NO SMOKING!

As new developments jostle for elbow space in the region, there is an urgent need for an efficient smoke-management system, says Alexandre Benoit.

Fires cause loss of life, damage property, injure people and harm the environment. Fire hazards in buildings are a global concern, especially in the UAE, where news of outbreaks of fire are frequent. Designing and installing a fire-protection system in buildings presently under construction, or already built, are therefore, important considerations to combat the menace.

Fire is the combination of flame and smoke. If flame is seen as the aggressive part of fire, which burns materials, smoke is made of combustion gases. The resultant toxic and opaque fumes hamper breathing and, more importantly, affect visibility needed to escape from a building on fire. This causes panic and poses further threat.

In fact, smoke is considered the major killer in a fire situation. It is, thus, evident that having an efficient smoke-management system in place assumes top priority. This leads us to the issue of the need for safe compartmentation.

A safe compartmentation using reliable motorised fire, smoke and heat dampers will effectively prevent the spread of fire, smoke and heat through the entire building and will, thus, manage to confine the smoke within the same compartment and will also limit the spread of flame. For example, each floor can be divided into two compartments with a fire door and a fire damper, to separate the two compartments on the same floor (See figure 1, the drawing of a hotel).

Thanks to the compartmentation, the safety of the people outside a compartment under fire is, at least theoretically, guaranteed. In reality, there may, of course, still be some fire, smoke, and heat hazards either due to improper or incorrect installation of compartment walls and shafts or due to lack of maintenance. On the other hand, a code-compliant installation with regular maintenance during the whole lifecycle of the building will guarantee safety for those outside the fire compartment, in case of a fire episode. It must be stressed here that regular testing and checking of the activated devices, like fire dampers, is essential.

Apart from compartmentation, installing an efficient smoke-extraction system will help those trapped inside the compartment under fire and escape the building safely during the early stages of

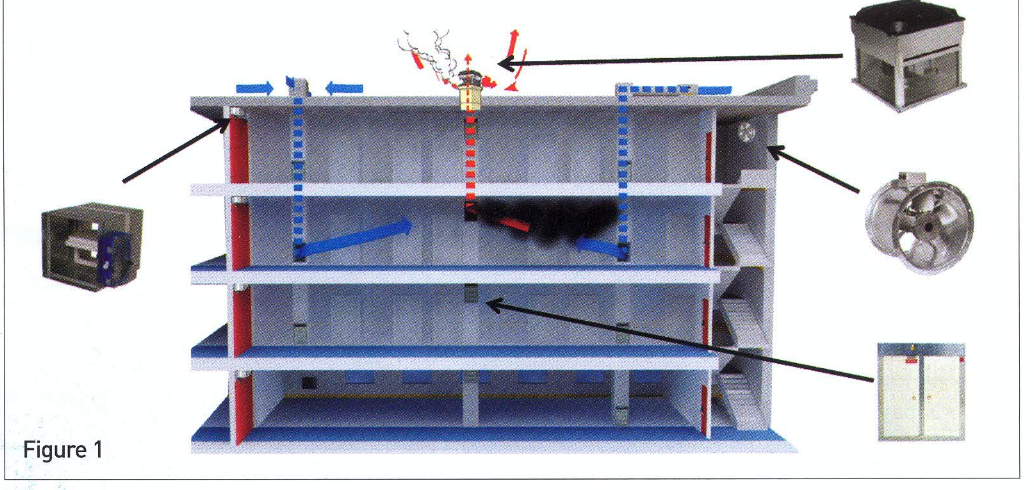


Figure 1

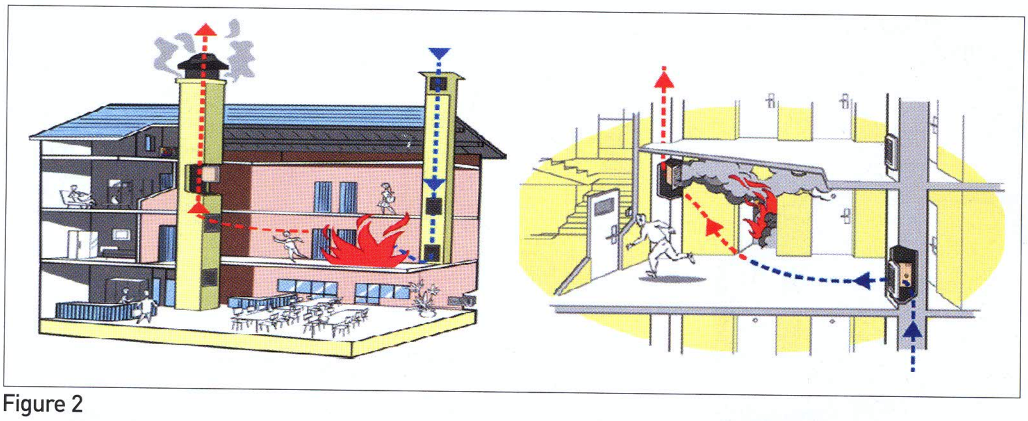


Figure 2

the fire. It is estimated that usually this takes about 20 to 30 minutes.

Compartmentation and smoke extraction are, therefore, complementary safety systems, where compartmentation confines and contains the fire within the location of its origin, with an increase of temperature and emission of smoke, heat and flammable hot gases, while smoke extraction exhausts these fumes and hot gases outside the building.

The management of smoke is best done by controlling the high pressure of smoke generated directly by the fire.

The way smoke spreads is by moving from areas of high pressure to areas of lower pressure, in an attempt to find a balance. The objective of a mechanical smoke-extraction system (corridor smoke control) is to create a low pressure point in a corridor (opening through a smoke exhaust damper) to create a controlled smoke passageway. The goal is to extract the most smoke and combustion gases in the early stages of a fire, in order to keep the escape and access routes free from smoke and gases (see figure 2).

A basic smoke-extraction system is made by one vertical riser supplying outdoor air through an air inlet located close to the floor, and another vertical riser that extracts smoke via a smoke exhaust fan through a smoke exhaust damper, located close to the ceiling. The aim is, through stratification, to create a smoke-free area in the lower area of a corridor to allow a safe escape, and confine the smoke to the upper area of the corridor before being discharged outside.

The advantage of the smoke-extraction system is to control the amount of smoke and heat, not by fighting against it, but rather by working together with its flow and leading the spread of smoke and heat towards safe exhaust openings. This is a key advantage, considering that the spread of fire does not follow a set path and there is no pattern of fire behaviour. It is nearly always unpredictable and uncontrolled.

By supplying fresh air and exhausting smoke and heat close to the fire location, a smoke extraction system reduces the dangers for fire fighters due to an under-ventilated fire, for example, flashover or backdraft. In turn, this dramatically eases the operation of the fire-fighters by reducing the temperature and increasing the visibility within the building. Even if the burning rate increases due to the supply of fresh air, the smoke-extraction system creates a safer environment by controlling the spread of fire and its intensity. This benefits both the victims and the fire fighters during the early stages of a fire.

It needs to be remembered that corridor smoke extraction should take place with priority for corridors with a total length of over 30m, for corridors leading to bedrooms and for corridors located, underground.

Major steps for the design:

1 Select location of air inlets and smoke exhaust dampers in the corridor

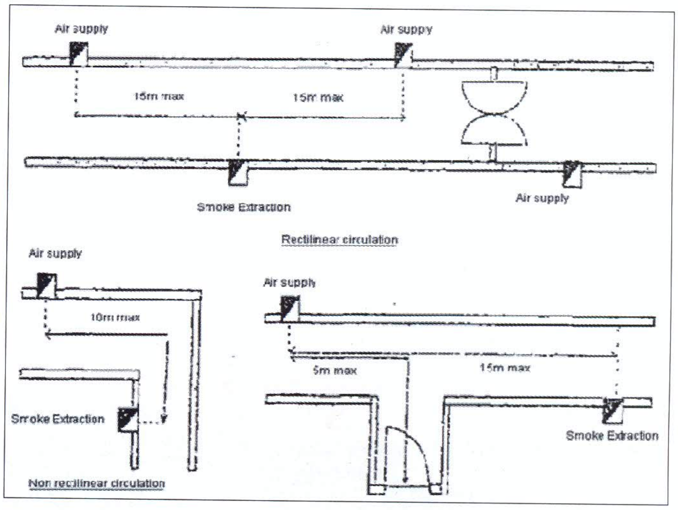


Figure 3

- Air supply inlets and smoke-extraction outlets need to be distributed alternately. The horizontal distance between supply and extraction, measured along the axis of the corridor should not exceed 15m in case of a rectilinear course, and 10m in the contrary case. When a smoke extraction outlet is served by two air supply inlets, the distances between inlets/outlets must be equivalent.
- Any door of a premise accessible to the public, not located between an air supply inlet and a smoke-extraction outlet, must be at the most, at a distance of five metres to one of them.

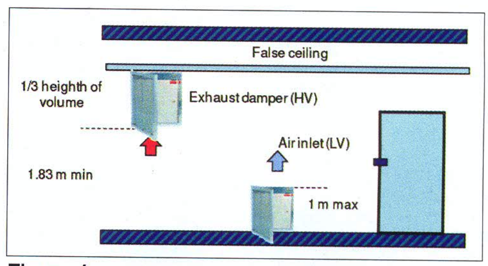


Figure 4

- Smoke extraction outlets must have their lower part at least 1m83 above the floor and be located entirely within the higher third part of the corridor.
- Air supply inlets must have their lower part at least 300mm above the floor and their highest part at most 1m above the floor; they are preferably located in close proximity to fire doors and access doors to staircases.

2 Select dimensions of both air inlets and smoke exhaust dampers, according to airflow requirements

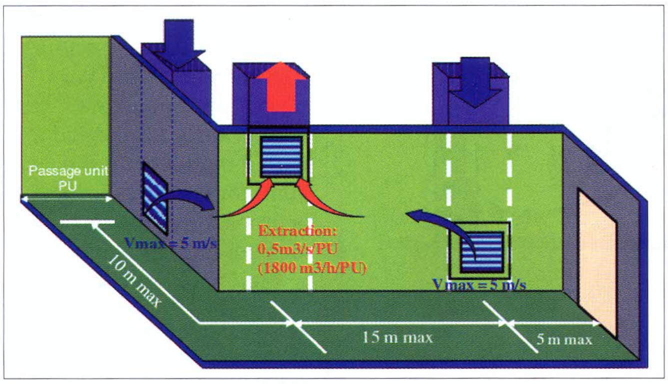
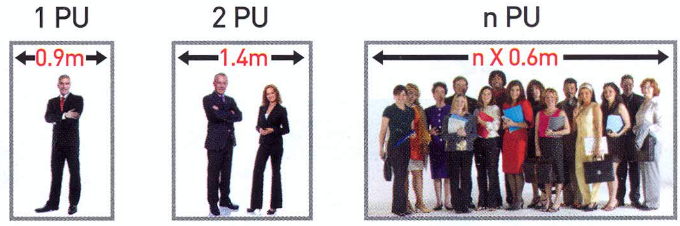
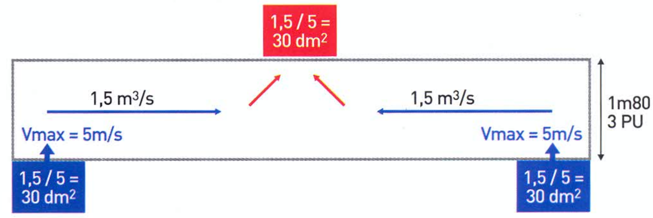


Figure 5
Note: A passage unit (PU) is a specific unit characterising the width of a corridor in proportion of the maximum number of people who potentially could be there at a specific moment.

- Any section of a corridor in between a smoke-extraction outlet and an air-supply inlet must be swept by an extraction airflow at least equal to 0.5m³/s per passage unit (round whole PU to the nearest value) in the corridor; however the total extraction airflow in a corridor (or a partitioned portion of a corridor) is limited to 8 m³/s.
- Air velocity through air-supply inlets must always be lower than 5 m/s. Natural air-supply inlets must be designed for the overall extracted airflow. Mechanical air-supply inlets must have airflow around 0.6 times the extracted airflow.





Example calculation

- A corridor with a length of 30m requires two air inlets and one smoke exhaust damper. A corridor with a width of 1m80 requires 3 PU. Then, the corridor shall be swept by an air flow rate of Q1 = 3 x 0.5 = 1.5 m³/s.
- As the air inlet flow rate shall be less than V1 = 5m/s, then its minimum area should be:
S1 = Q1/V1 = 1.5/5 = 30 dm².
- The smoke exhaust damper shall extract Q2 = 2x1.5=3 m3/s. The exhaust air flow rate is, in general, V2 = 8m/s, then its area is S2 = Q2/V2 = 3/8 = 37.5 dm².
- For example, if the total area of the fire zone is 300m² with a height of 2.5m, then the total volume is 750m³ and the air change rate will be 3x3600 m3/h /750 = 14.4 volume/hour.

3 Select the right smoke exhaust damper to ensure the best safety and to ease the installation (vertical or horizontal ductwork)

A smoke exhaust damper (see *Smoke exhaust dampers comparison*, opposite page) is a device within an air distribution system to control the movement of smoke, i.e. to stay close to prevent the spread of flame, smoke and heat into other compartments or to open to extract smoke outside from the fire zone.

A smoke-exhaust damper is always motorised to be operated via a fire alarm control panel (FACP), connected to smoke detectors, in case of fire and via a building management system in case of preventive maintenance.

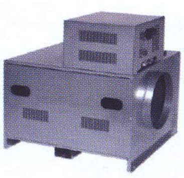
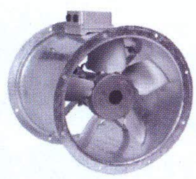
As for a fire damper, a smoke-exhaust damper must be airtight at low and high temperature to ensure no smoke leakage in case it has to stay in the closing position. Indeed, they have to prevent the smoke to spread from the smoke exhaust riser towards any other floors. They have also to ensure no heat transfer to prevent the spread of fire.

Concerning their installation, the easiest and most effective installation is to mount directly the smoke exhaust damper on a vertical smoke exhaust riser to limit the ductwork in the building.

Smoke Exhaust Dampers Comparison

Type / Model		Motorized Smoke Exhaust Dampers SD 125	Motorized Smoke & Heat Exhaust Dampers VRFI	Motorized Smoke & Heat Exhaust Dampers VANTONE
Standards		UL 555S	NF - EN 1366-10	NF - EN 1366-10
Key Features	Fire Resistance	1.5h	2h	2h
	Quick Operation	motorization	motorization	motorization
	No Smoke Leakage	Ok for cold smoke and fumes up to 120°C or 175°C	Ok for cold and hot smoke and fumes	Ok for cold and hot smoke and fumes
	No Heat Transfer	GI blades	Refractory blade	Refractory blade
	Easy Maintenance	Remote control with BMS	Remote control with BMS	Remote control with BMS
	Easy Installation	Horizontal ductwork	Horizontal ductwork	Vertical ductwork
	Energy Saving	Only power cut-off	Only power cut-off	Power cut-off + Power emission available

4 Select the right smoke exhaust fan to fit the duty point calculated (airflow rate, pressure) and the space consideration for installation

Supply and exhaust fans must be designed according to the ductwork features and the rated airflow increased by an acceptable amount of leakage (around 20%).

Smoke exhaust fans must ensure their function during two hours with smoke at 400°C. Each smoke exhaust fan must be able to be shut down from the manual control location for security setting. They must be installed either outside the building or in technical premises separated from adjacent volumes by one hour degree fire-resistant walls. The access door shall be half an hour degree fire resistant and equipped with a door lock. The ventilation inside the premises shall be compatible with the operation of various equipments installed in these premises.

The control devices must ensure fans startup, within a maximum delay of 30 seconds in order to allow the operation of all activated safety devices (fire dampers, smoke exhaust dampers, and doors) ensuring smoke extraction and partitioning of the smoke extraction zone. ■

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Smoke Exhaust Fans Comparison

Type / Model		Roof Fan VELONE	Cabinet Fan CYCLONE	Axial Fan HELIONE
Standards		EN 12101-3 (CE)	EN 12101-3 (CE)	EN 12101-3 (CE)
Key Features	Fire Resistance	400°C - 2h	400°C - 2h	200°C or 400°C - 2h
	Speeds	1 or 2	1 or 2	1 or 2
	Direct/Belt driven	direct driven	belt driven	direct driven
	Max Airflow	27000	32000	72000