SABA
adhesives & sealants

SMOKE RESISTANCE

An essential element in fire safety

Introduction

Fire safety and constructional fire prevention make an essential contribution to safety in homes, offices and other dwellings and buildings.
To guarantee a high degree of fire safety, government has prescribed strict laws and regulations that are set out in the Dutch Buildings Decree 2012.
For example, the Buildings Decree stipulates that connection and expansion joints must be sealed with a fire-resistant sealant using certified products.
The Buildings Decree assumes it to be a given that certified fire-resistant sealing products are also smoke-resistant.

However, that assumption often appears to be false in actual practice. Smoke resistance is not a given and during a fire, smoke often is the number one cause of death.

This is why the rules concerning smoke resistance are being tightened in the BBL [Structures (Living Environment) Decree] – the replacement of the Buildings Decree. Smoke resistance plays a fundamental role in fire safety. This whitepaper explores the following topics in greater detail:

- The importance and the safety benefits of smoke resistance;
- The current Dutch standards and the expected new standards in 2022;
- New smoke resistance tests using a smoke passage test.

Finally, the whitepaper includes recommendations about smoke-resistant seals of connection and expansion joints.

1. The essential importance of smoke resistance

Smoke spreads faster than the fire itself, but is not as easily controlled. Moreover, in a fire the spread of smoke is virtually unavoidable. In a fatal fire in a student flat in Diemen, in the Netherlands, the smoke only took seven minutes to spread throughout the flat with all of its attendant fatal consequences (Fire Rode Kruislaan in Diemen - IFV, 2017). However, the spread of smoke can be significantly delayed by implementing effective measures.

Escaping safely in the event of fire

The most important objective of smoke resistance is to give people sufficient time to escape during a fire and to avoid from being impeded by smoke at an early stage. The term used to express this is the Required Safe Escape Time or RSET. Effective smoke resistance and smoke control increases the time people have available to safely escape; this is referred to as the Available Safe Escape Time or ASET. The greater the difference between the required safe escape time and the available safe escape time – the Safety Margin – the greater the chance that someone can safely escape in an emergency situation. When the required escape time exceeds the safety margin, people end up
in situations that impair health. The greater this excess, the more serious the impact on health.

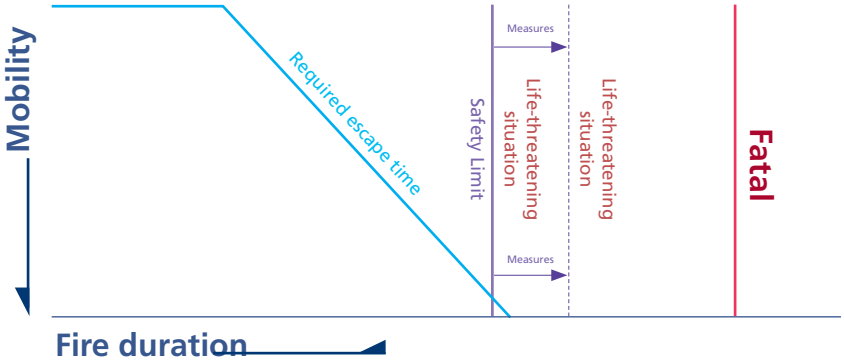
What is smoke?

Smoke is an aerosol, a mixture of solid particles and liquid droplets, and consists of:

- *Soot*
- *Liquid droplets (water vapor)*
- *Gases, for example: CO, CO_2, NO_x, HCN, HCL*

Almost all of these gases are already poisonous and harmful to health in small quantities.

Escaping safely in the event of fire (diagrammatic illustration)



Escaping safely (RSET)
Minimum time required to escape

Safety margin (ASET)
Maximum time available to escape
(can be influenced by implementing measures)

Life-threatening
Rescue only possible by emergency services

Renewed focus on

smoke-resistant measures

Developments, such as an increase in the use of synthetic materials in furniture, adversely affect the RSET and ASET. Tightened laws and regulations and a focus on better smoke-resistant measures can counter these adverse effects.

The consequences of smoke:

Disorientation and longer escape time

Minor health complaints:
Burning eyes, irritated airways and shortness of breath

Serious health complaints: *Shortage of oxygen, disruption of mental processes, loss of consciousness and suffocation*

2. Tightening fire safety regulations

The objectives of the fire safety regulations are as follows:

- **Prevent victims;**
- **Promote safety during a fire;**
- **Prevent a fire from developing, spreading or flashing over.**

To achieve these objectives buildings are equipped with detectors, fire extinguishing systems and emergency escape routes, for example. Use is made of compartmentalization to counter the spread of smoke and fire; a structure must be subdivided into one or more fire compartments. A fire compartment consists of a part of the building that is designated as a maximum fire expansion area. The partitions between these compartments must have a 30 to 60 minute fire resistance rating, with the exception of specific situations. The current fire resistance regulations are set out in the Buildings Decree 2012.

Fire resistance is no guarantee of smoke resistance

The Buildings Decree 2012 uses the fire resistance's flame density criterion as the basis for the smoke resistance guidelines. These guidelines assume that the smoke resistance
(in minutes) is equal to 1.5 times the flame density
(in minutes).

For example, given a flame density of 20 minutes, the assumption is that the partition has a smoke resistance of 30 minutes.
However, actual practice shows that the fire resistance properties of a partition and its flame density
are not all that closely correlated. Fire resistant partitions in which active sealants, such as foaming agents, are used react to rising temperatures in a fire. Many of these active sealants only provide effective smoke resistance following activation (starting at approximately 200°C and depending on their location within the building, this is several minutes after the start of the fire). Prior to activation or in case of cold smoke, the smoke has free reign. In the future BBL [Structures (Living Environment) Decree], smoke resistance is evaluated separately, and other factors, such as cold smoke, are taken into account, so that the level of attention devoted to smoke resistance once again is commensurate with the current situation.

What is the BBL?

The objective of the new Environment and Planning Act (likely to go into effect on January 1, 2022) is to simplify and merge the regulations relating to spatial development in the Netherlands. The BBL [Structures (Living Environment) Decree], which is considered to be the successor to the Buildings Decree 2012, forms part of this.

The fire and smoke resistance criteria for buildings set out in the BBL are aligned with the use of these buildings (just as they were in the Buildings Decree). Every building has at least one functional use*, for example: a residential function or
an education function. A single building can also have different types of functional uses, for example a care home combined with a healthcare function, a residential function and an office function. Or, for example, a combination of shop function, sports function and office function.

Because a single building can have different types of functional uses, the BBL methodology has been organized such that it is easy to design and verify buildings with different types of functional uses in terms of the regulations and requirements relating to fire safety and smoke resistance.

** According to the definition of terms, a functional use is defined as: 'the sections of a building that have the same designated use and that collectively form an occupancy unit'.*

More strict smoke resistance criteria in the BBL

The current Buildings Decree specifies that the smoke resistance of a building can be determined by testing its fire resistance and then checking the construction's flame density.
The rule of thumb is the one-and-a-half-times measure: if a
door's flame density has a 20 minute fire resistance rating, then it is assumed that it has a 30 minute smoke resistance. This assumption has proven to be incorrect, which is why the smoke resistance criteria for new buildings will be tightened. The new situation will make a distinction between resistance to the passage of cold smoke and hot smoke. The building will actually have to be tested for leak-tightness. The associated classifications are as follows:

- ✔ **Sa**
  (smoke resistant at room temperature (ambient); also referred to as cold smoke): this requirement primarily applies to buildings not used for sleeping.

- ✔ **S200**
  (smoke resistant at 200°C; also referred to as hot smoke): this requirement primarily applies to buildings used for sleeping, such as hotels, hospitals and day nurseries.

The objective of the tightened regulations is to drastically limit the spread of smoke, so people can safely escape.

3. Leak test determines degree of smoke resistance

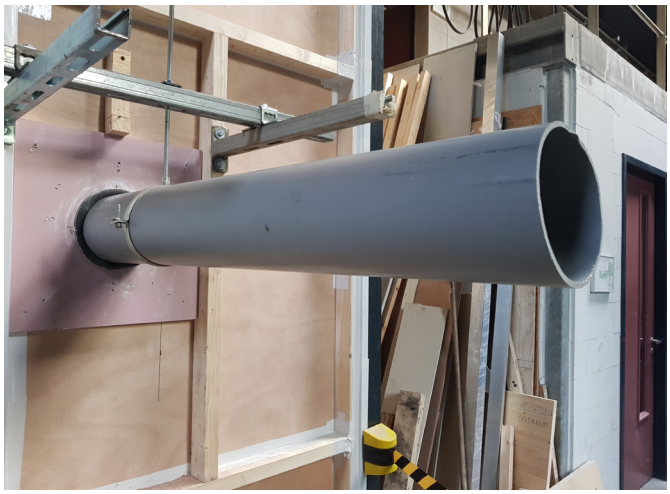
A leak test is used to test the smoke resistance of (linear) sealant seams or (sealed) transits, for example, for the Sa (cold smoke / room temperature) and S200 (elevated temperature) classifications. Depending on the customer's wishes
concerning the application of the tested product, sealants can be placed in a test set-up
in materials such cellular concrete, steel and wood.

To conduct the leak tests, the BBL refers to the NEN 6075. This standard includes all requirements a product is expected to meet in order to be awarded the
Sa or S200 classification. A smoke chamber is used to carry out the actual tests. The set-up of the smoke chamber is detailed in the EN 1634-3.

This European standard was originally intended for testing the leakage flow rate of doors. The NEN 6075 describes how to test other structural components,
such as sealant seams, in accordance with the EN 1634-3.

Test set-up

The test set-up consists of a test frame in which the test pieces – the sealant seams and/or other seals (transits) in different materials – are placed. The test pieces are then tested, one at a time. During testing, the other seams, that are not tested, are protected from smoke, heat and other potential influences. This prevents other sealant seams from having any effect.

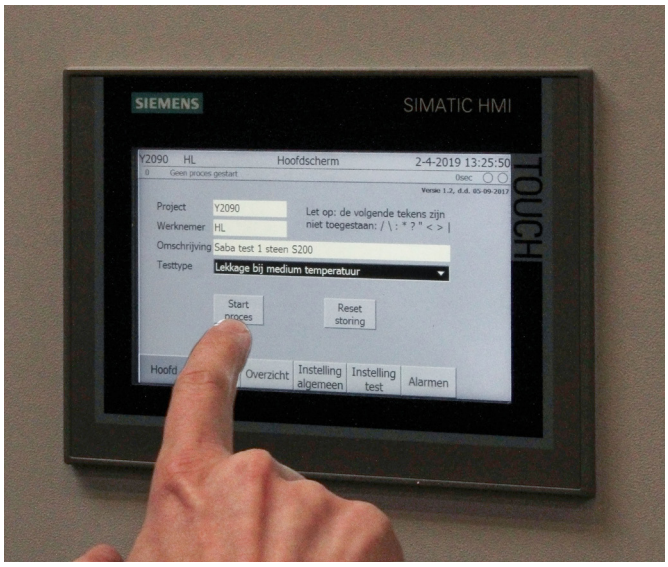


Pressure test

Overpressure is created on one side (the heated side) for each test set-up. (In contrast to a door test, overpressure only needs to be created on one side of a sealant seam.)

The system subsequently measures the leakage flow rate. The leakage flow rate is the total leakage at a certain differential pressure. Testing is conducted at different differential pressures (10 Pa, 25 Pa, 50 Pa). Two tests are performed for each test piece; one test whereby the test piece is sealed airtight and a test whereby the test piece is open. The difference between these two tests is the leakage flow rate of the test piece at a certain pressure. During and immediately after the test, the test piece is visually checked for any damage or deformation.

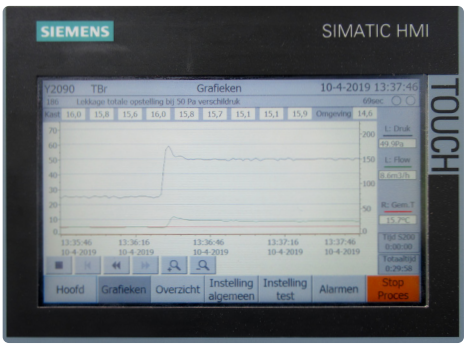
Every situation is different; the same thing applies to a substrate combined with a seal. This is why smoke resistant (and fire resistant) products must be tested for each situation. This is the only way in which a conclusion can be drawn with any certainty about the smoke resistance of a seal in a specific situation.



4. Test results

As explained in Chapter 3, the smoke resistance between two rooms is determined in accordance with the NEN 6075. The test is performed in accordance with the EN 1634-3.

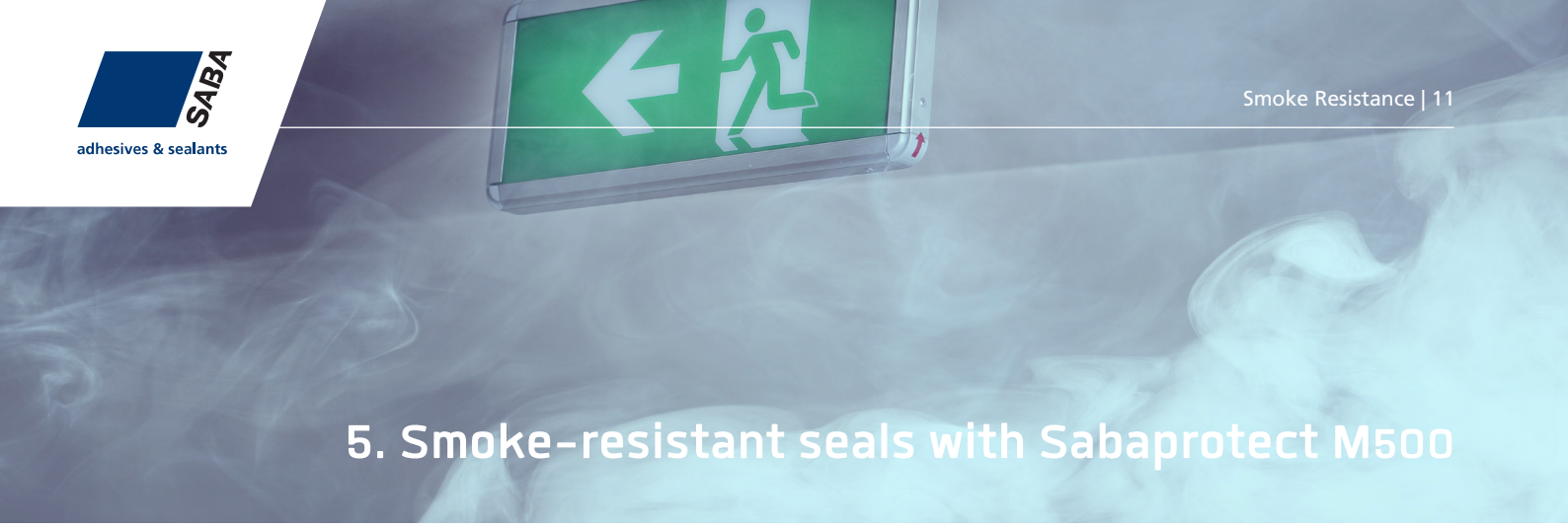
The maximum leakage flow rate for each category in a specific classification is set out in the NEN 6075. For linear seams (expansion and/or construction joints) the applicable requirement is a maximum leakage flow rate of 0.1 m³/h per meter of seam length and a maximum of 3 m³/h per m² across the seam's surface area. For transits the applicable requirement is a maximum leakage flow rate of 3 m³/h per m² across the transit's surface area (the transit without cables or pipes). The most recent version of the NEN 6075 (2020) includes the possibility of testing a sealing system with transits.
A specific configuration must be tested for this purpose. The applicable requirement here is a maximum flow rate of 20 m³/h.



When the leakage flow rate stays below the required values, the tested pieces are deemed to comply with the conditions required to be awarded the Sa and/or S200 classification. If in accordance with the BBL the smoke resistance between two rooms is required to be S200, this means that all structural components between these rooms must meet the S200 classification. This then not only concerns the sealant seams or the transits, but also the doors and any ventilation ducts that may be present between the two rooms. All of these structural components must meet the S200 classification.
This classification can only be obtained by conducting a leakage test.

Overview of Test Results

Test Piece	Type of system	Brief Description	Total leakage (m³/h), Sa at a differential pressure of			Total leakage (m³/h), S200 at a differential pressure of		
			10 Pa	25 Pa	50 Pa	10 Pa	25 Pa	50 Pa
1	Linear seam	Cellular concrete	0.0	0.0	0.0	0.0	0.0	0.0
2	Linear seam	Steel	0.1	0.1	0.1	0.0	0.0	0.0
3	Linear seam	Wood	0.1	0.0	0.0	0.1	0.0	0.0
4	Linear seam	Knauf DF	0.1	0.0	0.0	0.0	0.0	0.0
5	Linear seam	Fermacell	0.0	0.1	0.0	0.0	0.0	0.0
6	Transit	PVC pipe	0.0	0.0	0.1	0.1	0.0	0.0
7	Transit	Steel pipe	0.0	0.0	0.0	0.0	0.0	0.0



5. Smoke-resistant seals with Sabaprotect M500

Depending on the building, SABA's Sabaprotect M500 can be used to create smoke resistant and fire resistant* sealing joints in:

- Metal stud walls
- Timber frames
- Plasterboard walls
- Fermacell
- Joints in stone-like structures
- The connection between different types of stone substrates and wood frames
- The connection between different types of stone substrates and steel frames

In addition to the product's excellent smoke and fire resistance, thought has also been given to the risks inherent in the product itself. This is why Sabaprotect M500 is Emicode EC1 PLUS certified and can be safely processed, without any health risks. Thanks to its very low emission and label-free properties, the product is suitable for application in BREEAM, as well as LEED projects.

In situations in which the intensity and temperature of a fire is too high, everything burns up. That includes the sealant, but when Sabaprotect M500 burns, no toxic substances are released.

Thoroughly tested

It is important to test the application in a specific situation, so that a reliable conclusion can be drawn about the degree of smoke resistance. SABA can conduct tests and issue recommendations about the application of a sealant.

When you opt for SABA's fire resistant systems, you can be certain that they have been thoroughly tested and therefore that they are fireproof and smoke resistant. You can also rely on our technical support; SABA's experts look forward to contributing ideas about how to accelerate, simplify or further improve your process.

** up to 120-minute fire resistance rating; complies with the Sa*

and S200 standards for smoke resistance

This whitepaper was developed in cooperation with Pieter Imminkhuizen, Project Manager Product Safety and Smoke Resistance at the Peutz Laboratory for Fire Safety.
This is an independent laboratory accredited by the Dutch Accreditation Council for establishing the smoke and fire resistance of various types of building materials and their reaction in the event of fire. In addition, the laboratory is designated as Notified Body, as a result of which the test results can be used as a basis for the CE markings of building products.

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