Steps to safety

Selecting the most suitable smoke control system for high-rise residential buildings calls for a degree of common sense, says **Paul Compton**

SMOKE IS the biggest killer in a fire – it reduces visibility to the point where it is difficult to find escape routes and incapacitates people very quickly. That is why it is critical to have an effective means of extracting smoke in case of fire.

What is the job of a smoke control system and why do we need it? Although all too often the answer is 'building control sign off with the minimum cost and effort', in fact the objective is primarily to protect the stairs against smoke ingress. Stairs are important because they are the main escape route and need to be available – therefore smoke-free – for a long period of time, due to the normal stay-put policy for residential buildings. The stairs also need to be available to firefighters for as long or longer, both for access and for tactical withdrawal.

In the UK, the approach to smoke control is to provide ventilation to the stair and to each lobby or corridor opening onto the stair. No ventilation is provided in other corridors, where cross corridor doors limit smoke spread. No smoke control is provided in the apartments themselves.

Before 2007, the approach was different. In these buildings, dead ends rather than spaces opening onto stairs (often the same spaces, but not always) were ventilated, and the stair ventilator(s) was expected to protect the stair from excess smoke.

Smoke control designs are based on the assumption that there is only one fire, that it is contained within one apartment, and that the apartment's fire door remains closed except when opened deliberately. While there are rare occasions when these assumptions are not valid, making them allows designs that are practical and cost effective.

Tall buildings

So what is special about tall buildings? To start with, in a high-rise building, people are less likely to know the layout of the stairs. Who would willingly walk more than four or five storeys by stairs when a lift is available? Also, the stairs are often not very hospitable spaces, as they will generally be designed for escape rather than circulation. In addition, it's much harder to enter a smoke filled stair knowing you have 20 storeys to descend rather than just a quick dash down two or three.

The Building Regulations allow smoke ventilation either by automatic opening ventilators (AOVs), natural shafts, mechanical shafts or pressure differential systems. They are all treated as equivalent except for a few special cases. However, they aren't equivalent in performance; they're just all deemed to satisfy.

It is worth noting that neither Approved Document B (ADB) of the Building Regulations, nor BS 5588

specifies any different approaches for high-rise buildings. BS 9991, on the other hand, does differentiate for tall buildings by requiring a pressure differential system to EN 12101-6 for firefighting stairs in buildings over 30m. This is usually taken to mean a stair pressurisation system, although a depressurisation system would also comply.

Some suppliers of mechanical shaft systems might refer to depressurisation to EN 12101-6, but a mechanical shaft system is not true depressurisation. When the standard was effectively written in 1997/8, mechanical shaft systems did not exist and the concept of depressurisation referred to depressurising the space containing the fire, not an intervening space between this and the stair.

To some extent the ventilation system for a tall building is self-selecting: stairs and lobbies are usually landlocked, so AOVs are not suitable (fortunately, as their performance under wind conditions is very variable), and space is at a premium, so space for a natural shaft system can be hard to find. This leaves mechanical shafts and pressurisation.

The premium on space also leads to building design choices that affect the possible ventilation solutions. For example, the use of the minimum number of stairs and the desire to allow extended dead end travel distances mean that pressurisation is unsuitable: the longer corridor would have to be pressurised, which would require accommodation air release from every apartment. Aside from being costly, this would lead to difficult future maintenance problems. As a result, enhanced mechanical systems are usually offered, to compensate for the longer travel distances.

These systems raise some difficulties for building control bodies because the system design and the shaft locations are critical and are usually proven by computational fluid dynamics (CFD). This requires an expert to properly review and approve it, as well as an expert to originally generate it.

All this means that if a building is designed to BS 9991, designers can have problems, as the standard recommends a smoke control system that is not suitable for extended corridor layouts. In this case, common sense dictates that the most suitable system should be selected, rather than one following the standard.

Ongoing performance

Whatever system is finally chosen, it is critical that it works well and continues to do so over the years, even if it becomes outdated due to changes in legislation and standards. For example, some AOVs installed to the pre-2006 editions of ADB will no doubt be too small according to the current definition in diagram C7, and some will be in what is now considered to be the wrong location. However, they wouldn't necessarily need to be replaced: maintenance to keep them operating correctly and a sensible risk assessment could allow these 'out of date' AOVs to provide suitable protection for many years to come.

Recurring issues

Some issues regularly recur, particularly on older mechanical shaft systems, which started to be installed from around 2003.

For example, regular tests and false alarm resets are usually carried out remotely, so finger trapping can be an issue. The management system should ensure there is someone standing beside each vent when they are being reset – unless guarding, anti-trapping software on the motors or a local manual reset switch are provided.

Lobby vents need to be 30-minute fire resisting and must not fail to the open position (they should fail to their current position), so that the shaft won't allow smoke and fire spread between floors, and so that a mechanical extract will only extract from one storey and not dissipate its performance over several storeys. Electromagnet control does not meet this requirement.

There's nothing wrong with mechanical shaft systems pulling the stair door ajar against a properly set up adjustable door closer to provide a source of replacement air. However, it is important to check if older systems are still properly set up, if any door closers have failed and been changed for whatever is easily available, and if there is a clear responsibility for their maintenance.

Running other services through a smoke shaft was only explicitly banned in 2011 by BS 9991. It's never been good practice, but it has always been tempting to use the shaft as an overspill services riser. But what happens if the services collapse under the heat in the riser and partially block it?

Older systems

The building leakage rate is critical to pressurisation system performance, but it can change over time: new services openings may not be properly sealed, lobbies may be altered and finishes may be updated, etc.

Pressurisation tests are needed regularly to ensure adequate pressurisation is still being achieved. I would never recommend bringing pressurisation right up to the apartment door, but building control bodies have been known to demand this and there are such systems out there. Accommodation air release, which allows the door open velocities to be achieved, then has to be provided from each apartment. How do you control the condition and maintenance of important fire safety equipment located in private apartments?

Architectural choices

In ADB compliant buildings, the regulations and standards don't cover some architectural decisions that can have a big effect on the system's performance. With natural systems, it is critical that smoke is encouraged to leave the lobby or corridor via the AOV or shaft, not the stairs. In this case, applying common sense can help:

- full height stair doors have no down stand above them to stop a ceiling jet in its tracks, so are better avoided
- putting an apartment door opposite a stair door means that the smoke flow is directed straight at the stair door – an offset is good practice
- ideally, the location of the extract should pull smoke away from the stair door, not towards it
- the top of ventilators, particularly in natural systems, should be as high as possible, not just 'level with the top of the door', as the requirement in ADB is often interpreted

Final thoughts

Smoke control is particularly important in tall buildings, as its primary purpose is to protect the escape stair. It's not just a final bolt-on solution, but should be considered in the early stages of design – although changes to plans can be accommodated. In high-rise buildings it may not be enough to follow the letter of ADB and BS 9991; adding common sense is always a good idea.

In existing buildings, there is a wide variety of systems, so the responsible person needs to know what is installed, how it operates and where it deviates from current good practice.

A good source of extra guidance is the Smoke Control Association's publication, *Guidance on smoke control to common escape routes in apartment buildings (flats and maisonettes): 2010*, available free from ***www.feta.co.uk/associations/hevac/hevac-publications*** ■

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