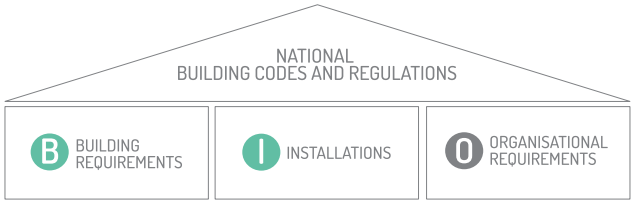
B.I.O. framework factsheet: SMOKE MANAGEMENT

REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

MODERN BUILDING ALLIANCE
Safe and sustainable construction with plastics

This factsheet focusses on one the element of the B.I.O. framework: the smoke management. It aims to illustrate why smoke management is a key component of an efficient fire safety strategy and how it is addressed in practice.



B.I.O. FRAMEWORK

This factsheet has been developed with the support of the Federation of European Heating, Ventilation and Air Conditioning Associations, REHVA, who published an extensive guidebook for engineers [1].

REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

Introduction

All smoke is toxic, regardless of its origin or composition. As such, smoke inhalation remains the primary cause of death in fatal fires across Europe. A key goal of the fire safety strategy of a building is therefore to avoid exposure to smoke. A relatively small fire inside a building may still generate a copious amount of smoke, even when limited to the object of origin. Moreover, smoke can easily spread beyond the room of origin if sufficient protection measures are not in place. While smoke inhalation is a significant risk, smoke can also decrease visibility, causing building occupants to panic during an evacuation and complicate firefighter interventions.

Smoke and fire detection as well as automatic extinguishing systems and compartmentation are vital aspects of a fire safety strategy that help to avoid exposure to smoke. Smoke management aims to actively or passively control the movement of smoke within buildings to avoid its spread and allow for both a quick and safe evacuations of occupants and easy control of the fire by fire brigades.

Smoke management is not aimed at extinguishing the fire. Rather, its primary goal is to allow for the evacuation of occupants and easy access to the location of the fire by firefighters.

The best way to protect people from smoke is to reduce exposure

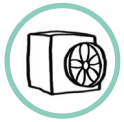
Smoke and hot gases generated by a fire pose a significant risk to people.

Among other hazards, smoke causes the following dangers:

- Can accelerate the spread of a fire due to their versatility and high temperature
- Can affect structural elements by subjecting them to high temperatures
- Can flood escape routes and exits leading to a possible entrapment
- Can make identifying the location of the fire problematic as well as making it more difficult to control and extinguish
- Can cause elements that are not affected by high temperatures to suffer significant deterioration due to the smell and corrosion of smoke and combustion gases

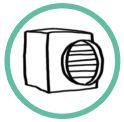
Different smoke management methods can be used

Various smoke management principles and methods can co-exist to fully adapt to the topology of the building. For example, some smoke management systems enhance the dilution or the layering of the smoke. Other methods such as the Pressure Differential System (PDS), keep specific areas smoke free such as evacuation routes, staircases or lift cases. Smoke compartmentation retains and compacts the smoke in its initial location or a dedicated area.



EVACUATION

A. Dilution of the smoke
B. Layering/stratification
C. Pressure Differential Systems (PDS) of the smoke



COMPARTMENTATION

D. Smoke compartmentation

FIREFIGHTING
STRUCTURAL SAFETY
COMPARTMENTATION
EVACUATION
EARLY SUPPRESSION
DETECTION
PREVENTION

A. Dilution of the smoke

Smoke dilution occurs following the introduction of air streams that extends the smoke to the upper areas of the room. The smoke rises and permits occupants to evacuate.

Dilution occurs via operating ventilation systems or unregulated supplies of fresh air by air inlets.

To secure an efficient extraction, the volume of the flow of ambient fresh air should be equal to the volume of smoke.

The benefits of smoke dilution are:

- Increased visibility, providing occupants more time to escape
- Reduced gas and smoke temperature preventing self-ignition of unburnt elements
- Improved conservation of allowable pollutant air concentration, which limits intoxication of occupants

t is important to note, however, that in the case of a fire that has been developing for several minutes, dilution cannot be achieved using natural or mechanical smoke extraction systems or aerators used by fire brigades and can conversely contribute to the spread of the fire. At this stage of a fire, the focus is on limiting smoke temperatures to remain under flashover conditions.

Solution to dilute the smoke: Use of ventilation system or air inlets

B. Layering of the smoke

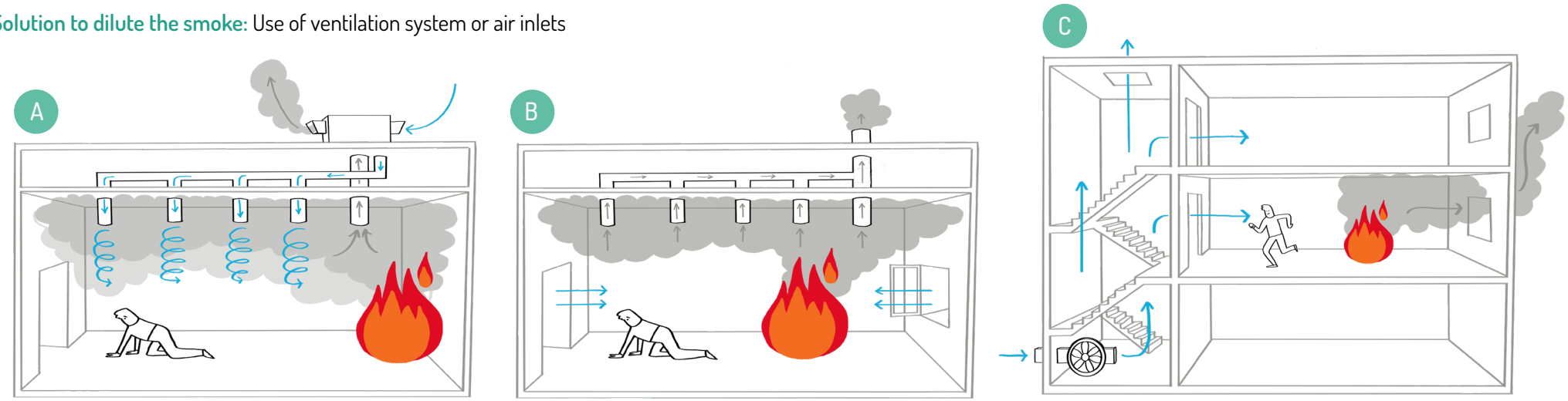
The layering of smoke consists of a low impulse air supply in the lower section of the room that clears the lower part of the room, allowing occupants to escape. The dimension of the extraction system must be adjusted to the typology and size of the room to clear the smoke efficiently.

Smoke layering systems: Mechanical smoke extraction system

C. Pressure Differential Systems (PDS)

This method to prevent the inflow of smoke in dedicated areas (such as evacuation routes, stairs cases, etc.). It consists of activating fans that creates an excess of pressure (overpressure) that will contain the smoke from spreading. This system takes into account the variation of pressure caused by the opening and closing of fire doors, the evolution of temperature from fire, the air density as well as structural leakages in walls, doors, roofs...

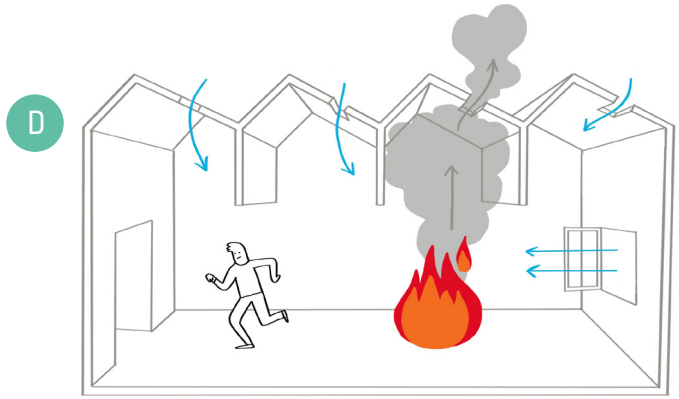
PDS systems: Air supply fans, pressure control dampers, air (smoke) release openings



D. Smoke compartmentation

In many cases, it is useful to divide fire compartments into smoke compartments. Smoke compartmentation aims at compacting and containing smoke in a dedicated area, limiting the spread of smoke.

Smoke compartmentation solution: Smoke curtains and barriers.



Conclusion

Smoke management must not be confused with extinguishing strategies. Smoke management aims to ensure occupants can leave the building and firefighters can reach the blaze as quickly as possible. Efficient design and effective functionality of smoke management systems are crucial in the case of a fire. It requires adequate engineering competencies to be provided by the ventilation engineer in collaboration with the fire engineer and the architect. The maintenance, testing and inspection of installations should be done regularly to ensure the system's performance.

Fire safety depends on the interaction of a myriad of good practices. Prevention, detection, early suppression, compartmentation, evacuation, structural safety and firefighting are the 7 layers that should be covered to ensure the fire safety of buildings.

To know more

1. Guidebook published by REHVA, "Fire safety in Buildings – Smoke management guidelines", #24, 2018
2. EU Fire Safety Guide, https://www.modernbuildingalliance.eu/EU-fire-safety-guide
3. IFV experiment: Practical research on smoke propagation (Ouderwater Experiments) – Hans Hazebroek and Lieuwe de Witte. https://www.youtube.com/watch?v=0MT0cGT0ryU
4. About smoke toxicity: https://www.modernbuildingalliance.eu/smoke-toxicity/

References

1. Guidebook "Fire safety in Buildings – Smoke management guidelines", The Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), publication #24, Reprint 2018
2. Der Fachverband Tageslicht und Rauchschutz, https://www.fvlr.de/mra_projektierung.htm accessed in July 2020
3. 'Propagacion de los incendios mediante las humos', Antonio Galán, 2016, accessed in July 2020 https://elblogdelaseguridadcontraincendios.es/propagacion-de-los-incendios-mediante-los-humos/
4. https://www.nist.gov/el/energy-and-environment-division-73200/nist-multizone-modeling/applications-contam/smoke accessed in July 2020

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