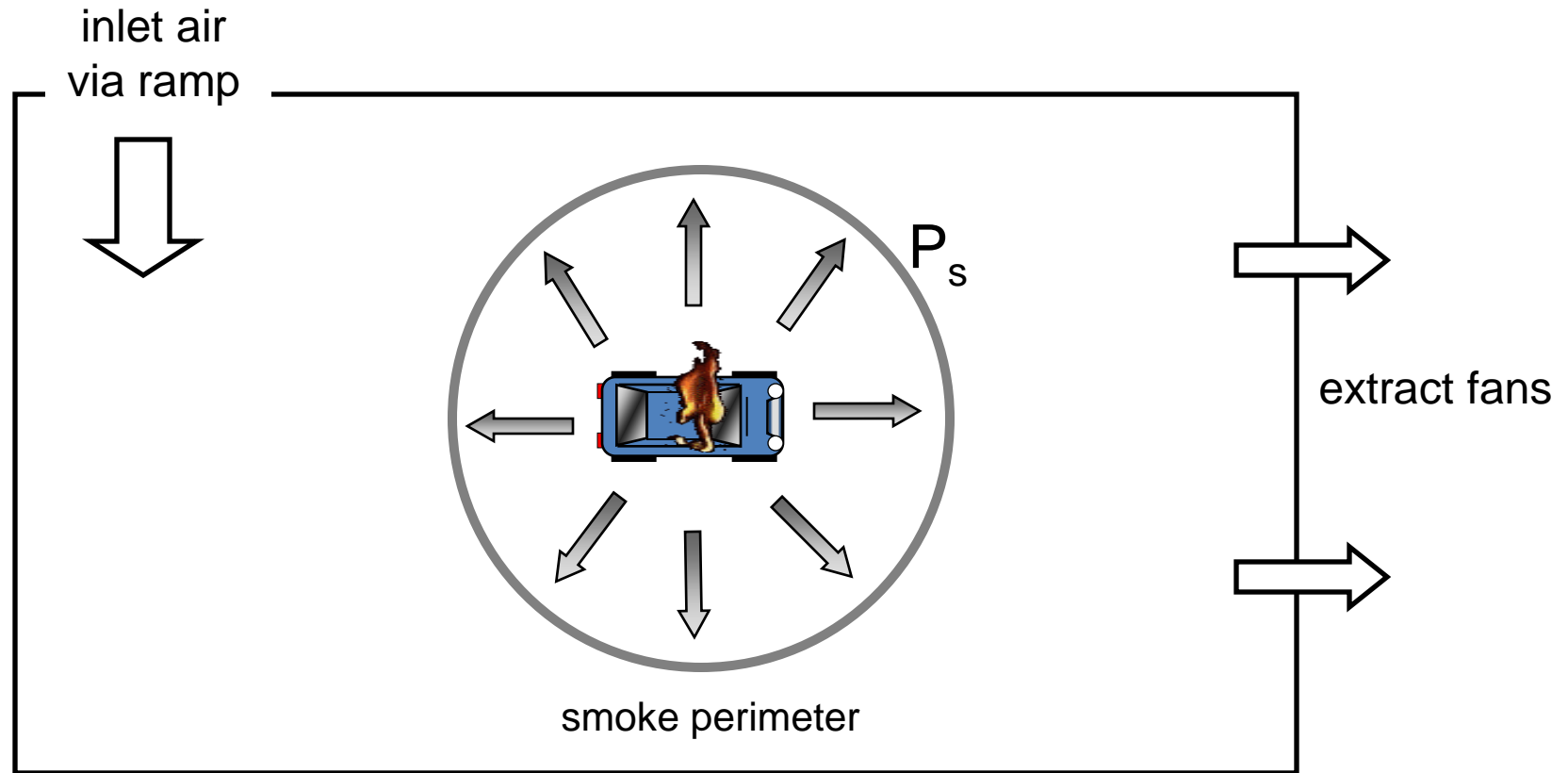
* based on Heselden's method of predicting smoke velocity

Traditional Methods Vs Fläkt Woods Thrust Fan System

SMOKE VELOCITY (V_s)

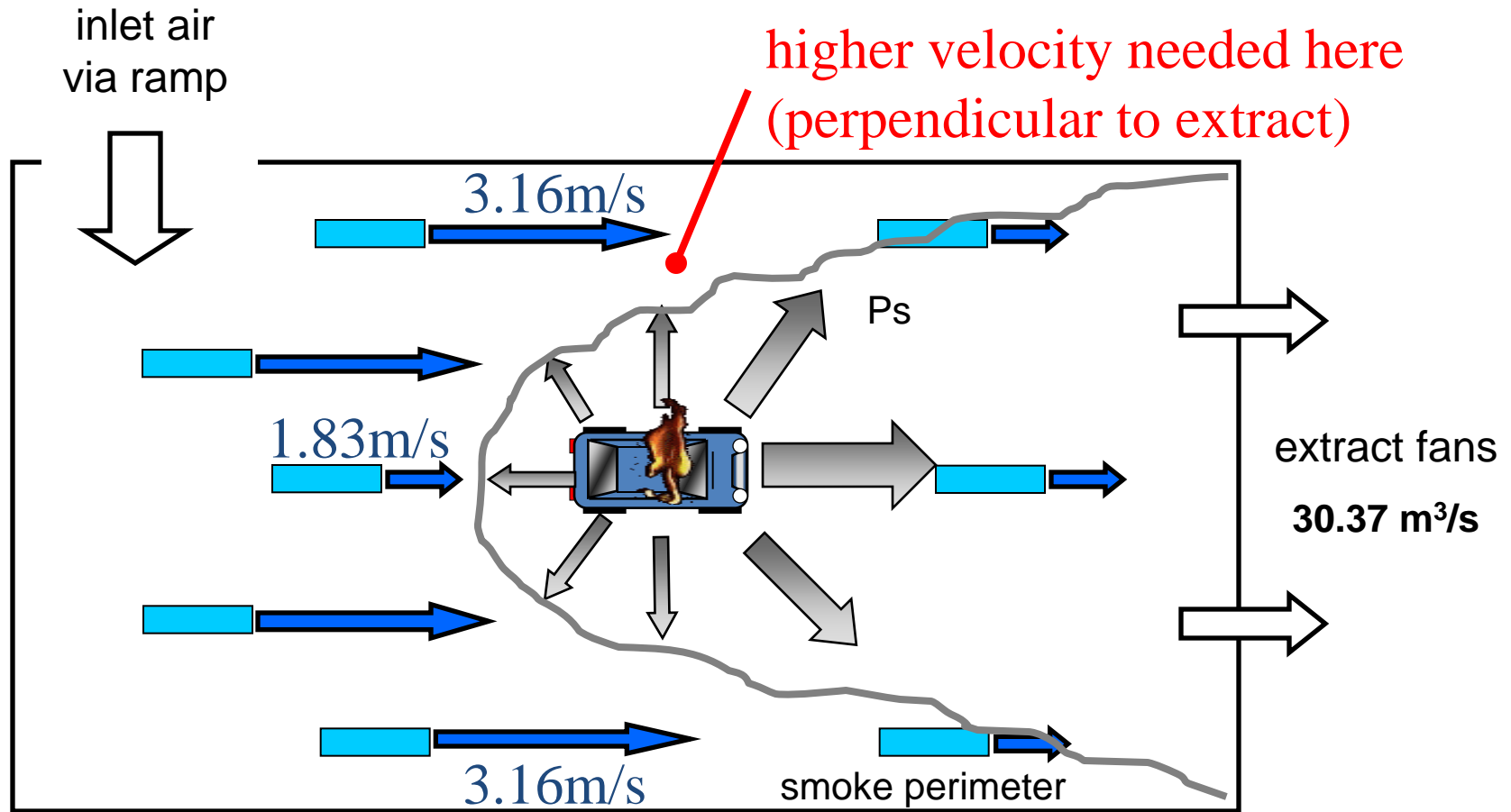


Traditional Methods Vs Fläkt Woods Thrust Fan System



For Car Parks, the tunnel theory is adapted to take P_s to be Smoke Perimeter

Traditional Methods Vs Fläkt Woods Thrust Fan System



controlling velocities

3.16m/s required - this will be for ALL fans



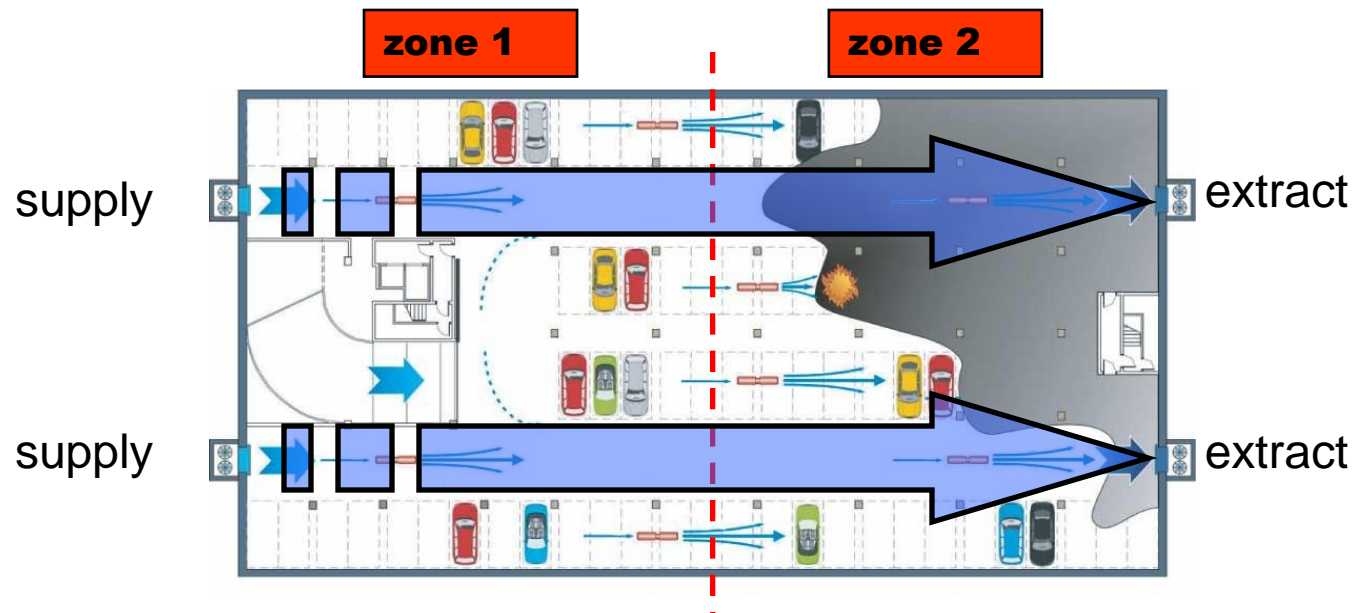
Traditional Methods Vs Fläkt Woods Thrust Fan System

Fläkt Woods Fully Reversible System

- Requires Supply *and* Extract Fans
- Supply fans are HT rated
- ***Truly Symmetrical*** blades (only Fläkt Woods)

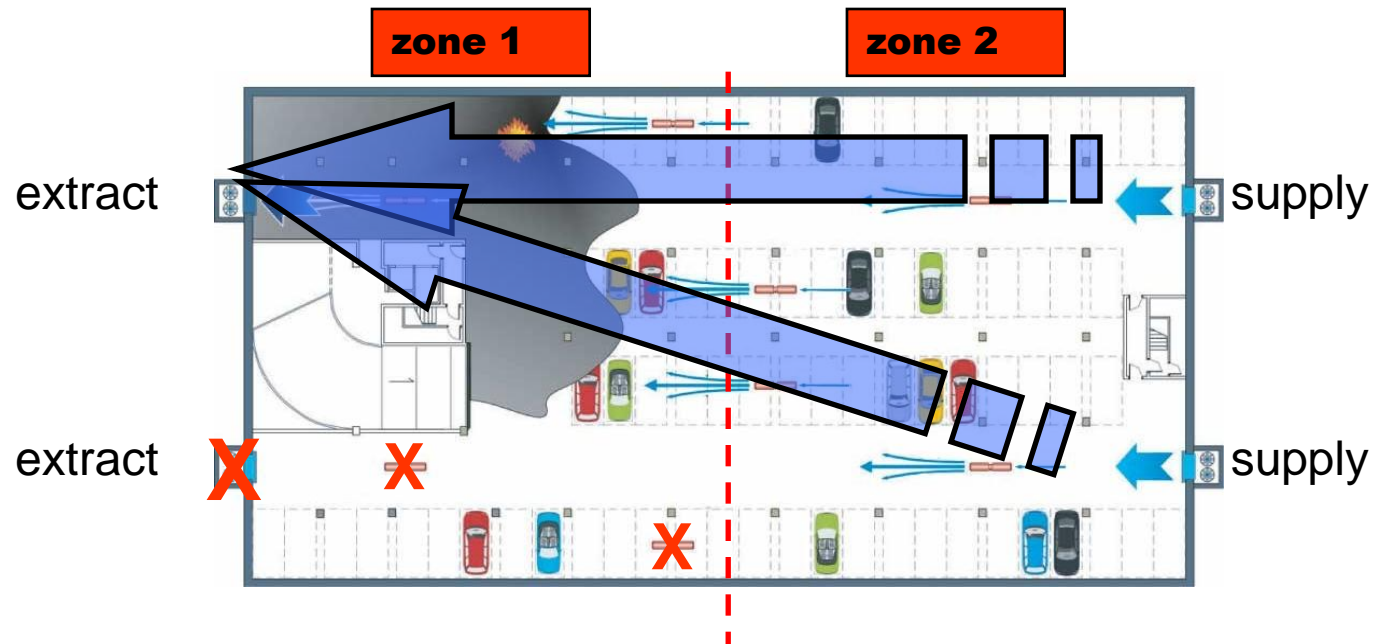
Traditional Methods Vs Fläkt Woods Thrust Fan System

air flow is controlled - critical velocity controls smoke



Traditional Methods Vs Fläkt Woods Thrust Fan System

fire in zone 1: extract and supply are reversed



Selected fans only run to minimise smoke spread

smoke is redirected to minimise spread



Topic Summary

- Understand the Limitations of Ducted Systems
- Design Uni-Direction Thrust Fan Systems
- Introduce Truly Reversible Thrust Fan Systems
- Review of Systems Available



The Benefits of Enhanced Design



Learning Objectives

- Computational Fluid Dynamics
- Advanced Controls
- System Benefits

The Benefits of Enhanced Design

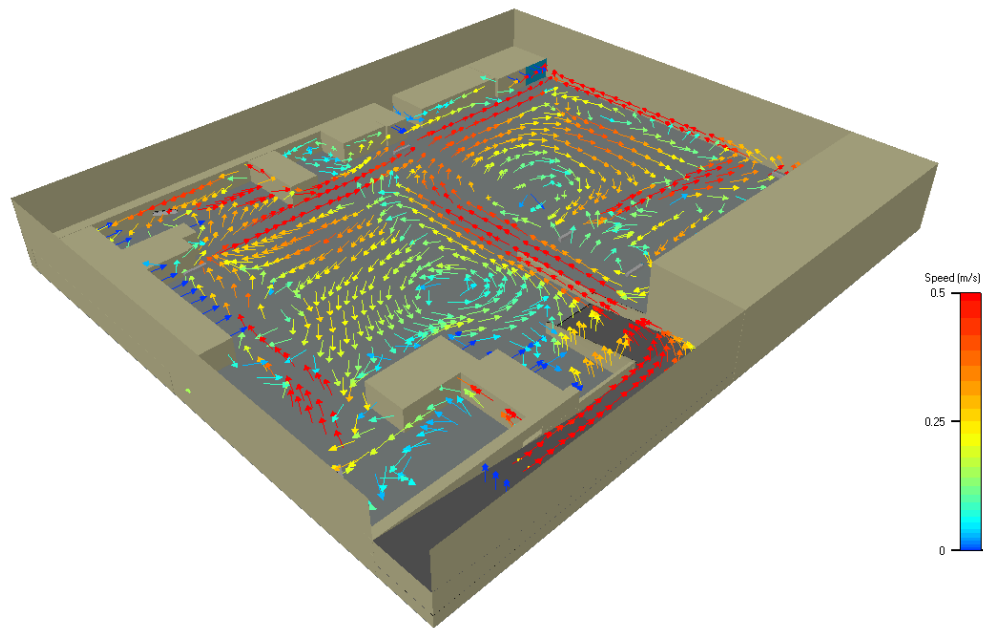
Computational Fluid Dynamics

- The software uses the mathematical method of Finite Volume Analysis. The model is divided into adjoining finite volumes with the conservation equations represented in algebraic form being solved iteratively for each finite volume.

$$\rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right) = -\frac{\partial p}{\partial x} + \mu \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) + \rho g_x$$
$$\rho \left(\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} \right) = -\frac{\partial p}{\partial y} + \mu \left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2} \right) + \rho g_y$$
$$\rho \left(\frac{\partial w}{\partial t} + u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} \right) = -\frac{\partial p}{\partial z} + \mu \left(\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2} \right) + \rho g_z$$

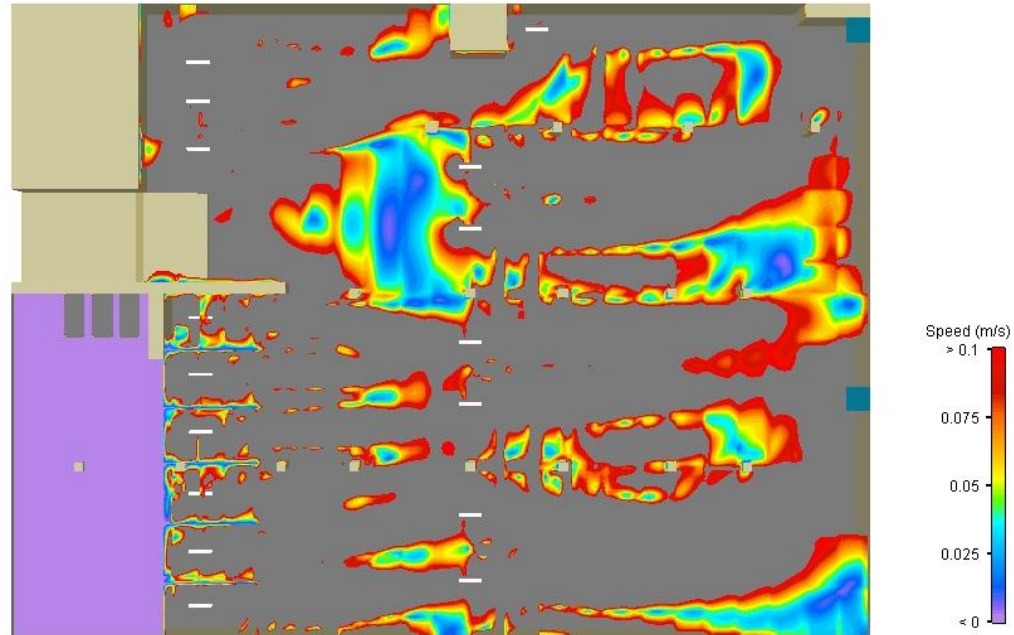
The Benefits of Enhanced Design

- As a result, it can calculate solutions for pressure (P), temperature (T), x-velocity (u), y-velocity (v) and z-velocity (w), as well as visibility and smoke spread.

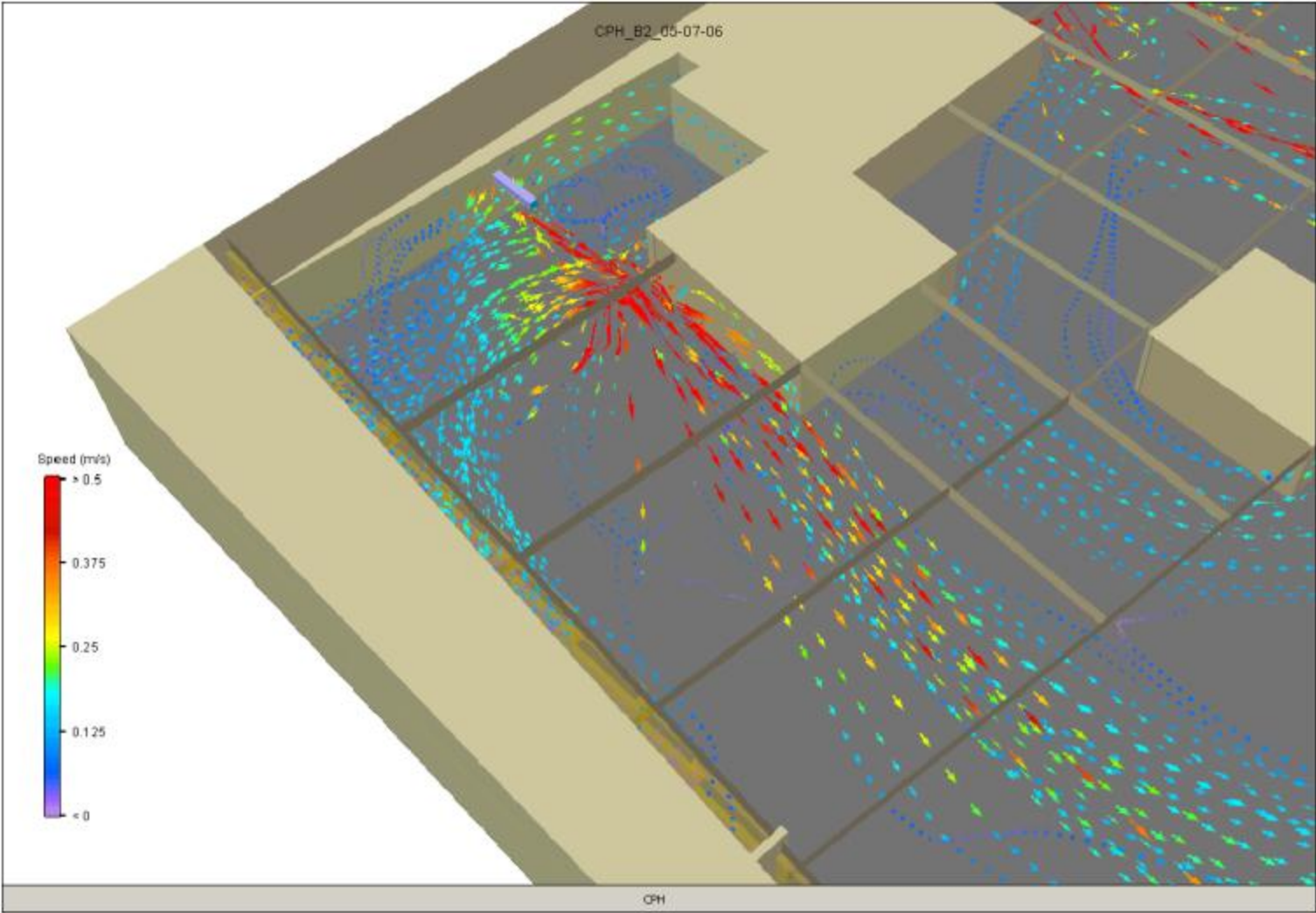


The Benefits of Enhanced Design

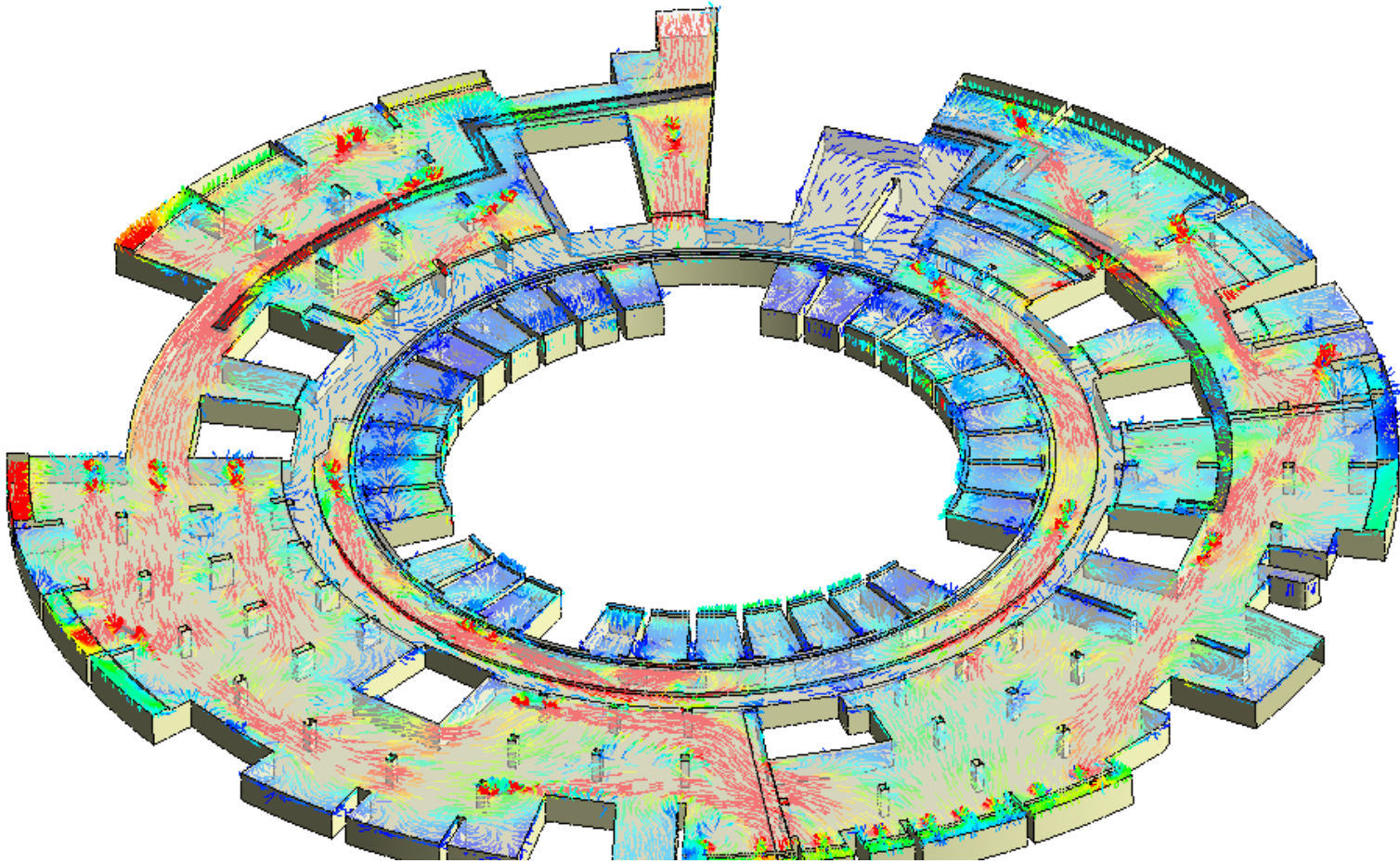
- Ensures that the best possible system is being designed for that specific car park
- It can then be confirmed during commissioning what has been modelled takes place in reality.



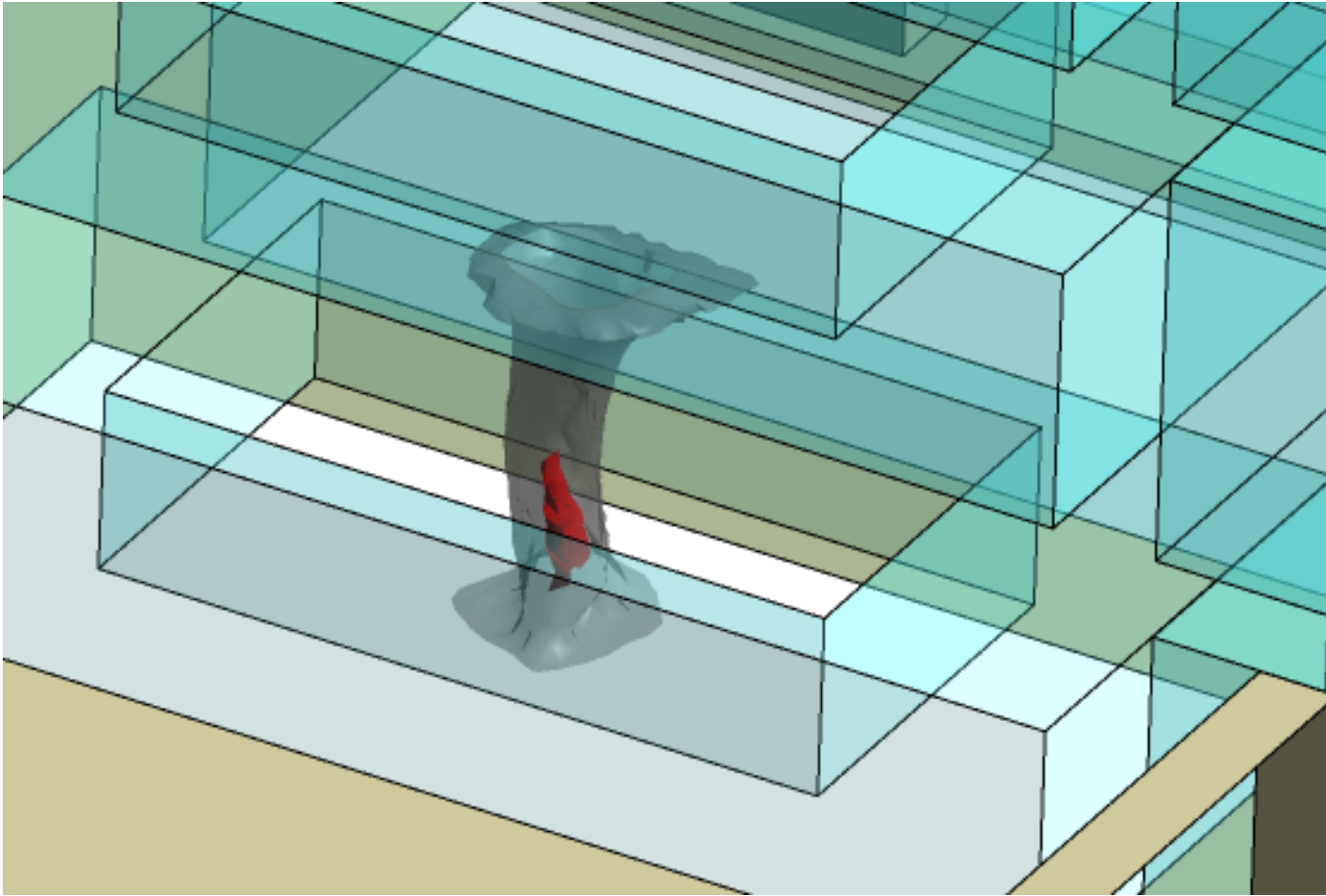
The Benefits of Enhanced Design



The Benefits of Enhanced Design

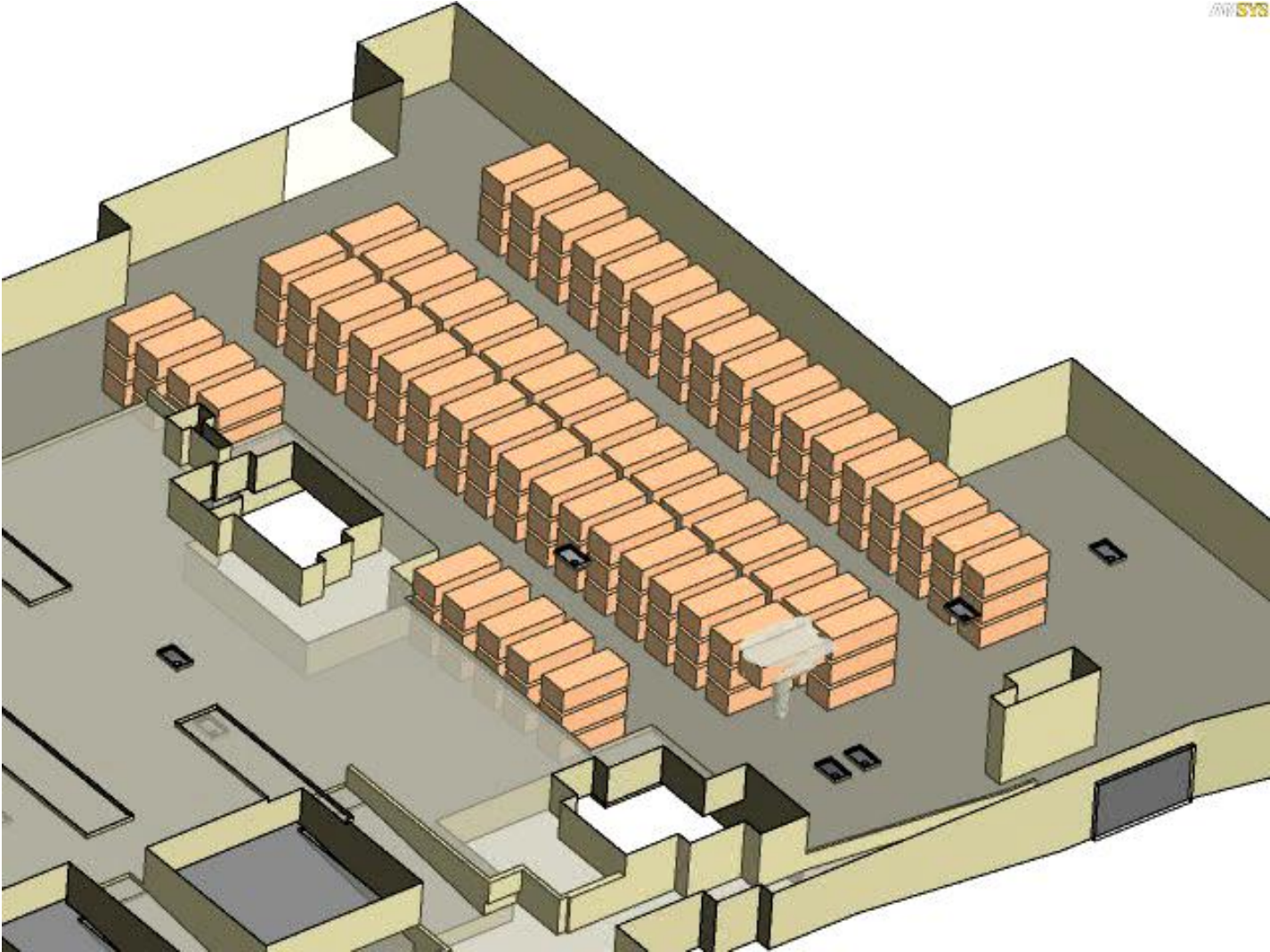


The Benefits of Enhanced Design



The Benefits of Enhanced Design

AW SYS



The Benefits of Enhanced Design

Controls

Operation philosophies:

- 24 / 7
- Timer
- CO / NOx sensors
- Wind sensors
- LPG





The Benefits of Enhanced Design

Controls – 24/7

- System operates at a required speed for high pollution ventilation during all times.
- Operates regardless of the movement in the car park.
- It is not dependent on any other variables (such as CO or NOX)
- **Very energy consuming!**



The Benefits of Enhanced Design

Controls - Timer

- System will switch on / off regardless of the movement in the car park.
- Controls should be programmed so that it should overpass the timer and turn on the system in emergency mode.

The Benefits of Enhanced Design

Controls – CO/NOx Sensors

- System operates in respect to the amount of CO / NOx detected in the car park / loading bay.
- ‘Intelligent’, energy efficient system.
- It will operate at higher speeds when there is a lot of movement in the car park / loading bay.
- It will just provide background ventilation if there is little or no movement.





The Benefits of Enhanced Design

Controls – Wind Sensors

- Used mostly in open sided car parks / tunnels.
- Air will be supplied and extracted via the openings (of the tunnel or) on the walls of the car park.
- System will operate in relation to the velocity of the wind.
- If the wind velocity is high enough then the system may switch off.



The Benefits of Enhanced Design

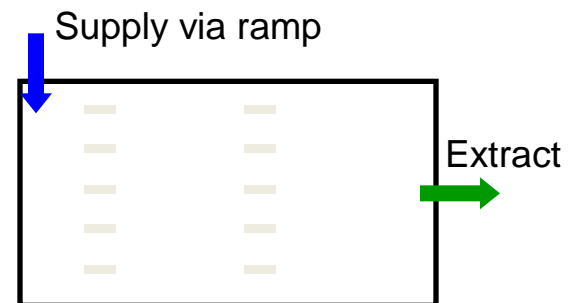
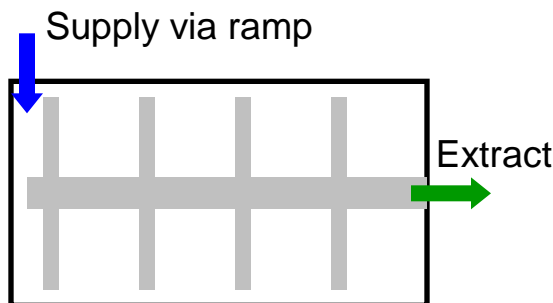
Controls – LPG Sensors

- Some countries already take into consideration LPG powered cars.
- LPG leaks / exhaust can be very dangerous.
- Requires a dedicated detection system.
- Mode of operation very similar to CO / NO_x detection systems.

The Benefits of Enhanced Design

Energy Efficiency

- Take a car park with 4000m² (80m long x 50m wide) with 3m height.
 - One is designed using a ***Jet Thrust System***
 - The other a ducted system
- Looking at the energy required depending on the controls, a comparison can be done on the various types of systems.



The Benefits of Enhanced Design

	Ducted System	Jet Thrust System	
		Main fans	Jet Thrust Fans
24 / 7	189.6kW	121.9kW	40.8kW
Timer	110.6kW	71.1kW	23.8kW
CO	51.2kW	33.1kW	6.8kW
CO (no background vent.)	31.6kW	20.3kW	6.8kW



The Benefits of Enhanced Design

summary - benefits of *Jet Thrust System*

- higher system performance - improved smoke control
- lower installation costs
- lower running costs
- optimises car park use (more space)
- lower external noise levels (lower powered extract fans)
- cleaner appearance
- lower install cost for other services (no routing around ducts)
- ***Truly Symmetrical*** blades allows fully reversible design if required



Topic Summary

- Computational Fluid Dynamics
- Advanced Controls
- System Benefits



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Product Range



Product Range

Introducing Europe's Largest Range of Car Park Ventilation Technology:

- Slimline Jet Thrust Fans
- Low Profile Jet Thrust Fans
- Standard Jet Thrust Fans
- Compact Profile Jet Thrust Fans
- EV Jet Thrust Fans
- Induction Thrust Fans

Product Range





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Course Summary



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