

Expect building failure – firefighters must always expect and plan for worst-case scenarios

Fires in residential high-rise buildings present tremendous challenges to firefighters, where inappropriate structural design, construction omissions and poor maintenance lead to widespread systemic failure. However, firefighters are now facing even greater challenges in these buildings due to more recent shifts in human behaviour.



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We know from experience that uncontrolled self-evacuation from residential buildings involved in fire is now commonly occurring. In the space of just 14 months, London Fire Brigade, for example, have recorded 20 fires where more than 40 occupants had self-evacuated tall residential buildings. We now prepare our firefighters to expect building failure, to expect the worst-case scenario and, most importantly, to always assume people will be self-evacuating in the stairwells. Wherever possible, the laying of hose-lines through stair doors should be avoided, to prevent or reduce dangerous amounts of smoke from entering the stairwell.

Examples of multiple building occupants being overcome whilst attempting to escape in heavily smoke-logged stairwells:

- In 1995, six people died in a stairwell of a burning high-rise apartment building in Ontario, Canada.
- In 1998, four people were overcome in a New York City smoke-filled stairwell during a high-rise apartment fire.
- In 2004, six Chicago office workers were trapped and overcome in a smoke-filled stairwell whilst making several 911 emergency calls for assistance.
- In 2017, a number of residents were overcome in a smoke-filled stairwell whilst attempting to escape the Grenfell Tower fire in London.
- In 2022, the FDNY reported that a number of residents were reportedly overcome in the stairwells of a Bronx apartment building in New York City. There were 17 fatalities overall.

It is clear that the fire service do have a responsibility to make all efforts to maintain protected escape routes and stairwells from any infiltration of smoke and combustion products, so that self-evacuating residents are able to escape in tenable conditions. Any decision or action that compromises the building's design intent to prevent smoke from infiltrating egress routes must be made with justifiable and purposeful intent.

Whilst there is often a clear benefit in an early firefighting action, human behaviour research demonstrates that many residents are likely to act on local fire instructions, which may suggest they leave, where they feel threatened. Despite designing for and encouraging a 'stay put' (defend in place) building fire strategy in the UK, the regulatory requirement is that: 'Sufficient protection to common means of escape is necessary to allow occupants to escape **should they choose to do so** or are instructed/aided to by the fire service. A higher standard of protection is therefore needed to ensure common escape routes remain available for a longer period than is provided in other buildings.' (s3.3 ADB-1 2019: (in part))

In situations where some, or all of the following exist:

- a) the building construction is obviously failing;
- b) building systems, installations or firefighting facilities are failing;
- c) where an external wind is impacting the fire-involved side of a building; or
- d) where the stair door is breached by hose-lines;

There should be some immediate consideration to prioritise the protection of people in the stairs over firefighting. This may require a command decision to be made with adequate measures of both situational awareness and haste. It requires some timely decision controls that consider if the suppression of a rapidly spreading fire that is not contained, is the most appropriate and viable strategy to save life. An external wall-cladding fire involving an 18-storey building in Milan in 2021 saw the fire department prioritise evacuation over internal firefighting, managing to evacuate all residents down the single central core stairwell that remained protected and smoke free (Figure 1). The fire at the Torre Del Moro began on the 15th floor and demonstrated multi-level compartment involvement (Figure 2) as the fire rapidly spread to involve almost the entire external wall (Figure 3).



Images courtesy of Vigili Del Fuoco.

▲ Figure 1.



▲ Figure 2.

Stairwell protection – a decision control process

Smoke control systems and fire resistive measures are provided by codes to 'protect the stair' for escaping occupants above the fire floor in 'stay put' 'defend in place' buildings, even during firefighting operations. Therefore, tactical objectives should embrace an intention to maintain escape routes 'smoke free' at all times, as part of any evacuation strategy. Whilst the fire service may have no direct responsibility in the evacuation of fire involved buildings, inevitably they will take responsibility when a building begins to fail by design, or where specific fire behaviour surpasses the passive or active design limitations. There has to be foresight of such failures and firefighting tactics and command strategies that encompass evacuation need pre-planning, training and equipping for. It is not appropriate to consider that any operational discretion policy might be used to approve actions that are reasonably foreseeable.

The tactical concept of 'Stairwell Protection Teams' originates from the 'Rapid Ascent Teams', that were introduced by Chicago Fire Department in response to a fire in 2004 where six occupants died in a smoke-laden stairwell. In 2010, Kent Fire and Rescue Service introduced the Rapid Ascent Team strategy for promptly searching high-rise stairwells, along with the R.I.C.E. command mnemonic (Rescue – Intervention – Containment – Evacuation).

This required an Incident Commander to follow a rapid but structured *decision control* process, prioritising the most appropriate action, based on a series of predetermined triggers (*Gulf Fire*, January 2016). Most importantly, the benefits of containment and evacuation options were at least considered, prior to internal firefighting taking place.

When you think more about this, it is a life-critical strategy that should be initiated from the point of arrival on-scene, at the earliest opportunity. In considering the potential evacuation of tall residential buildings, the act of controlling and protecting the stairwells from the outset and allowing self-evacuating occupants to naturally decant, will ensure an access and egress route is always available, should a full evacuation ever become necessary.

■ **Stairwell protection** is primarily a proactive strategy that is directed at protecting occupants who may already be self-evacuating, whilst at the same time securing or preparing stairwells for an emergency evacuation should it ever be needed during firefighting operations. The strategy is aimed at using all available means, tactics and resources to mitigate smoke infiltration into stairwells that should be implemented on arrival, as a primary high-rise firefighting strategy.

■ **Stairwell search** is where teams of firefighters are deployed reactively in a failing building to areas above the Bridgehead (Forward Command Post) to search for, assist or rescue occupants who are trapped or threatened by fire or smoke. In order to do this, a search sector and a search and rescue commander are established.

Stairway protection team objectives

- To maintain tenable levels in stairwells being used by self-evacuating residents.
- To prepare stairwells, should they be needed for an emergency evacuation.
- To monitor fire gas levels within the stairwell and report details to the Bridgehead.
- To advise, support and escort down (where necessary) residents in the stairs.
- To provide smoke hoods to residents (where available) in accordance with guidance.
- To refuge residents where stairwell tenability is beyond acceptable AEGl levels.
- Ensure vulnerable or mobility-impaired residents are identified, located and either supported in situ, escorted down, or rescued, depending on the situation.
- To ensure all doors into the stairwell remain closed, as far as possible.
- To protect stair doors from smoke infiltration by deploying smoke-



◀ Figure 3.

It is here that building designers can assist firefighters and further protect residents in providing a fire-protected lobby between the stair and accommodation corridor. The lobby should be equipped with a rising main stand-pipe large enough to support twin outlets for two separate hose-lines at each floor level. In the UK there is a code of practice (BS PD 7974-5) supporting 150mm rising mains and enabling twin outlets at each floor. This design guidance offers the following advantages:

- The stair door can remain closed during firefighting and residents in the stair are protected from smoke.
- The provision of a pressurised stair will further enhance protection.
- Firefighters can operate with greater safety and for longer duration within the stairwell, assisting residents who may be self-evacuating.
- The provision of an attack hose-line, supported by a safety hose-line, from the twin outlets in the firefighting lobby will reduce firefighter physiological impacts, in not having to lay hose-lines up narrow stairwells to upper levels.
- Stairwells remain free of hose-lines and trip hazards.
- If firefighters are forced to retreat from the fire floor under emergency evacuation conditions, their egress is fully protected by a closed door in the stairwell.

In some multi-stair buildings the fire service approach may take the form of designating a fire attack stair and an evacuation stair. This may be determined either by (a) design (some stairs may have specific ventilation systems, such as smoke towers, for evacuation), or by (b) fire location (generally the nearest stair to the fire). In such cases, stairwell protection teams may still be needed to ensure the fire attack stair, in particular, is protected and searched. Portable smoke blocking curtains and positive pressure ventilation may further assist in these cases.

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blocking door curtains as an additional preventive measure.

- To control ventilation in the stair, using portable PPV fans where viable.
- To continually update information on the status of the stair to the Bridgehead.

When monitoring gas levels and considering what are tenable limits, there is relevant international guidance presented in the form of Acute Exposure Guideline Levels (AEGLs) for the two most common asphyxiant and toxic fire gases such as carbon monoxide and hydrogen cyanide. AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes (min) to 8 hours (h). Three levels – AEGL-1, AEGL-2, and AEGL-3 – are developed for each of five exposure periods (10 and 30 min and 1, 4, and 8 h) and are distinguished by varying degrees of severity of toxic effects. The recommended exposure levels are applicable to the general population, including infants and children, and other individuals who may be sensitive or susceptible.

- **AEGL-1** is the airborne concentration (expressed as parts per million [ppm] or milligrams per cubic meter [mg/m³]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
- **AEGL-2** is the airborne concentration (expressed as ppm or mg/m³) of a substance above which it is predicted

that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.

- **AEGL-3** is the airborne concentration (expressed as ppm or mg/m³) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Note: Although the AEGLs represent threshold levels for the general public, including sensitive subpopulations, it is recognized that certain individuals, subject to idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL.

Approaching a fire from behind the protection of fire-resisting doors

Whilst it is clearly essential that firefighters initially approach a fire from a safe area and utilise a range of precautions and control measures in order to enhance their safety, it is acknowledged that firefighters have developed a strong preference for initiating their attack from behind the protection of one, or multiple, fire doors existing between the involved fire compartment and the stairwell. In many high-rise situations, this causes fire attack hose-lines to be laid from a rising main standpipe outlet in the stairwell, possibly even from floor levels below. This causes the stair door to remain held open by hose, potentially allowing large amounts of smoke to enter the stairs. It is also true that firefighters are trained to follow a hose-line back to the stairwell door in almost zero visibility, should they need to retreat back to the safety of the stair in a hurry.