Cladding System Toxicity Study

A brief summary of progress and outstanding issues

6th International Tall Building Fire Safety Conference

18th June 2019

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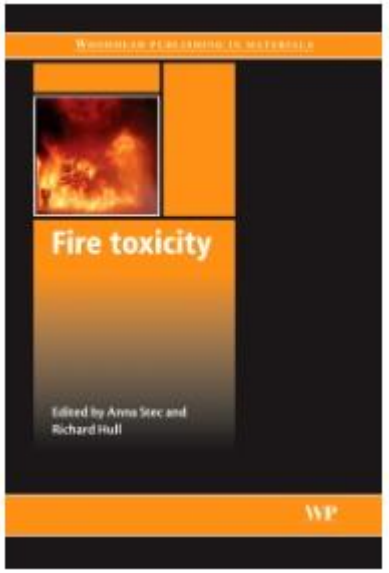
Fire Toxicity

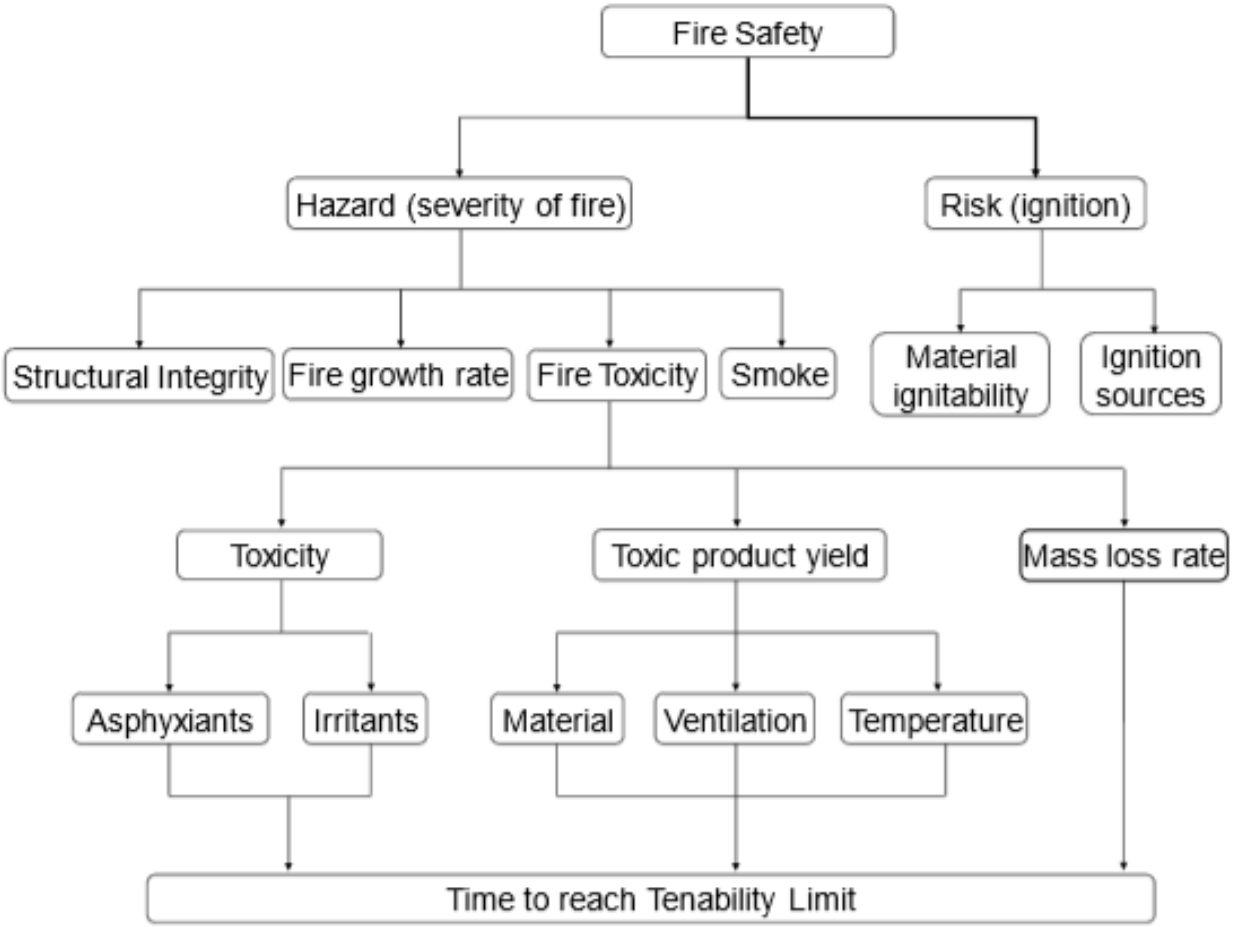
Toxic fire effluents are responsible for the majority of fire deaths, and an increasingly large majority of fire injuries, driven by the widespread and increasing use of synthetic polymers.

Fire safety has focused on preventing ignition and reducing flame spread through reducing the rate of heat release, while neglecting the important issue of fire toxicity.

Anna Stec & Richard Hull – Lancaster UCLAN



Fire Toxicity



Toxic threat

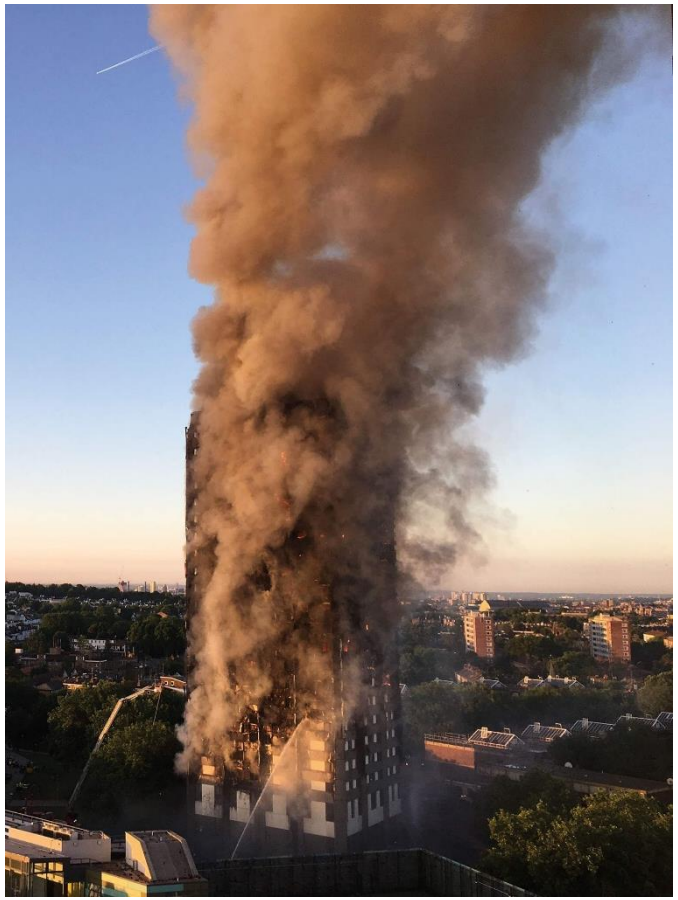
- Loss of visibility which may hinder escape
- Substances irritant to the eyes and lungs which may hinder escape (hydrochloric acid, formaldehyde, acrolein)
- Poisons that cause asphyxiation (preventing oxygen getting to the body) by:
  a) preferential combination with haemoglobin (carbon monoxide)
  b) by inhibiting cytochrome oxidase which prevents the use of oxygen by the body's cells (hydrogen cyanide)
- Gases that stimulate respiration thereby increasing the impact of other toxicants (carbon dioxide)
- Reduced oxygen availability as it is consumed by the fire
- Substances that exhibit longer-term toxicity to humans (particulates, carcinogens, and endocrine disruptors)

Toxic sources

- Working assumption has always been that the sources of toxicity stem from the furnishings and contents of the occupied space

Toxic sources

- Do we still think this is true?
- Do our regulations protect those inside a building well enough from building materials on fire outside it?



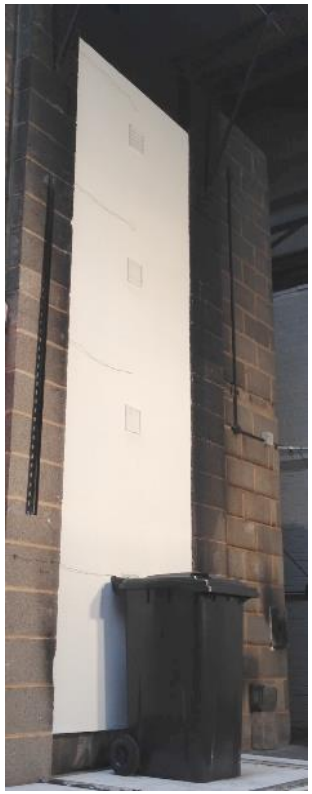
Potential for occupant toxic exposure from burning building products

- Point 1 – there is no toxicity limitation criteria for building materials
- Point 2 – there is no requirement to fire stop services penetrating the external envelop of the building
- Point 3 – the impact of penetrations on cladding fire performance is not assessed
- Point 4 – Fire can spread faster in the cladding void than some reactive cavity barrier devices can operate
- Point 5 – It is vital to understand how toxic threat is adjusted by the burning scenario

Legitimate breaching of the cladding system by un-fire-stopped devices

- The external envelope of a building is not considered a fire compartment boundary and as such there is NO requirement to fire stop penetrations.
- There is NO requirement to understand how penetration of the cladding by ducts and vents will impact a fire test (BS8414).
- We know from our testing of ETIC systems that this has the potential to radically alter test outcome.

Timber Frame & ETICS experience



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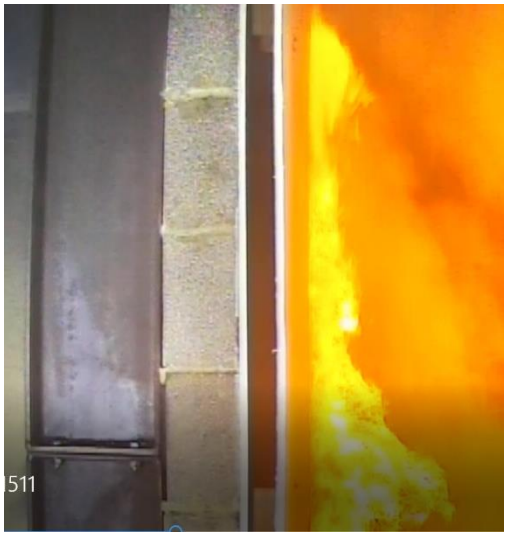
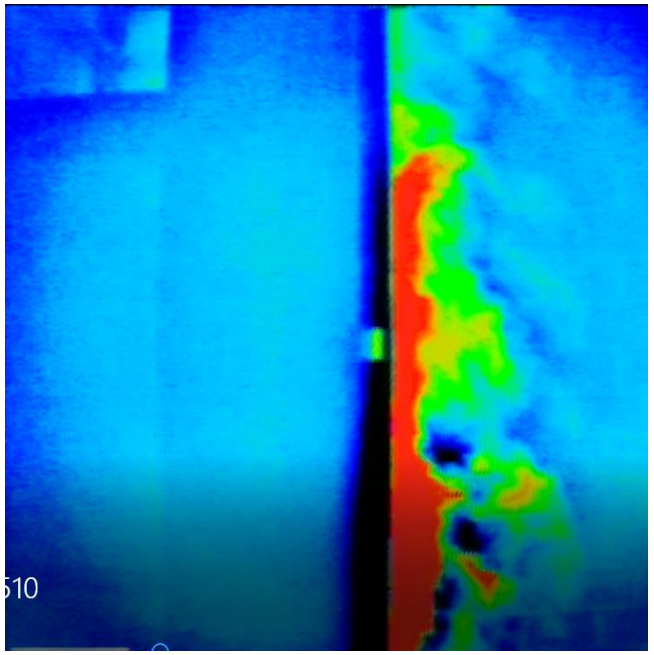
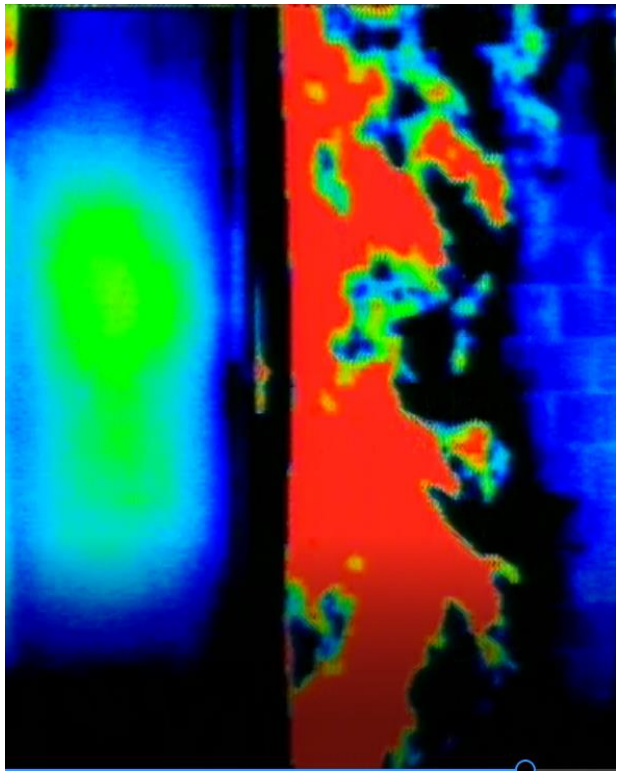






Performance of Cavity Barriers

Capability of intumescent cavity barriers in vented rainscreen systems

Issue:

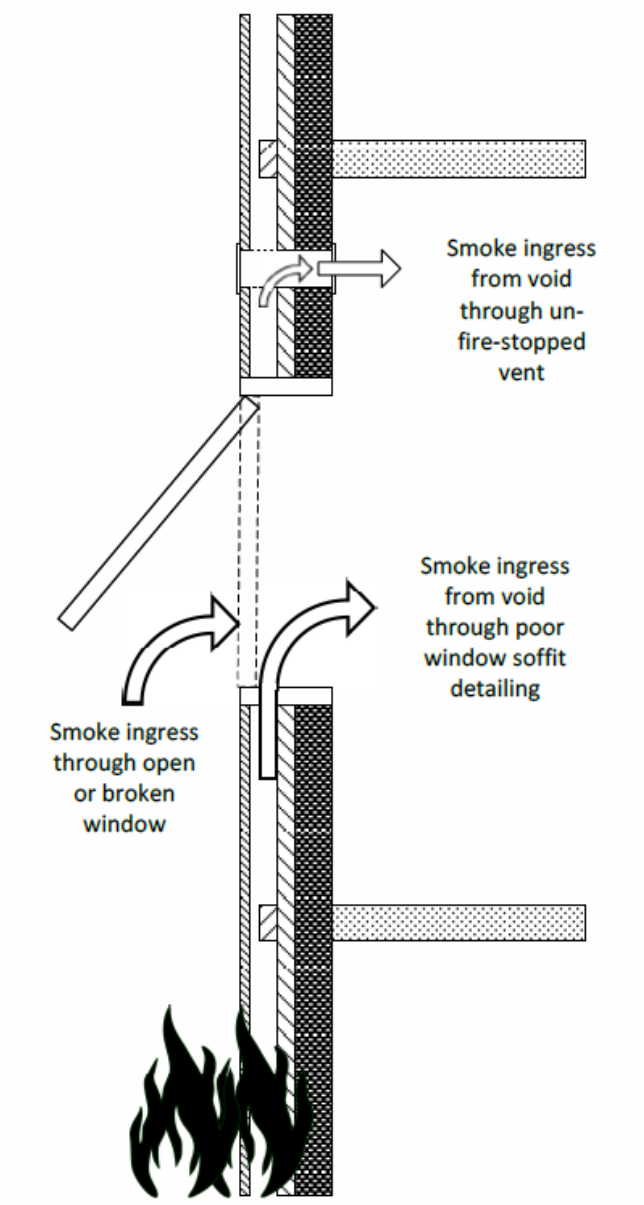
- BS8414 is not suitable for the evaluation of cavity barrier performance since the current configuration allows for pre-heating through the rain-screening without direct flame impingement
- A separate test should be considered that matches performance to the ignition properties of the materials they separate – including membranes

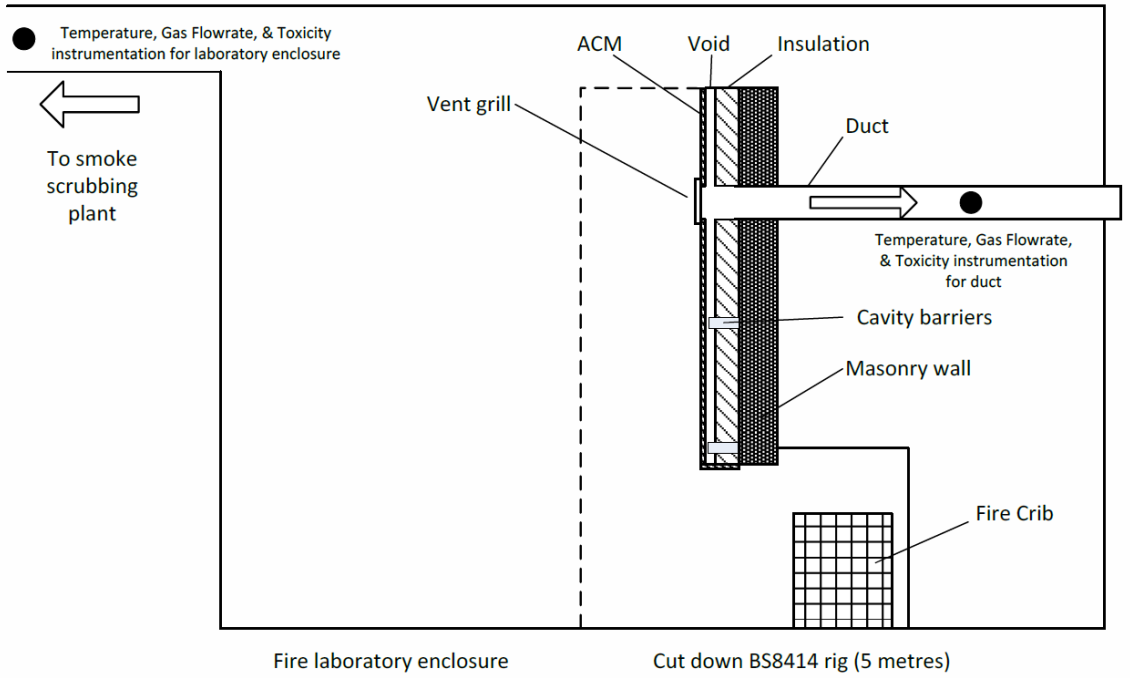
Summary

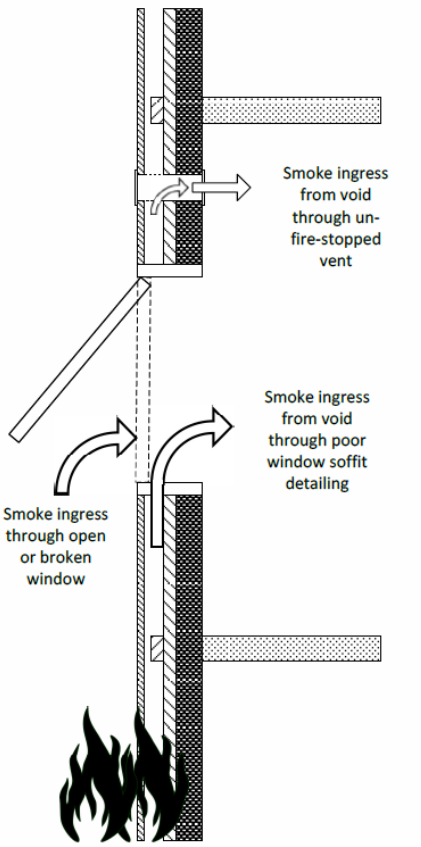
Cladding System Toxicity: it has been demonstrated that

- fire may enter the cladding void via ‘soft spots’
- in some material configurations cavity barriers may not prevent spread
- that there is potential for the communication of gases, smoke and fire to all occupied spaces that connect to the cladding void via i.e. vents

… so is their potential for occupant harm?


Smoke ingress from void through un-fire-stopped vent
Smoke ingress from void through poor window soffit detailing
Smoke ingress through open or broken window


Temperature, Gas Flowrate, & Toxicity instrumentation for laboratory enclosure
To smoke scrubbing plant
ACM
Void
Insulation
Vent grill
Duct
Temperature, Gas Flowrate, & Toxicity instrumentation for duct
Cavity barriers
Masonry wall
Fire Crib
Fire laboratory enclosure
Cut down BS8414 rig (5 metres)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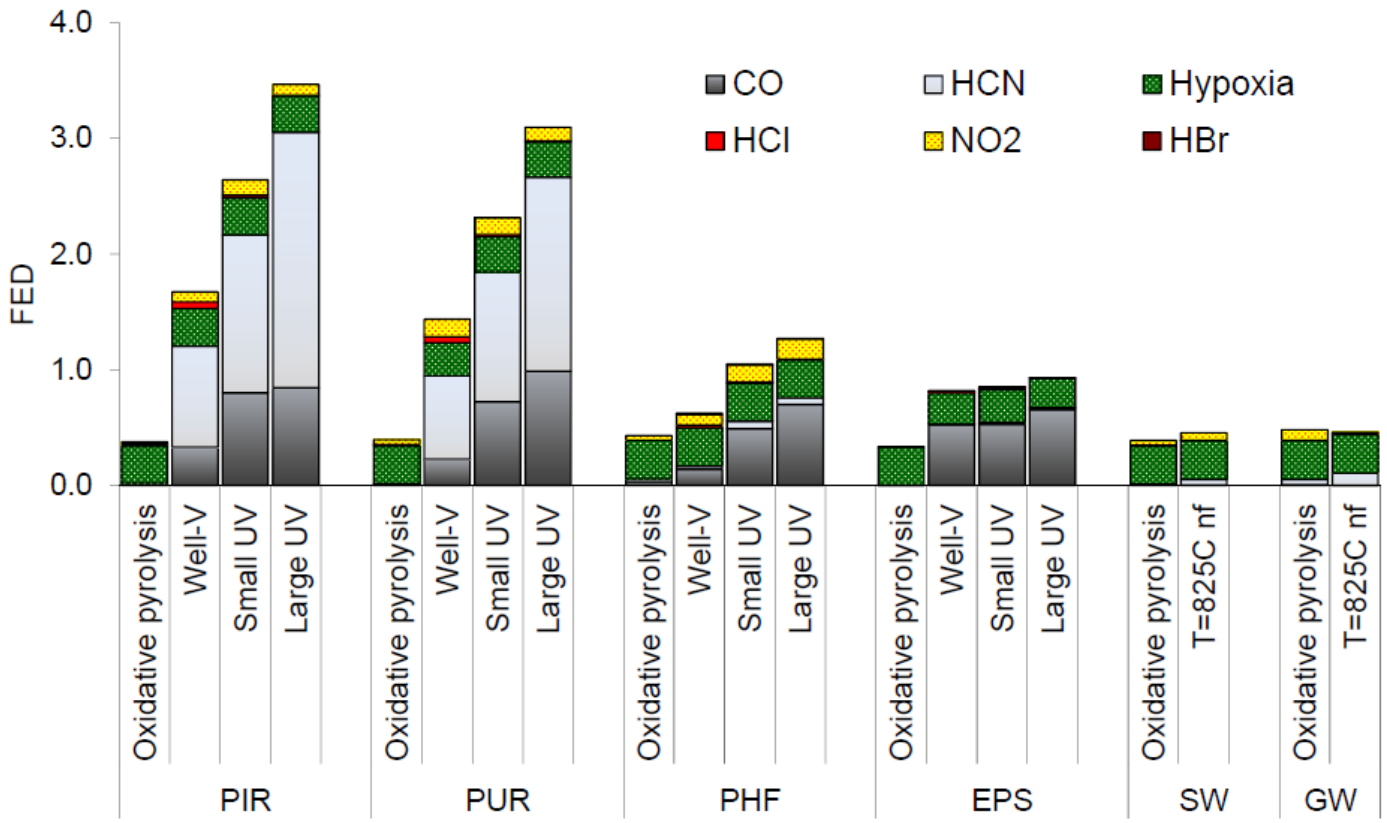
FED
4.0
3.0
2.0
1.0
0.0
CO
HCN
Hypoxia
HCl
NO2
HBr
Oxidative pyrolysis
Well-V
Small UV
Large UV
PIR
PUR
PHF
EPS
T=825C nf
SW
GW

Figure 3 - Stone wool insulated system with A2 ACM panels

Figure 4 - PIR insulated system with A2 ACM panels

Figure 5 - Phenolic insulated system with A2 ACM panels

Figure 6 - PIR insulated system with PE ACM panels (note test had to be stopped early, after 12 minutes)

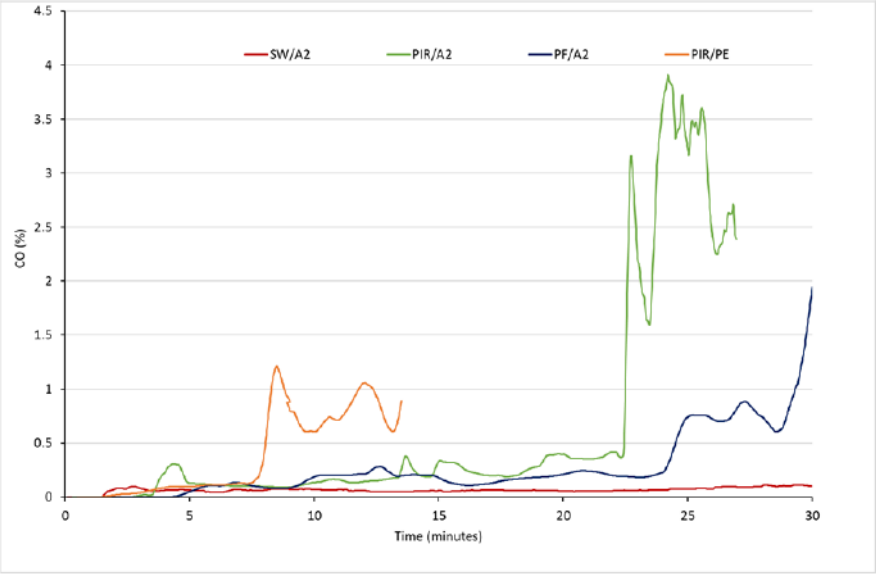

Figure 12 – Carbon Monoxide concentrations measured in cladding system vent

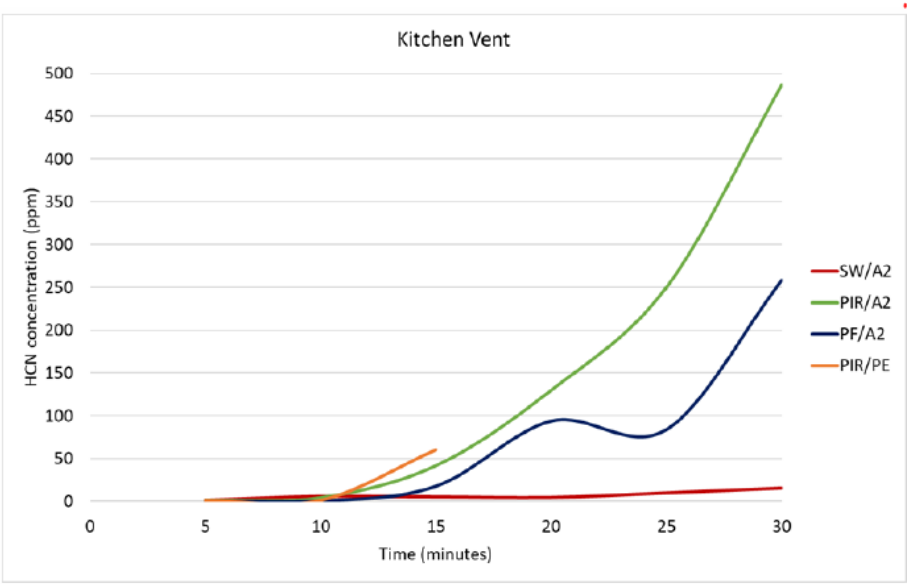

Figure 14 – Hydrogen Cyanide concentrations measured in cladding system vent

FED analysis of gases in 50m^3 room connected to cladding void via a 100mm diameter vent:

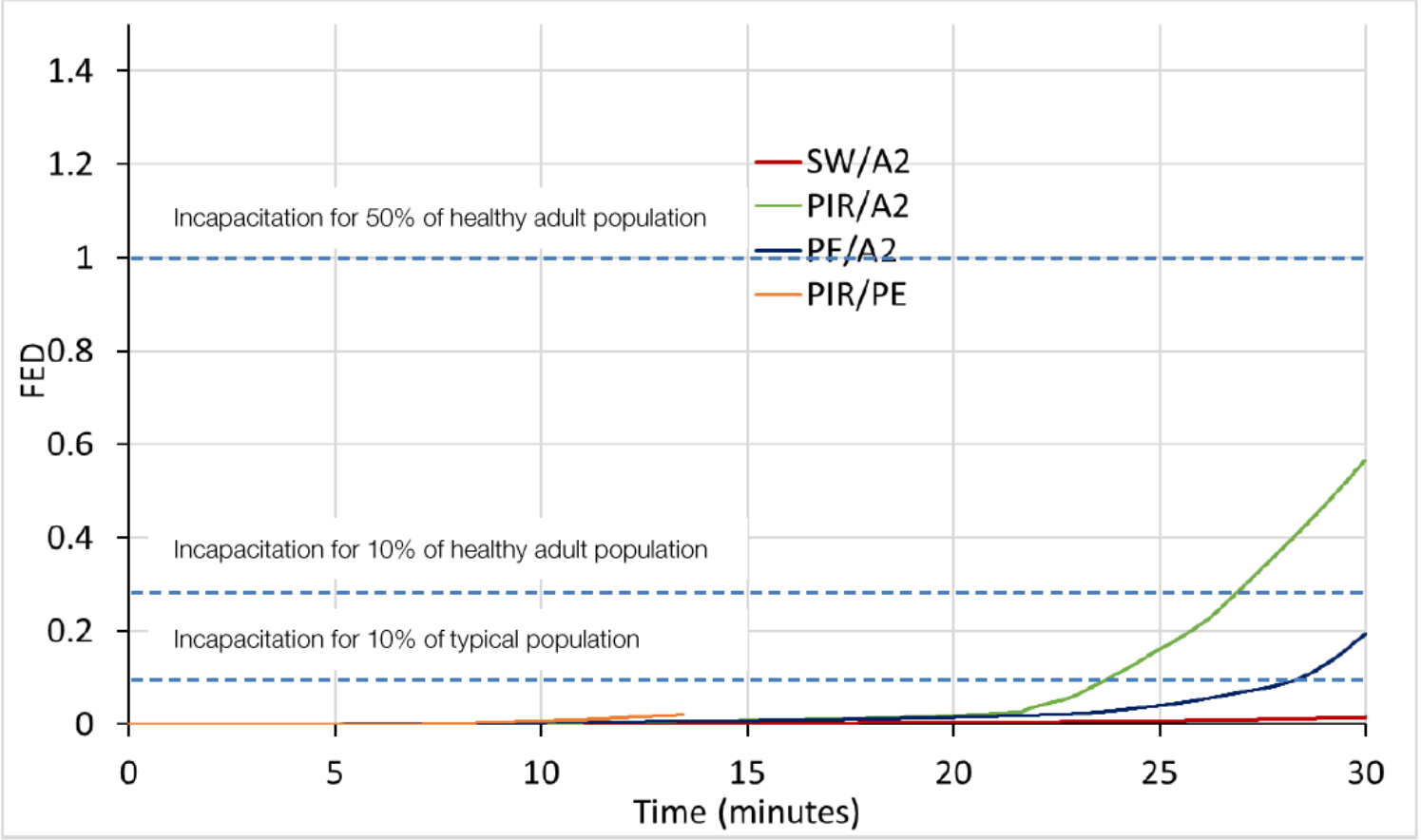

Figure 16 – Total FED for incapacitation for gases entering a 50m^3 room from cladding through 100mm vent (The curve for PIR/PE is shown until the wood crib was extinguished at 12 minutes)

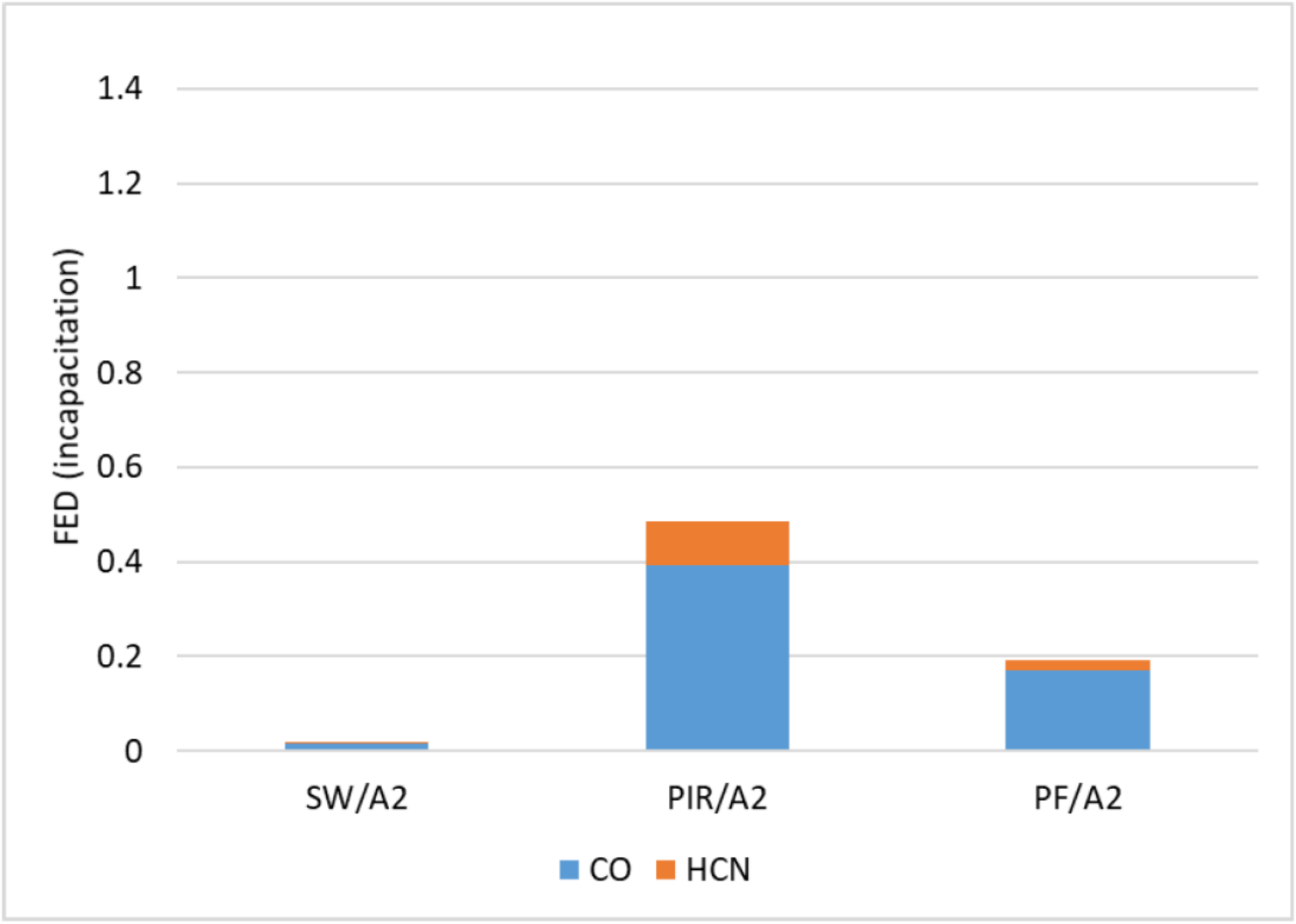

Figure 17 – Contribution of CO and HCN to incapacitation at 30 minutes for gases entering a 50m^3 room from cladding through 100mm vent

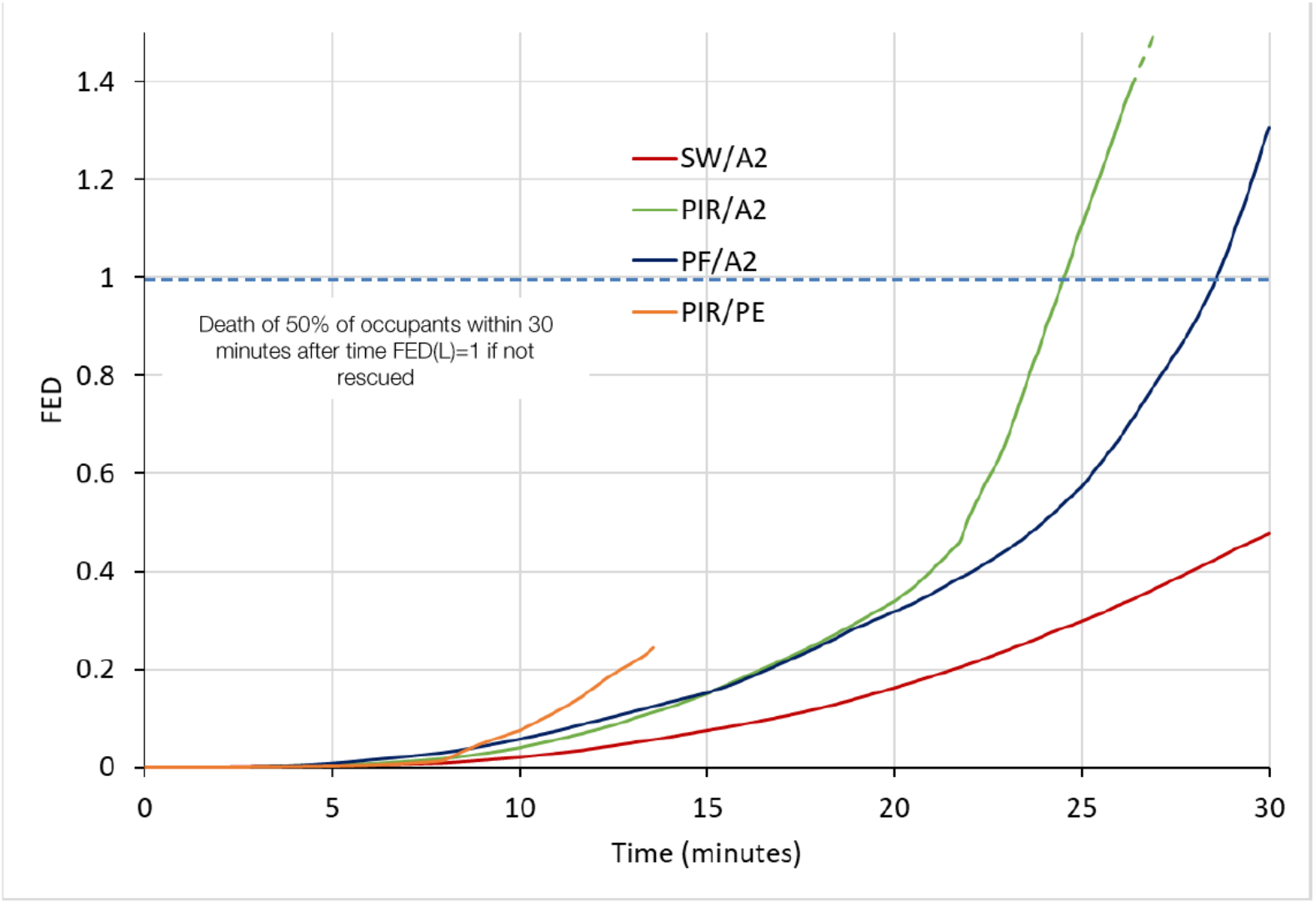

Figure 18 – Total FED for lethality for gases entering a 50m^3 room from cladding through 100mm vent (The curve for PIR/PE is shown until the wood crib was extinguished at 12 minutes)

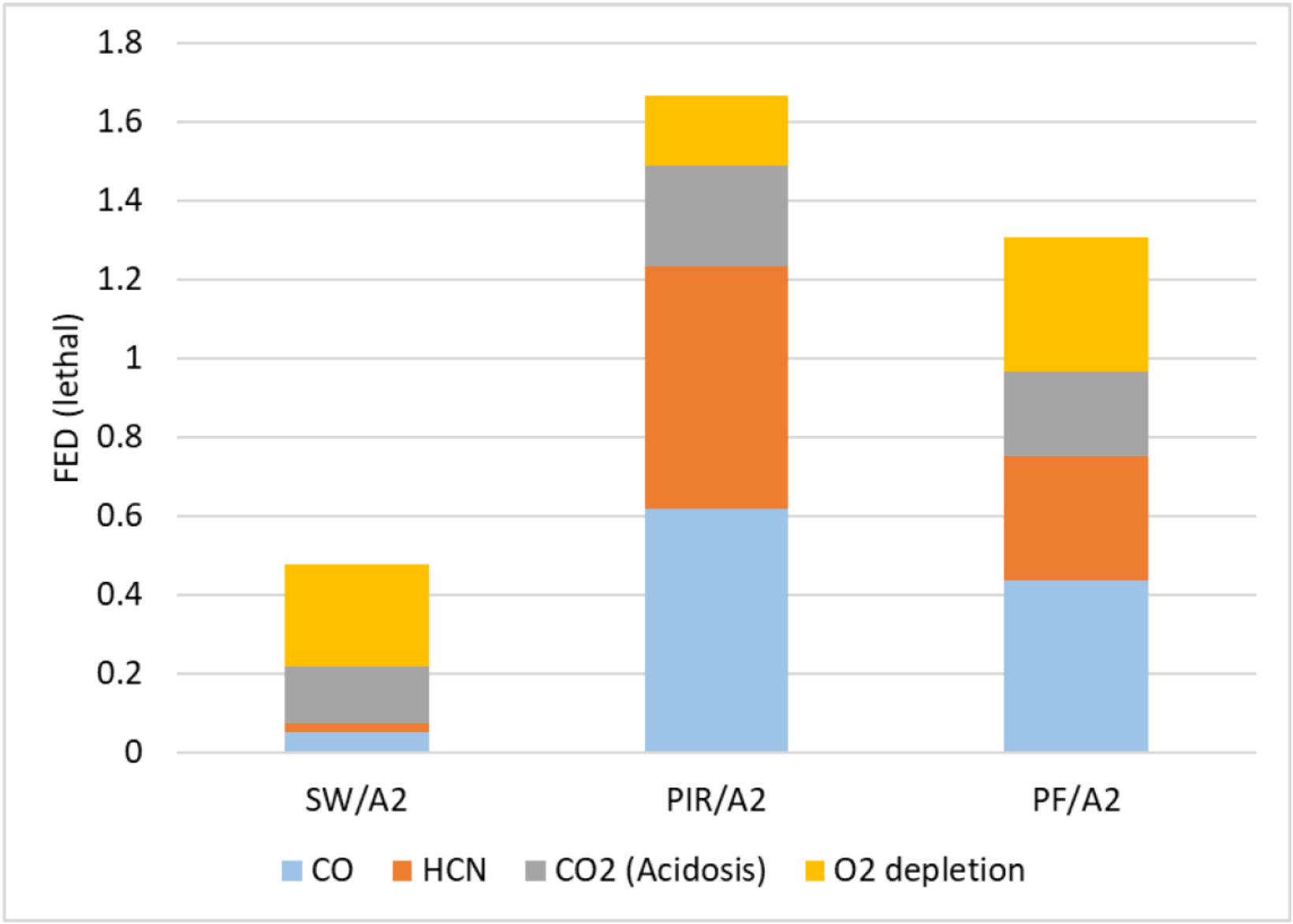

Figure 19 - Contribution of CO, HCN, CO_2 and O_2 to lethality at 30 minutes

For a 50m^3 room, connected to the rain-screen void via a 100mm vent, the results suggest that for some material combinations (ones with higher combustible content) incapacitation can occur in around 10 minutes after the fire breaks into the location of the cladding system containing the vent (at around 7, 22, and 29 minutes for PIR/PE, PIR/A2, and PF/A2, respectively), and, if they cannot escape before becoming unconscious, that death may follow within 30 minutes if they are not rescued.

Conclusions

- BS8414 testing neither looks for, or allows for an understanding of occupant toxic thread potential
- Regulations are inadequate for the separation of occupants from toxic harm from external building materials
- The toxic threat from materials burned in an oxygen starved environment (such as a cladding void) is many times that from its free burning value

FPA and UK insurers support the ban on combustible materials but would like to see the minimum height requirement removed. We also support the banning of single stairwells and the requirement for high-integrity detection systems.

Thank you

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