# Fire Safety Performance of Wall Systems

**Ryan Carvalho[1*], Moisés Silva[1], Mariana Novaes[1], Marianna Rivetti[1], Ariane Rubin[1], Adriano Puglia[1], Juliana Guerreiro[1], Luciano Pisanu[1], João Jesus[1]**

*[1]SENAI CIMATEC University Center; Salvador, Bahia, Brazil*

**This article emphasizes the importance of proper performance of vertical sealing systems in building fire safety. It verifies the role of seals as elements to contain the spread of fire in buildings, based on the ABNT NBR 15575 - Part 4 Performance Standard. The research is grounded in analyses of the standard, PBQP-h, and academic literature in databases. Summary tables present criteria, evaluation methods, responsibilities, and necessary validations to ensure adequate performance. It is concluded that compliance with the Performance Standard is crucial to ensure the safety of occupants and the building's structure. The article highlights the importance of tests and project analyses in meeting the requirements of adequate performance.**

**Keywords: Fire Safety Walls. Performance. Fire Seals. Wall System.**

Fires constantly threaten built environments, endangering human life, property, and the environment. In its relentless pursuit of innovation and efficiency, the construction industry has incorporated various materials and technologies. While these advancements offer numerous benefits, they also increase vulnerability to such disasters. Given this reality, understanding the factors contributing to the occurrence and spread of fires in buildings is crucial. It is also essential to explore prevention and control strategies to ensure occupants' safety and preserve built structures.

In Brazil, in 2022, there were 2,041 fire-related incidents in buildings. Commercial buildings accounted for 379 reports, followed by assembly locations, with 333 notifications for public meeting places and 306 for warehouses [1]. Figure 1 presents data on fires in commercial establishments, warehouses, and other categories.

Given the paramount importance of life and property preservation, the construction industry implements various fire containment and preservation strategies to ensure fire safety. In this context, fireproofing plays a fundamental role in safeguarding occupants and maintaining the integrity of buildings. Fireproofing is a compartmentalization element, a critical component restricting fire spread between different areas [2]. This limitation prevents rapid escalation, keeping evacuation routes accessible and safe.

Furthermore, fireproofing protects structural elements and equipment, thereby minimizing the damage caused by fire to the building and reducing the risk of collapse [3]. Therefore, fireproofing not only safeguards building occupants but also preserves the property.

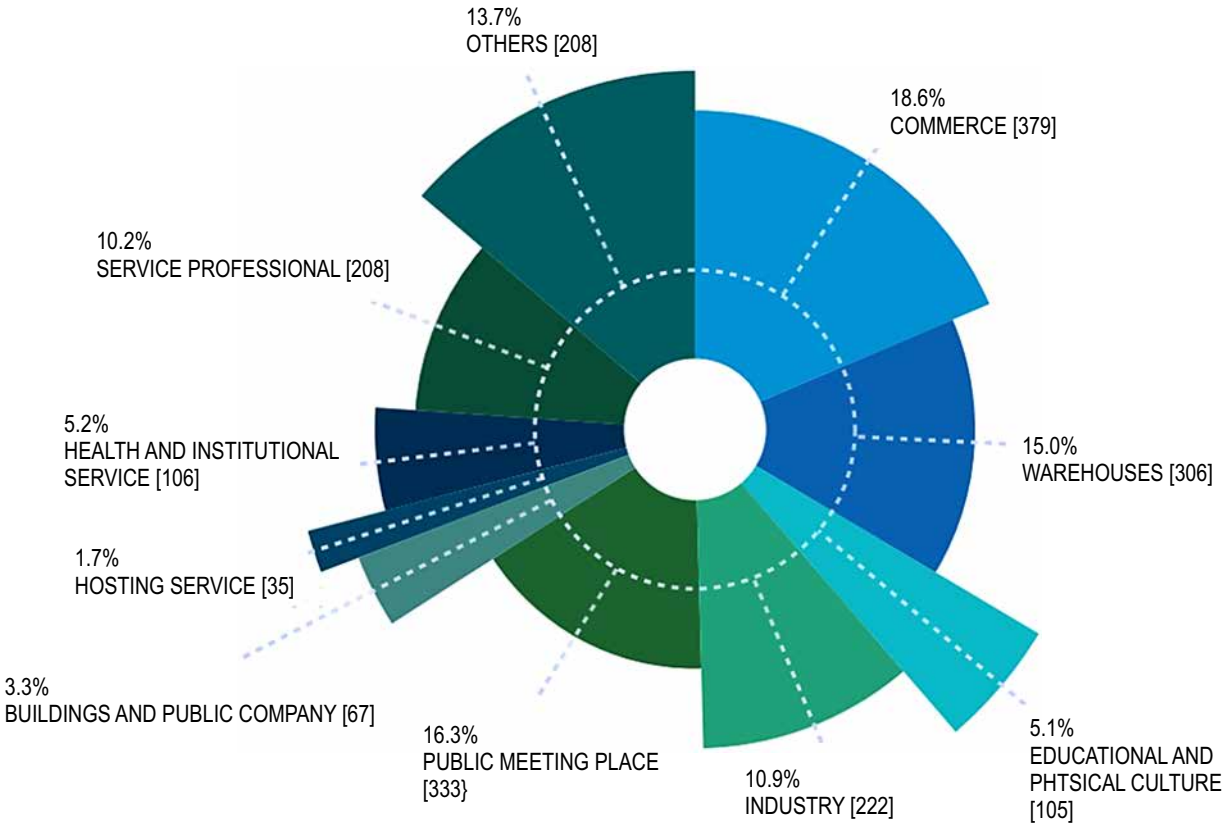
NBR 15575 [4], also known as the Performance Standard, consolidates technical requirements to ensure building quality, safety, and comfort. In Part 4, this standard addresses the internal and external vertical sealing systems specifications, including a dedicated fire safety section. Various aspects are covered, such as fire resistance, smoke tightness, insulation, and flame propagation. These requirements ensure that the fireproofing used in buildings performs adequately in fire situations.

This article discuss the importance of fire protection in preventing and combating fires, emphasizing the criteria established by NBR 15575 - Part 4 and its relevance for the safety and protection of residential buildings. Through this discussion, we aim to contribute to a better understanding of this critical topic within the construction industry and to advocate for practices that ensure the safety of all stakeholders involved.

Received on 25 February 2024; revised 31 May 2024.
Address for correspondence: Ryan Carvalho. Av. Orlando Gomes, No. 1845 - Piatã, Salvador - Bahia, Brazil. E-mail: ryan.araujo@ba.estudante.senai.br.

J Bioeng. Tech. Health 2024;7(2):226-231

**Figure 1.** Incidence of structural fires by type of occupancy.




## Materials and Metthods

This research delved into norms concerning fire safety sealing systems, focusing on the requirements outlined in NBR 15575 [5], as it sets the minimum criteria that seals must meet. The guidelines established by the National System of Technical Evaluations of Innovative Products and Conventional Systems were also examined. We created summary tables to streamline the topic based on the book "Analysis of Criteria for Meeting the Performance Standard" (Table 1), presenting the requirements, criteria, evaluation methods, responsible parties, and technical evidence for compliance with the standard above. Each aspect contributes to understanding the expected behavior of a sealing system.

The tables created aim to succinctly address the central questions regarding the performance standard. They indicate which criteria must be met to validate a wall system concerning fire safety. The first line of Table 1 presents the required requirements, followed by their respective criteria established in the standard. To enhance understanding, lengthy texts have been summarized and simplified. The technical standards necessary to meet the criteria are highlighted in the third line. The evaluation method determines compliance with the criteria and the system's performance level. Responsible parties are identified to facilitate inspection and project analysis, as they are responsible for providing evidence of performance. Therefore, information such as test reports, inspection reports, designers' statements, technical specifications, and design solutions can be used to demonstrate compliance with the expected performance.

## Results and Discussion

Fire safety relies on the intricate details of a building, including materials, construction

**Table 1.** Summary table model used.

| **Requirement** | Standard Item | **Requirement Title** | |
|---|---|---|---|
| **Criterion** | Standard Item | Criterion Title | Topics/Single Text |
| **Standard** | Standard to be met | | |
| **Evaluation Methods** | Method to be used | | |
| **Responsibles** | Process agent | | |
| **Evidencess** | Document required for validation | | |

processes, structural systems, connections between elements, seals, ceilings, roofing, and coatings. All these aspects are significant and must be considered in the technical performance evaluation.

Compartmentalization Elements

Compartmentalization stands out as one of the most effective methods for fire protection. It involves dividing a building into sections containing flames, preventing horizontal and/or vertical fire spread. This protective measure is deemed passive, utilizing elements with diverse functions to shield the building from fire, thus avoiding additional energy consumption.

Compartmentalization elements are construction components endowed with fire-resistant properties that restrict flames' vertical and/or horizontal propagation [6]. Consequently, proof of fire resistance and adherence to fire reaction requirements are imperative. Within the context of seals, only internal horizontal compartmentalization and external facade compartmentalization are encompassed, exemplified by:

- Internal horizontal compartmentalizers: Following internal vertical compartmentalization, floors are established. Frequently, these floors possess extensive areas and necessitate further compartmentalization, employing horizontal elements to delineate spaces. As a result, internal walls that lack structural function yet possess fire-resistant properties are employed [6].
- External facade compartmentalizers: Analogous to floors requiring internal horizontal compartmentalization, facades necessitate external vertical compartmentalization. This prerequisite precludes fire spread through the facade, preventing it from reaching the floor above immediately [6].

Performance Evaluation

Building performance evaluation can occur through prototypes, designs, and descriptive memoranda before construction. However, projects often entail uncertainties and lack details, particularly in innovative systems, necessitating additional evaluations. These assessments facilitate the development of constructive solutions, even in their nascent stages, underscoring their significance in advancing and refining construction systems.

According to the Technological Research Institute (IPT) [7], the initial evaluation stage entails analyzing the project to identify the interface's technical specifications and construction details. Standard specifications are pivotal in helping construction system developers enhance their projects. Thus, Table 2 addresses widespread inflammation in vertical seals, presenting pertinent classifications. Table 3 addresses fire spread in vertical seals, aiming to categorize dwelling facades to prevent excessive smoke production that could hinder occupants' escape. Table 4 addresses the fire spread while preserving the structural stability of the vertical seals. This norm item aims to resist inflammation for some time without losing its structural function.

The tests and their respective standards proposed by fire safety are listed in Table 5. These tests for fire reaction and resistance are intended to

**Table 2.** Occurrence of generalized inflammation according to NBR 15575-4.

| **Requirement** | 8.2 - PT 4 | **Make It Different for Gereralized Infflamation to Occur** | |
|---|---|---|---|
| **Criterion** | 8.2.1 - PT 4 | Evaluation of the fire reaction of the internal face of vertical enclosures and their respective insulating cores. | The internal surfaces of external vertical enclosures (EVE) (facades) and both surfaces of internal vertical enclosures (IVE) must be classified as follows: a) I, II A, or III A when associated with kitchen spaces; b) I, II A, III A, or IV when associated with other indoor areas of the dwelling, except kitchens; c) I or II A when associated with common areas of the building or interior of stairwells, but with a maximum specific optical smoke density (Dm) lower than 100. NOTE: Materials used within the walls, whether internal or external, must be classified as I, II A, or III |
| **Standard** | NBR 9442 | | |
| **Evaluation Methods** | Test | | |
| **Responsibles** | Constructor | | |
| **Evidences** | Supplier report | | |

**Table 3.** Fire propagation with preservation of structural stability according to NBR 15575-4.

| **Requirement** | 8.3 - PT 4 | **Hard Fire Spread** | |
|---|---|---|---|
| **Criterion** | 8.3.1 - PT 4 | Evaluation of the fire reaction of the external face of vertical enclosures of the facade. | The external surfaces of the VVEs (façades) must be classified I or II B. |
| **Standard** | NBR 9442, EN 13823. | | |
| **Evaluation Methods** | Test | | |
| **Responsibles** | Constructor | | |
| **Evidencess** | Supplier report | | |

**Table 4.** Fire propagation with preservation of structural stability according to NBR 15575-4.

| **Requirement** | 8.4 - PT 4 | **Make the Fire Spread Difficult and Preserve the Structural Stability of the Building** | |
|---|---|---|---|
| **Criterion** | 8.4.1 - PT 4 | Fire resistance of structural and subdivision elements | Structural walls must have fire resistance for a minimum period of 30 minutes, ensuring stability, watertightness, and thermal insulation. |
| **Standard** | NBR 14432 e NBR 5628 | | |
| **Evaluation Methods** | Test | | |
| **Responsibles** | Builder and/or Structure Designer | | |
| **Evidencess** | Supplier report and/or Project declaration | | |

**Table 5.** Fire reaction tests requested by NBR 15575-4.

| Test | Standard |
|---|---|
| Incombustibility Test | ISO 1182 |
| Flame Spread Test (Ip) | ABNT NBR 9442 |
| Specific Optical Density of Smoke Test (Dm) | ASTM E662 |
| SBI Test - Single Burning Item Test | ISO 13823 |
| Ignitability Test | ISO 11925-2 |

evaluate two critical aspects of fire protection: the materials used and their behavior under fire. These tests are intended to comply with the requirements presented in the standard. They are necessary to assess whether the material used in constructing the walls of the environment will guarantee safety for the residents of the building.

Evaluations in Innovative Wall Systems

Next, we present innovative wall systems with a Technical Assessment Document (DATec) (Table 6), meeting SINAT guidelines (NBR 15575-4). Those presented in the table meet the requirements requested by the standard and have commercial validation.

## Conclusion

The Performance Standard, ABNT NBR 15575 - Part 4, establishes crucial criteria for the construction industry, particularly regarding the sealing system. These criteria delineate various performance levels tailored to meet the demands of end consumers.

Given the many criteria, it became imperative to synthesize and organize this information into tables, streamlining the work involved in designing and constructing buildings. The significance of this endeavor lies in the systematic compilation of information from Part 4 of the Performance Standard and its application to innovative sealing systems, specifically concerning fire safety.

It is paramount for companies to ascertain their compliance with the standard and the level of performance they achieve through tests or other relevant analyses. Additionally, it is essential to delineate the responsibilities of the various stakeholders (developers, builders, suppliers, and designers) to ensure the attainment and maintenance of desired performance levels and to raise awareness of these responsibilities.

Fire safety is a critical aspect of the construction industry, and the Performance Standard is indispensable in fostering safer buildings concerning fires, ensuring that sealing systems meet requirements and effectively protect life and property.

## References

1. Sprinkler Brasil (São Paulo). Base de dados Sprinkler Brasil. Available at: https://sprinklerbrasil.org.br/.
2. Negrisolo W. Arquitetando a Segurança Contra Incêndio. Tese (Doutorado – Área de Concentração: Tecnologia da Arquitetura) – Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo, São Paulo, 2011
3. Seito AI, Gill AA, Pannoni FD et al. A Segurança Contra Incêndio no Brasil. Projeto Editora. São Paulo, 2008
4. ABNT – Associação Brasileira de Normas Técnicas. ABNT NBR 15575-4. Edificações Habitacionais – Desempenho – Parte 4: Requisitos para os sistemas de vedações verticais internas e externas – SVVIE. São Paulo: ABNT, 2021.
5. Borges CAM. O conceito de desempenho de edificações e a sua importância para o setor da construção civil no Brasil. 2008. Dissertação (Mestrado em Engenharia de Construção Civil e Urbana) - Escola Politécnica, University of São Paulo, São Paulo, 2008. doi:10.11606/D.3.2008.tde-25092008-094741.
6. Academia AKI. Segurança contra o fogo: Influência das vedações externas. CTE, 2019.
7. IPT – Instituto de Pesquisas Tecnológicas. Reação ao Fogo de Materiais: Avaliação das características de reação ao fogo dos materiais – Ensaio SBI. São Paulo. 2022. Available at: https://.ipt.br/. Acessed on: May 18, 2024.

**Table 6.** DATecs and respective guidelines.

| Sinat Guideline | DATec | Description | Control and evaluation measures | |
|---|---|---|---|---|
| Nº001 Rev.03 | Nº 005-C | Lightweight concrete with polymer and fiberglass reinforcement protected with polyester | Use of non-combustible materials and controlled smoke emission | 30 min RF with load application of 1,520 kgf/m |
| Nº002 Rev.02 | Nº 008C | Panels of ceramic blocks and reinforced concrete ribs | Use of non-combustible materials with controlled smoke emission. | 30-minute fire resistance with a load application of 9 kN/m (ground floor) and 18 kN/m (upper floor). |
| | Nº 012-E | Reinforced concrete panels and ceramic blocks. | | 60-minute fire resistance – both faces coated with gypsum (thickness=5mm). |
| Nº003 Rev.02 | Nº 014C | SaintGobain dry construction system - Light Steel Frame. | Use of Class I and IIA materials in terms of smoke emission and flame propagation. | 30-minute fire resistance with a load application of 600 kgf/m. |
| | | | Kitchen walls with gas equipment use 2 layers of ST gypsum boards on the inner face. | |
| | Nº 041 | Tego Frame constructive system with prefabricated steel frame panels. | Use of Class I and IIA materials in terms of smoke emission and flame propagation. | 30-minute fire resistance with a load application of 1,500 kgf/m. |
| Nº004 Rev.02 | Nº 017A | Global Constructive System with PVC panels filled with concrete. | - | Fire reaction of PVC profiles: Ip=23 and Dm=405. 30-minute fire resistance with a load of 20 kN/m. |
| | Nº 037 | Bazze PVC Constructive System with rigid PVC panels filled with concrete. | Use of PVC, Class IIA, in terms of smoke emission and flame propagation. | 64-minute fire resistance with a load application of 1.6 tf/m. |
| Nº005 Rev.03 | Nº 040 | Immergrün constructive system with prefabricated wood frame panels. | Use of Class IIA materials in terms of smoke emission and flame propagation. | 30-minute fire resistance with a load application of 1,400 kgf/m. |
| | Nº 020-D | Structured system with lightweight pieces of sawn solid wood. | Wooden pieces encapsulated with ST gypsum boards. Use of double layers of gypsum boards with staggered and treated joints. | Fire reaction for the inner face (gypsum board) and outer face (cement board). |
| | | | | 30-minute fire resistance with a load application of 20 kN/m. |