

## Performance Based Design in Fire Safety of Buildings

Although performance-based design (PBD) in the field of fire safety engineering has been in existence for more than two decades in some countries, there still appears to be a lack of clarity about what PBD actually is<sup>1</sup>. This might be because of the significant differences in building methodologies used in different member states, which influence local standards and industry practice. In Sweden and UK, the countries that have the most experience of PBD, local authorities still have a high degree of influence over which fire design solutions are approved<sup>2</sup>.

Performance-based design (PBD) in fire safety is an approach that focuses on achieving specific fire safety goals and objectives through a more flexible and innovative design process. Unlike prescriptive codes, which specify exact materials and designs, PBD allows designers to choose materials and systems that meet the desired performance criteria. By adopting a performance-based approach, fire safety design can be optimized to achieve specific goals and objectives e.g. safe evacuation within a specified time or structural stability for a specified time.

The fundamental principles guiding PBD require an holistic approach at system level by relying on science-based fire safety engineering methods. As promoters of the holistic approach to fire safety in buildings, the Modern Building Alliance developed the [“Seven Layers” concept](#) for fire safety in buildings. The Modern Building Alliance presented this concept as part of the novel [“B-I-O framework”](#) with a comprehensive and structured list of elements, for Member States to consider whilst reviewing their approach to building fire-safety regulation.

The key steps in PBD for fire safety are:



<sup>1</sup> <https://www.sfpe.org/publications/periodicals/sfpeeuropedigital/sfpeurope17/issue17feature2>

<sup>2</sup> [https://people.fsv.cvut.cz/~wald/fire/COST\\_C26\\_Prague/pdf/5-1\\_Fire%20design%20in%20Europe\\_sm.pdf](https://people.fsv.cvut.cz/~wald/fire/COST_C26_Prague/pdf/5-1_Fire%20design%20in%20Europe_sm.pdf)

The benefits of PBD come with some downsides. More quality control may be required during the design process and after the building is occupied. The use of functional performance criteria and trade-offs in FSE require the engineer to have high ethical standards, as they must adopt an independent position and a high level of self-criticism. Ethics also play a role in researching alternative products, components and/or subsystems<sup>3</sup>.

A significant advantage of Performance Based Design is the flexibility it offers in architectural and material choices. PBD allows designers to use innovative materials and construction techniques, provided they meet the safety performance criteria. This includes the use of alternative materials, advanced composites, or unique architectural features such as large atriums and open floor plans, which may not conform with traditional prescriptive codes<sup>4</sup>.

This flexibility supports the creation of buildings that are not only safe but also architecturally distinctive and functional. For instance, modern glass facades, innovative building materials, and new construction technologies can be incorporated into designs, enhancing both aesthetic and environmental performance<sup>5</sup>.

## Advantages of Performance Based Design

1. Flexibility and Innovation: PBD allows architects and engineers to innovate, using non-traditional designs and materials that might not comply with prescriptive codes but can still achieve safety objectives. This supports creative and functional architectural designs<sup>6</sup>.
2. Resource Optimization: By tailoring fire protection measures to specific risks and needs, PBD can lead to more efficient use of resources and potentially lower costs. It avoids over-engineering and focuses on the necessary<sup>7</sup>.
3. Suitability for Complex Buildings: PBD is particularly advantageous for buildings with unique or complex designs, such as skyscrapers, large commercial spaces, or historic buildings, where standard codes may not be sufficient or practical<sup>8</sup>.

## Disadvantages of Performance Based Design

1. Complexity and Cost: Implementing PBD requires detailed analyses, sophisticated simulations, and expert knowledge, making it more complex and potentially more expensive in the design phase compared with prescriptive approaches<sup>4</sup>.
2. Specialized Expertise Required: Successful application of PBD necessitates expertise in fire dynamics, risk assessment, and fire protection engineering. This often requires hiring specialized consultants, which can increase project costs<sup>9</sup>.
3. Regulatory Challenges: Gaining regulatory approval for PBD projects can be more complicated. Authorities may require extensive documentation and validation, leading to longer approval times and possible delays in project timelines.<sup>10</sup>

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<sup>3</sup> [https://www.europeanfiresafetyalliance.org/wp-content/uploads/2022/12/Session-IV-EUFSW-2022\\_Diane-Daems.pdf](https://www.europeanfiresafetyalliance.org/wp-content/uploads/2022/12/Session-IV-EUFSW-2022_Diane-Daems.pdf)

<sup>4</sup> Buchanan, A. H., & Abu, A. K. (2017). Structural Design for Fire Safety. John Wiley & Sons.

<sup>5</sup> National Fire Protection Association (NFPA). (2020). Performance-Based Fire Protection Design. nfpa.org.

<sup>6</sup> Buchanan, A. H., & Abu, A. K. (2017). Structural Design for Fire Safety. John Wiley & Sons

<sup>7</sup> SFPE Handbook of Fire Protection Engineering, 5th Edition. (2016).

<sup>8</sup> National Fire Protection Association (NFPA). (2020). Performance-Based Fire Protection Design. nfpa.org.

<sup>9</sup> Society of Fire Protection Engineers (SFPE). (2016). Guidelines for Evaluating Fire Risk in Buildings. sfpe.org.

<sup>10</sup> International Fire Engineering Guidelines, International Code Council. (2005).

## Some common tools and methods used in PBD for fire safety include:

- Fire modelling and simulation (e.g., CFD, FDS)
- Risk assessment and analysis
- Fire safety engineering principles (e.g., fire dynamics, human behaviour)
- Performance-based design guidelines and frameworks (e.g., NFPA 101, ISO 21542)

## Conclusion

Performance Based Design represents a forward-thinking approach to fire protection in buildings, focusing on achieving specific safety outcomes through tailored solutions. Its flexibility and potential for innovation make it particularly valuable for complex or unique building projects. While it involves greater complexity and the need for specialized expertise, the benefits in terms of resource optimization and design freedom can outweigh these challenges. By integrating PBD into fire protection planning, architects and engineers can create safer, more efficient and more innovative buildings, that meet the diverse needs of today's built environment.

Performance based design is certainly needed to replace detailed regulations for design in health care facilities, industrial facilities, renovation projects, and energy efficient buildings etc. This must cover all fire safety goals, such as life safety, property protection, continuity of operation, environmental protection, and to cover growing complexity and need for quality. The fire behaviour of buildings products and building contents should be addressed holistically, taking into account all performance aspects not only fire. Collaboration among stakeholders and professionals involved in the building process should be encouraged.

## About the Modern Building Alliance

We are an alliance of trade associations and companies representing the plastics industry in the construction sector. Plastics are increasingly used in building and construction applications to make our buildings more sustainable, from window frames and durable pipes to state-of-the-art insulation solutions. An essential pillar of our cause is the ambition for greater fire safety across the construction industry. It is a key driver of our product design and manufacturing: improving the fire safety in buildings is a joint responsibility of the whole value chain involved in building and construction. That's why, by engaging with policy makers and stakeholders, we are committed to supporting the EU in ensuring safe and sustainable construction for people across Europe.

