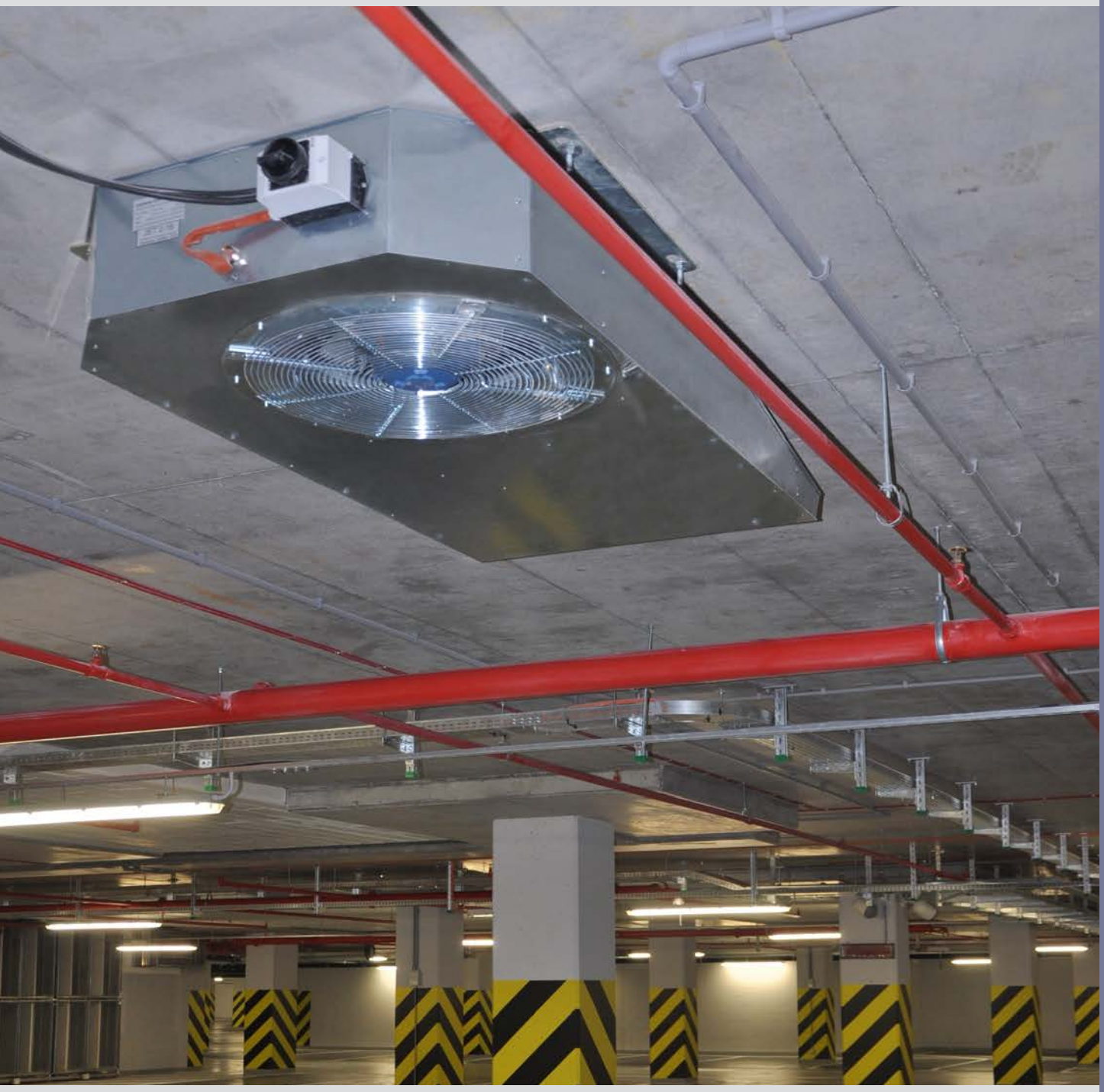
Colt car park ventilation systems
Saudi Arabia



Introduction

"Maintaining air quality while satisfying safety requirements is a key challenge for car park ventilation"

Why ventilate car parks?

Car park ventilation systems are required to achieve two objectives.

Firstly, when a car park is in general use, it is important that the exhaust gases produced by vehicles are effectively removed and that there are no pockets of stagnant air.

Secondly, in the event of a fire, assistance needs to be given to the Civil Defence to clear smoke from the car park during and after the fire.

Car park ventilation systems may in addition be designed to provide clear smoke free access for fire fighters to tackle the seat of the fire, or protect means of escape from the car park. These more complex systems are in excess of the standard design requirements as and are used as compensating features when other requirements are not met.

In this leaflet we:

- Provide an understanding of the legislative framework
- Explain how ventilation systems can both help meet legislative requirements and achieve design objectives
- Look at the equipment options.

CODES AND STANDARDS

The ventilation requirements for car parks are detailed in:

- Saudi Building Code 201– Architectural
- Saudi Building Code 501– Mechanical
- Saudi Building Code 801– Fire Protection
- BS7346-7:2013

With regards to BS7346-7:2013 "Components for smoke and heat control systems – Part 7: Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks", this gives design guidance on ventilation of car parks, including best practice for compliant systems and fire engineered systems.

OPEN PARKING GARAGE

Within Saudi Building Code (SBC), guidance is given as to what constitutes an open parking garage. As part of the SBC guidance the natural ventilation openings required for a parking garage to be considered 'open' is defined:

"2.18.3.3.1 Openings. For natural ventilation purposes, the exterior side of the structure shall have uniformly distributed openings on two or more sides. The area of such openings in exterior walls on a tier must be at least 20 percent of the total perimeter wall area of each tier. The aggregate length of the openings considered to be providing natural ventilation shall constitute a minimum of 40 percent of the perimeter of the tier. Interior walls shall be at least 20 percent open with uniformly distributed openings.

Exception: Openings are not required to be distributed over 40 percent of the building perimeter where the required openings are uniformly distributed over two opposing sides of the building."
SBC 201 page 2/39

Note: Further ventilation requirements may be requested by the SBC if area or height increases are to be applied to the parking garage construction.

ENCLOSED PARKING GARAGE

Parking garages or portions thereof which do not meet the requirements within SBC for what constitutes an open parking garage are considered to be 'enclosed'.

Enclosed parking garages must be provided with a mechanical ventilation system in accordance with SBC.

"2.4.1 Enclosed parking garages. Mechanical ventilation systems for enclosed parking garages are not required to operate continuously where the system is arranged to operate automatically upon detection of a concentration of carbon monoxide of 25 parts per million (ppm) by approved automatic detection devices.

2.4.2 Minimum ventilation. Automatic operation of the system shall not reduce the ventilation rate below 0.25 liter/sec. per square meter of the floor area and the system shall be capable of producing a ventilation rate of 7.6 liter/sec. per square meter of floor area.

2.4.3 Occupied spaces accessory to public garages. Connecting offices, waiting rooms, ticket booths and similar uses that are accessory to a public garage shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 2.3.3."
SBC 501 page 2/7 to 2/8

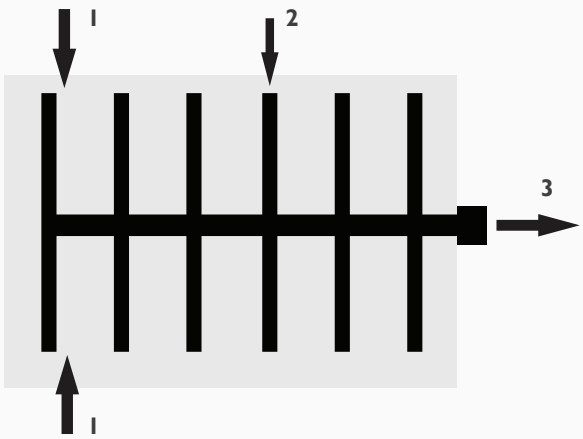
MECHANICALLY VENTILATED CAR PARKS

The traditional mechanical ventilation system provided for car park ventilation is a ducted mechanical extract system.

Guidance on the best practice for ducted mechanical extract systems can be found in BS 7346-7: 2013.

An important aspect of a well designed ducted mechanical extract system is the correct distribution of the extract points and ductwork.

"8.1.5 Extract points should be arranged so that 50% of the exhaust capacity is at high level and 50% is at low level and evenly distributed over the whole car park." *BS 7346-7:2013 page 14.*



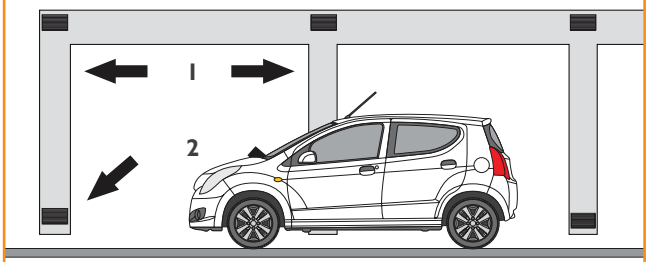
1 - Inlet
2 - Ductwork
3 - Extract

Typical mechanical ventilation using a ducted smoke clearance system: plan view

ISSUES WITH THE TRADITIONAL DUCTED MECHANICAL EXTRACT SYSTEM

There are a number of issues relating to ducted mechanical extract systems which often cause problems for designers:

- The ductwork runs underneath the ceiling, reducing the already restricted area available to other services such as sprinklers and lighting.
- Downstand beams require the ducting to be set down below them, thus meaning lower general clearance heights . Alternatively, more complex ducting must be provided with bends to travel beneath the beams.
- Low level extract points required to give a good ventilation solution, often require protective barriers to surround them to prevent damage, and these take up valuable floor space.
- High exhaust volumes required for larger car parks can mean large duct sizes required and potentially high static pressure values for the system.
- The ductwork can give the car park a cluttered look and can potentially interfere with CCTV coverage if present.



1 - 50% high level extract
2 - 50% low level extract

Typical mechanical ventilation using a ducted smoke clearance system: section view

Image from BS7346-7:2013 page 15

Impulse / Induction Ventilation Systems

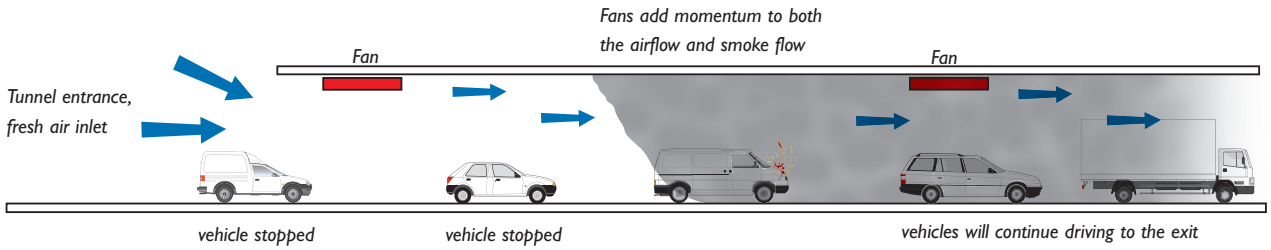
WHAT ARE IMPULSE / INDUCTION VENTILATION SYSTEMS?

In recent years jet fan technology has established itself as the new standard in car park ventilation. Impulse / Induction ventilation systems are now viewed as an improved alternative to ducted mechanical extract systems, overcoming many of the problems associated with such systems.

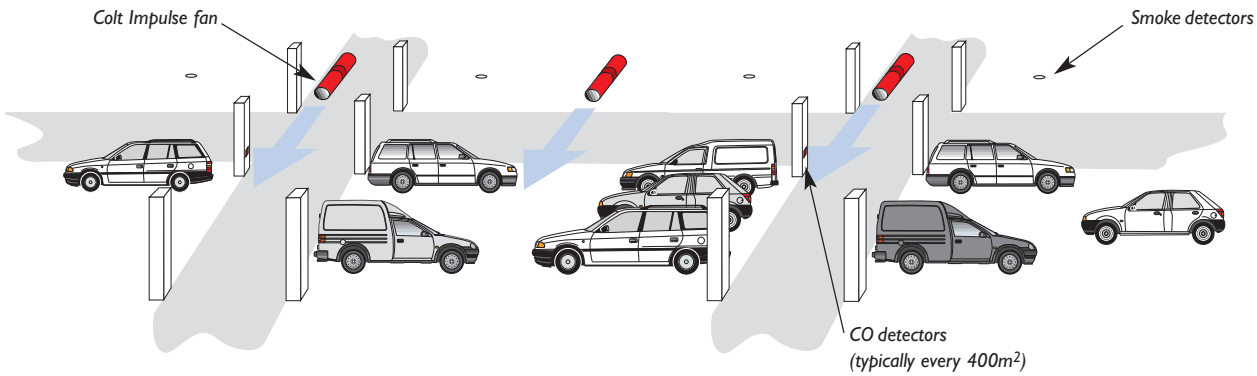
An Impulse fan is an axial impeller fan unit similar to a tunnel jet fan, but has a reduced diameter in order to be fitted into a car park structure without compromising clearance height.

An Induction fan is a further enhancement on the impulse fan, utilising a centrifugal impeller to make the units more efficient and powerful, thus reducing the number of units required.

A typical Impulse fan will provide appropriate ventilation to approximately 500m^2 of car parking area, where as a typical Induction fan will cover twice the area at around 1000m^2 per unit. However, please note that the coverage area can change depending on car park arrangement and complexity so design advice should be sought from an appropriately qualified and experienced design engineer.



The principles of car park impulse ventilation have been developed from procedures used for tunnel ventilation. In the event of a fire, smoke will be 'pushed' and 'pulled' to the exit. Vehicles in front of the fire will continue through to the exit, whilst vehicles behind the fire will, of course, have to stop. Although trapped, these vehicles should be safe from the smoke.



Fan positioning needs to take into account roof geometry (particularly deep downstand roof beams) and risk of airflow blockage by tall vehicles.

The introduction of CO detectors allows use of a more sophisticated control system to match the ventilation rate to the car park usage, further reducing running costs and noise levels.

FEATURES AND BENEFITS OF IMPULSE / INDUCTION VENTILATION SYSTEMS

Easier and quicker installation - Impulse or Induction fans are much quicker and easier to install than extensive ducting.

Optimal use of space - compared with ductwork Impulse or Induction ventilation systems require much less space in the ceiling area improving the coordination with other services

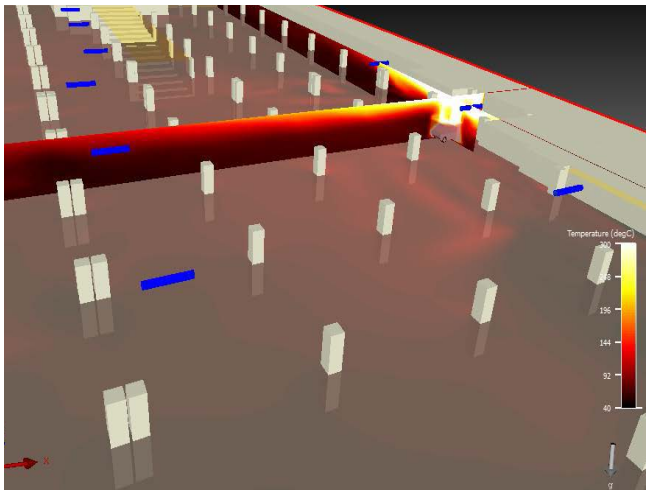
Better car park security - no ducting improves CCTV coverage, keeping the environment safer and lighter.

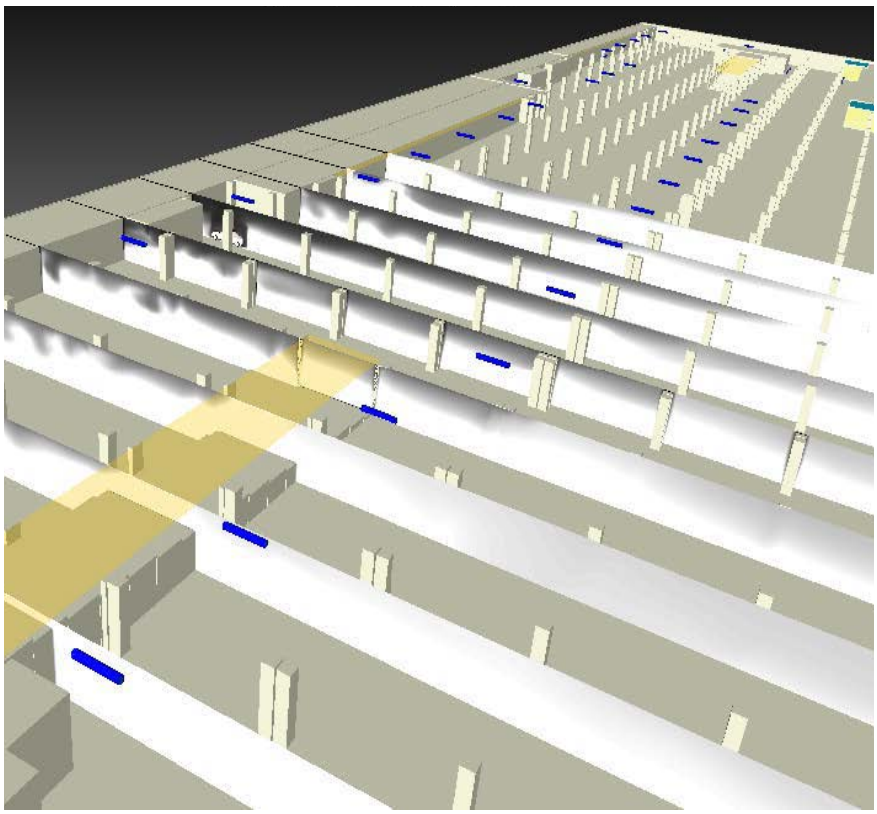
THE DESIGN APPROACHES

The system described in SBC are not intended to assist means of escape in case of fire, but to assist fire fighters by providing smoke clearance. Even a casual inspection of the requirements shows that these methods cannot be expected to do more than limit smoke density and speed smoke clearance once the fire is extinguished.

Where Impulse fans are used, they are typically located over roadways in a layout engineered to ensure there are no areas where it would be possible for fumes to build up due to lack of air movement. In many car parks only a single large extract point is required, located as far away from the inlet openings as possible. This method satisfies the requirements of SBC.

These systems are suitable for use in sprinkler protected car parks. Close co-ordination is needed to ensure optimum placement for both sprinklers and ventilation.





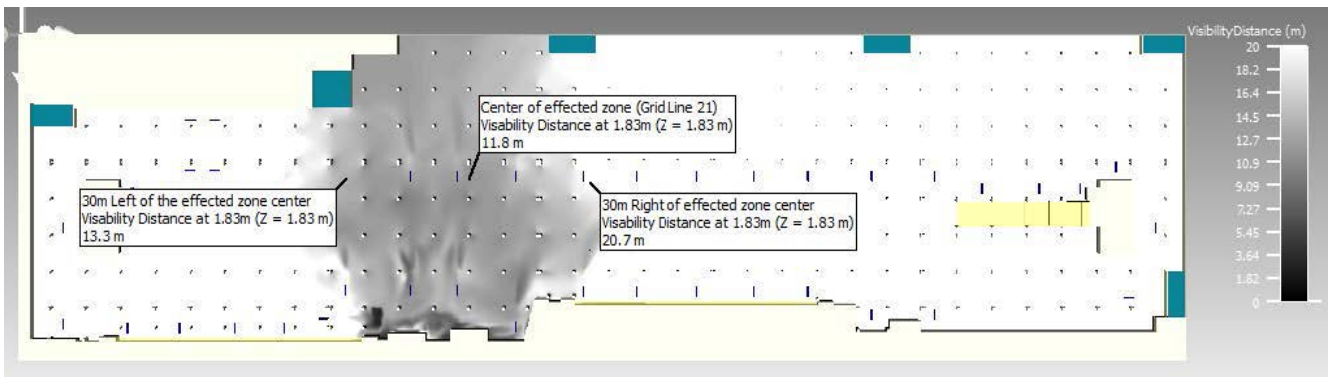
Smoke Control

Provision of a car park ventilation system capable of smoke control is an uncommon requirement but can on occasions be required.

Typically a smoke control system will be necessary where there is a requirement to compensate for a variation against the standard code requirements, such as extended travel distances to escape routes.

When a smoke control system is to be adopted then the objective of the system is to be specified clearly by the responsibly consulting engineer. Based on the specific requirements, a specialist Colt engineer will provide a design to accomplish the desired system effect.

A smoke control system will require an addressable smoke detection system so that the site of the fire can be pinpointed. A control system then starts the selected Impulse / Induction and extract fans to control the direction of the smoke and achieve the system objectives.



Computational Fluid Dynamics (CFD)

WHAT IS THE PURPOSE OF CFD?
Design of impulse ventilation systems is usually proven by the use of CFD.

The initial system design and impulse fan layout is undertaken by a suitably trained and experienced engineer.

Then the layout as described by the engineer is entered into the CFD model to create a representation of the building which can then be used to calculate the predicted airflow behaviour within the space.

CFD modelling allows for the detailed computation of airflow in car parks, taking into account often complex geometry of individual buildings.

CFD modelling has the objective of confirming the viability of the ventilation scheme. Colt offers CFD modelling of the system and a full technical report for approval prior to installation.

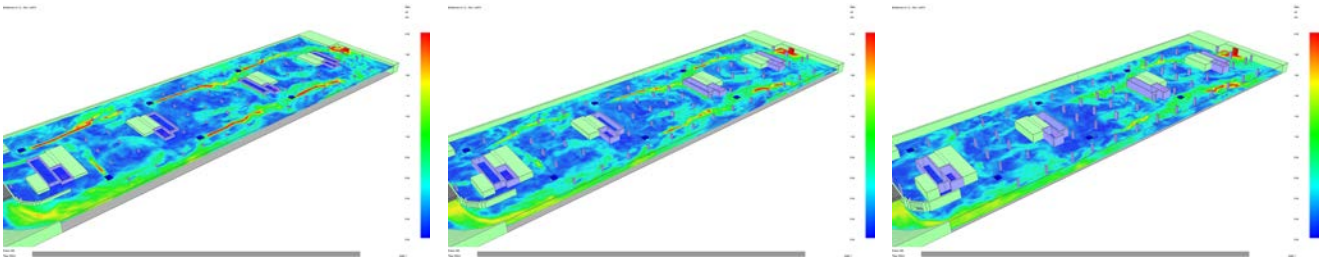
Within the full technical report provided by Colt, images and explanation to illustrate how the system is compliant with the relevant design criteria will be given.

Typical information for compliance against SBC would include:

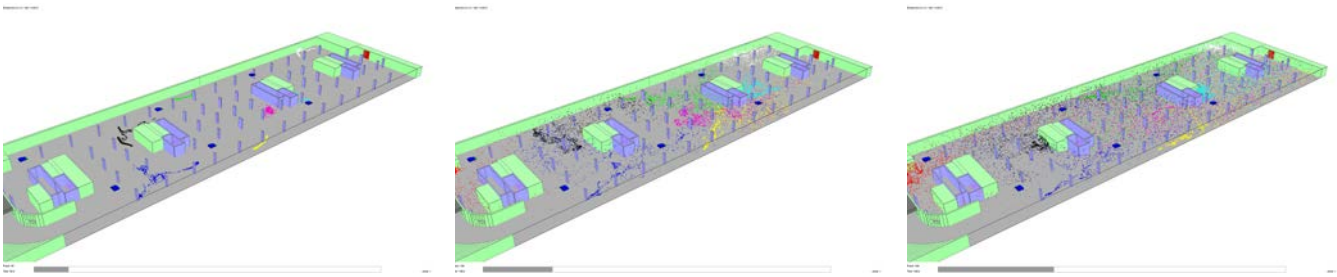
- Confirmation of the total volume of extract in accordance with the code requirement
- Confirmation of airflow speeds to illustrate there are no stagnant areas within the car park.
- Confirmation that there are no adverse pressure conditions which may affect an adjoining occupied space.

Additional information showing fire scenarios may also be included as required.

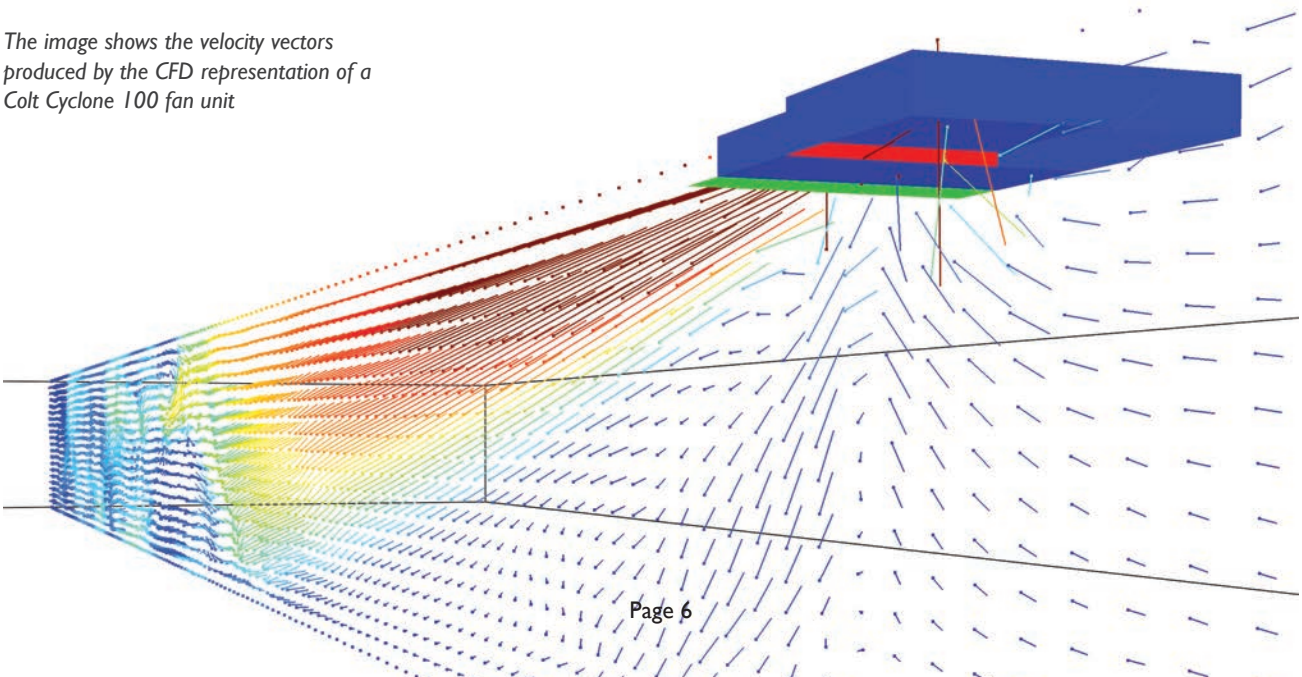
This car park has a ramp providing air inlet on the left hand side, Cyclone fans distributed around the car park and extract plant on the right hand side. Red on the scale represents air speeds of 3m/s and above and dark blue represents 0m/s. These three slices show air velocities at different levels, showing that air moves right across the car park towards the extract point at all levels.



We now show an animation sequence of the same car park. The Cyclone fans are represented by blue squares. The different colour dots show different sources of pollutant, whether this be fume or cool smoke. Again we see that the air mixes evenly across the complete car park.



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



Colt Cyclone

Colt Cyclone is low profile, high velocity induction jet fan intended to control air movement and direct polluted air and smoke towards the extract positions in a car park or underground service area.

THE COLT CYCLONE CAR PARK INDUCTION JET FAN UNIT

General description

Colt Cyclone is a low profile, high velocity induction fan intended to control air movement in car parks and underground service areas.

Cyclone uses tunnel ventilation technology to eliminate the need for costly and bulky ductwork. Compared to ductwork systems, this may save car parking spaces, reduce running costs and noise, and make the car park a lighter, less cluttered environment.

Manufacture

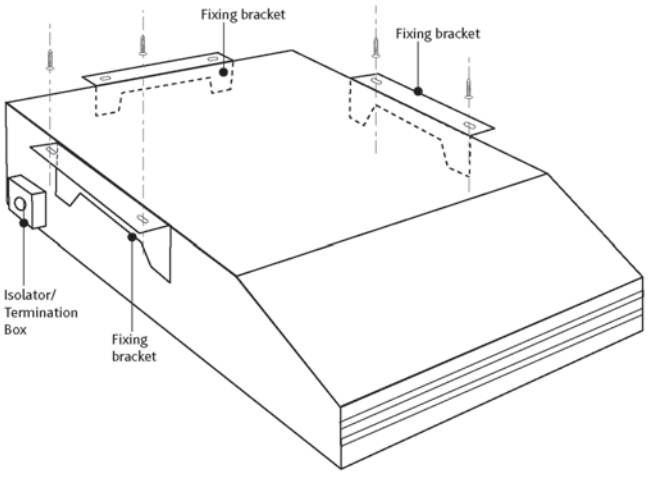
All unit cases are manufactured from Alu-zinc. The standard unit is provided with a natural galvanised finish. If required, the unit can be provided with a polyester powder paint finish in any standard RAL colour.

Cyclone units are manufactured under the BS EN9001 quality standard. Each unit is given a functional test before despatch from the factory.

Installation

Cyclone is designed to be fitted directly to the underside of the car park ceiling.

Using fixing brackets attached to the unit, the unit can be easily installed directly to the ceiling / support crossbars with certified anchoring bolts.



Dimensions

Cyclone	CPV-50	CPV-100
Length of Unit	1310 mm*	1945 mm*
Depth of Unit	226 mm	278 mm
Width of Unit	940 mm*	1305 mm*

*Inclusive of allowance for terminal box and fitting brackets.

Performance

The Cyclone CPV-50 and CPV-100 units are two speed units which produce a nominal thrust of 50N and 100N respectively when operating at full speed.

The corresponding airflow volumes are:

Unit Code	High Speed		Low Speed	
	Thrust (N)	Volume (m^3/s)	Thrust (N)	Volume (m^3/s)
Cyclone CPV-50	50	1.7	12	0.85
Cyclone CPV-100	100	2.69	25	1.83

The unit is certified in accordance with EN 12101-3 for operation at 300°C for 2 hours.

Electrical Information

Motors are insulated to class H and are totally enclosed type, protected to IP55. Motors comply with BS 5000, EN 600034 and IEC 34-1.

Unit Code	kW High	kW Low	FLC High	FLC Low	SC High	SC Low
Cyclone CPV-50	1.2	0.30	4.35	1.88	23.5	5.83
Cyclone CPV-100	2.2	0.55	7.64	2.89	49.7	9.87

Cyclone units are suitable for 380V/60Hz and 400V/60Hz as standard.

Colt Jetstream SA

Colt Jetstream SA is an impulse jet fan intended to control air movement and direct polluted air and smoke towards the extract positions in a car park or underground service area.

THE COLT JETSTREAM SA IMPLUSE UNIT

General description

The Jetstream SA impulse unit comprises a high temperature axial fan with specially designed inlet and outlet attenuators which, along with the fan unit, are encased in a Alu-zinc acoustic enclosure.

The Jetstream SA uses tunnel ventilation technology to eliminate the need for costly and bulky ductwork.

Compared to ductwork systems, this may save car parking spaces, reduce running costs and noise, and make the car park a lighter, less cluttered environment.

Manufacture

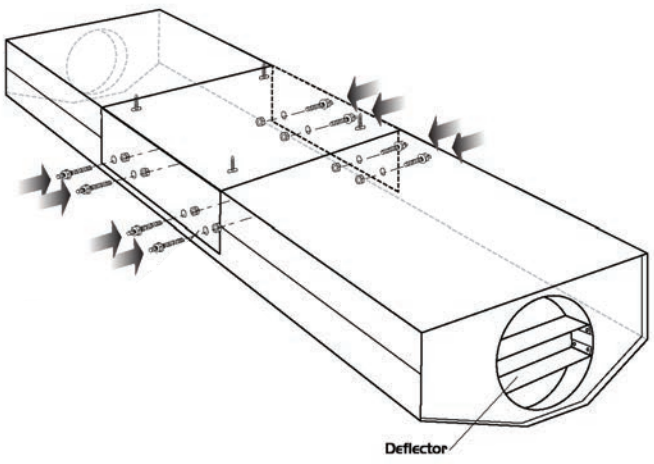
All unit cases are manufactured from Alu-zinc. The standard unit is provided with a natural galvanised finish. If required, the unit can be provided with a polyester powder paint finish in any standard RAL colour.

Jetstream SA is manufactured under the BS EN9001 quality standard. Each unit is given a functional test before despatch from the factory.

Installation

Jetstream is designed to be fitted directly to the underside of the car park ceiling.

Using a specially manufactured fixing bracket the unit can be easily installed in a simple two step procedure. Installing the bracket to the ceiling first then offering up the unit into the purpose made bracket and fitting the unit to the bracket through four side holes on each side of the unit.



Dimensions

Length of Unit 2300 mm

Depth of Unit 403 mm

Width of Unit 700 mm*

*Please allow for an extra 55mm for the width of the terminal box.

Performance

The Jetstream SA unit is a two speed unit which produces a nominal thrust of 50N when operating at full speed and 12N at low speed. The corresponding airflow volumes are 1.8m^3/s and 0.9m^3/s respectively.

The unit is certified in accordance with EN 12101-3 for operation at 300^{o}C for 2 hours.

Electrical Information

Motors are insulated to class H and are totally enclosed type, protected to IP55. Motors comply with BS 5000, EN 600034 and IEC 34-1.

Unit Code	kW High	kW Low	FLC High	FLC Low	SC High	SC Low
Jetstream SA	1.5	0.34	3.41	1.02	19.1	3.8

Jetstream SA unit is suitable for 380V/60Hz and 400V/60Hz as standard.

Options

Alternative unit options including reversible units and single speed units for control via variable speed drive are available if required. Please contact Colt Arabia for further details.

Extract / Supply

There needs to be an adequately designed ventilation extract system to extract the air. In addition, where the natural air supply is insufficient, a system of supply fans may also be required.

EXTRACT / SUPPLY

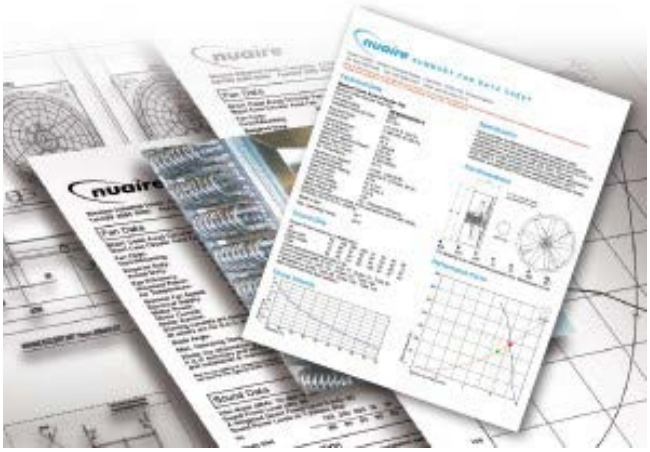
To meet the requirements of the SBC it is not enough to provide only Impulse / Induction fans, there needs to be an adequately designed ventilation system to extract the air.

The required extract system would be sized and the fans selected by Colt as part of the complete car park ventilation system design.

In additional to the extract system, where the natural air supply is insufficient, supply fans may also be required.

The size and volumes of the extract and supply fans will vary for each car park.

Colt Arabia is able to select units to accommodate any foreseeable requirement.



AXUS AX

The AXUS AX range are axial flow fans designed to provide extract ventilation or supply ventilation in almost any situation.

General description

The AXUS AX range of axial flow fans are primarily designed for 'in duct' applications. However, they can be used in any application subject to correct installation design and the provision of appropriate accessories such as inlet cones, discharge cowls, etc.

A suitable selection from the AXUS AX range can be provided for almost any application, such as day to day ventilation, smoke & heat exhaust ventilation, and even ATEX applications.

The robust unit design means that the AXUS AX range are suitable for indoor or outdoor installation and can be installed at any angle.

The AXUS AX range of axial flow fans are produced in sixteen case sizes from

Manufacture

Cases are manufactured from various materials such as pre-galvanised steel, stainless steel, or hot dipped galvanised steel.

Impellers are manufactured from a range of materials including GRP, aluminium alloy, or steel to suit the required application.

All motors are tested and certified to BS and EN standards and can be Class F or Class H, TEFC or TENV, as required depending on the fans designed application.

If required, the AXUS units can be provided with a polyester powder paint finish in any standard RAL colour.

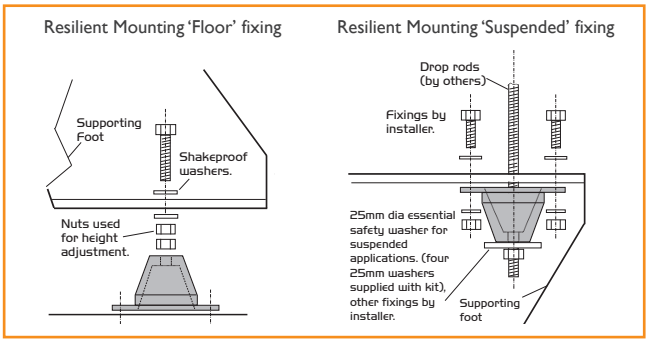
AXUS units are manufactured under the BS EN 9001 quality standard. Each unit is given a functional test before despatch from the factory.

Options

The AXUS AX range of axial flow fans is available in multiple options including reversible options, high temperature options at 300ºC & 400ºC for 2 hours, long case & short case options, bifurcated options, contra rotating options, and run & standby in series options.

Installation

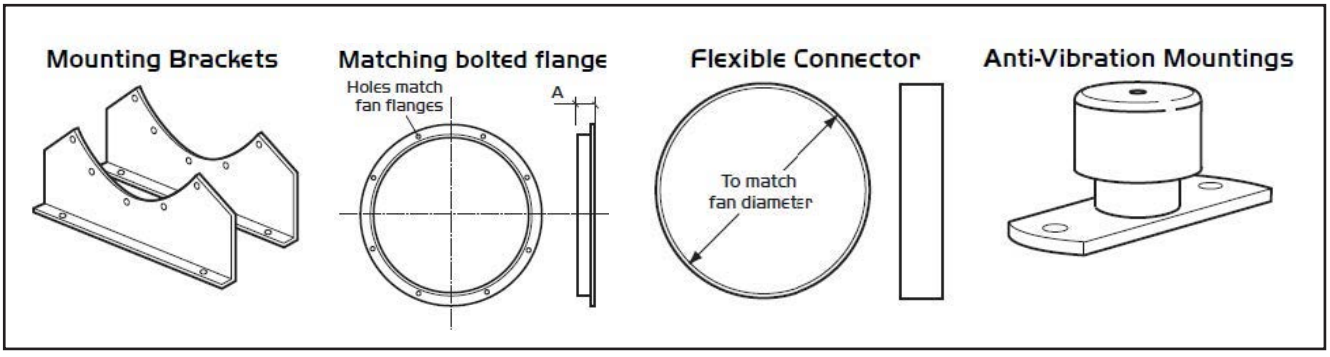
The AXUS range can be installed into a large variety of applications and installation arrangements. Typically in all installation arrangements anti vibration mountings are used as illustrated in the examples below:



Ancillaries

The AXUS AX range can be accompanied by many standard ancillaries depending on the requirement of the installation.

Some of the available ancillaries are show below. For further details and selections please contact Colt Arabia.



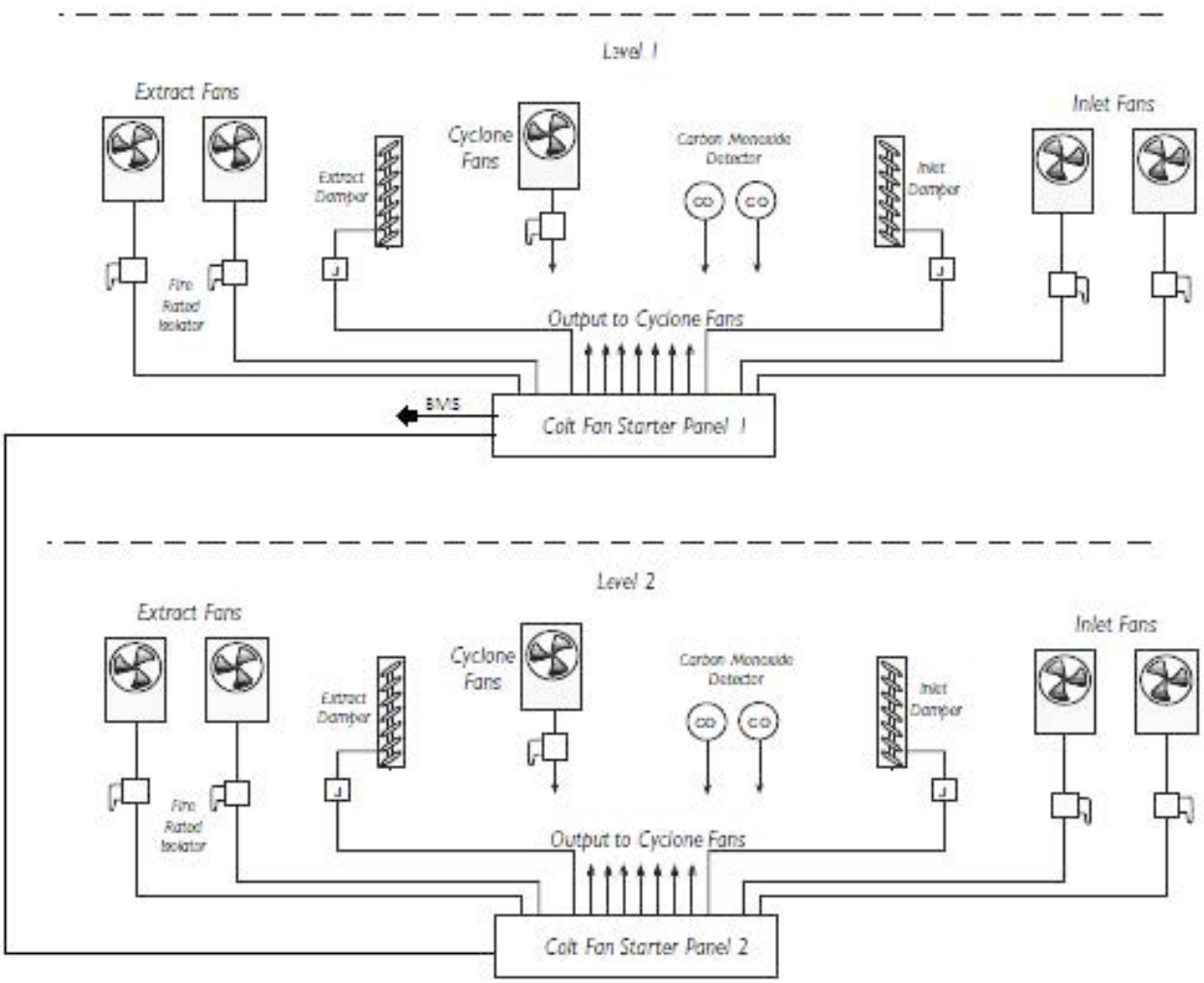
CONTROLS AND SENSORS

The design of the controls and sensors is an integral part of the car park ventilation system. The arrangement of sensors is determined at the design stage, along with the controls cause and effect which determines the way the equipment responds to any given conditions.

In accordance to SBC for the car park ventilation system must not provide less 0.25 liter/sec. per square meter of the floor area and the system shall be capable of producing a ventilation rate of 7.6 liter/sec. per square meter of floor area. However, the system can be controlled with the use of CO detection throughout the car parking area.

Typical control schematic

Shown below is a typical control system for a 2 level car park with CO control, mechanical exhaust and mechanical inlet.



Typical sequence of operation

In accordance with Saudi Building Code 501- Mechanical, the enclosed car parking system is not required to operate at peak exhaust rate continuously where the system is arranged to operate upon detection of a concentration of carbon monoxide of 25 parts per million (ppm) by approved automatic detection devices.

Therefore, to reduce overall system power consumption the basic sequence of operation should be as follows:

Day to day operation

CO < 25ppm	***Background Ventilation*** Exhaust rate provided by main exhaust fans running to give not less than 0.25 liter/sec. per square meter of the floor area of the car park. This is achieved either through the use of variable speed drives to main exhaust fans or through limiting the numbers of exhaust fans operating. Induction fans will be off.
CO > 25ppm < 50ppm	***Environmental Ventilation*** Exhaust rate provided by main exhaust fans running to give not less than 7.6 liter/sec per square meter of the floor area of the car park. Exhaust fans to run at full design exhaust rate. Induction fans will be on at half speed.
CO > 50ppm	***High CO Ventilation*** Exhaust rate provided by main exhaust fans running to give not less than 7.6 liter/sec. per square meter of the floor area of the car park. Exhaust fans to run at full design exhaust rate. Induction fans will be on at full speed.

*Note – When the CO detection falls below the operating set points the system should continue to operate at the higher ventilation rate for 5 minutes before returning to the lower ventilation rate. This run on time should ensure the CO levels are sufficiently diluted to prevent the system switching continuously between two system conditions.

Smoke / Fire Detection Smoke/Fire	***Smoke Clearance Ventilation*** Exhaust rate provided by main exhaust fans running to give not less than 7.6 liter/sec. per square meter of the floor area of the car park. Exhaust fans to run at full design exhaust rate. Induction fans shall initially be switched off upon smoke / fire detection. After the designated escape period (typically around 3-5 minutes), the Induction fans will be switched on at full speed.

Some benefits of working with Colt

THE COLT PACKAGE

Colt Arabia can offer a comprehensive package, which can include:

- Scheme design, CFD analysis and report
- Supply of impulse / induction fans, extract and /or supply fans, and control systems including CO detection
- Supervision of installation
- Commissioning
- Training for the engineers of end users for operation and maintenance of the system.

OTHER REASONS TO CHOOSE COLT

- Colt Smoke Control systems are suited to both commercial and industrial buildings, and may be adapted to suit most architectural requirements.
- Over the years Colt has funded a large proportion of the research into smoke control, and its representatives maintain an unparalleled level of technical expertise.
- Colt's CFD modelling approach is reliable and has been confirmed by empirical full scale hot smoke tests.
- Colt's in-house research and development capability ensures that Colt fire protection systems are designed, tested and updated by Colt to meet or exceed relevant legislation and standards.

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