DOW BUILDING SCIENCE

Fire-rated Dow Technologies Technical Manual

Table of contents

Scope

In this manual, you will find a brief review of silicone chemistry and how it can help enable the desired level of fire behavior when installed as part of a fire rated system. The typical reaction to fire of DOWSIL™ Fire Rated Sealants is described, as well as the classification level which can be reached.

This manual then reviews the fire resistance behavior of the DOWSIL™ Fire Rated Sealant range. The importance of joint detailing as well as the general rules for extended applications are described, in the event that tested details do not correspond with the project needs. These rules are only informative. Seals that differ from the tested designs may have to be independently tested or assessed to ensure that the required specific fire ratings remain valid. In terms of testing, the details of tested penetration seals and linear joints are described for both floors and walls. When required, detailed drawings can be provided.

System use of DOWSIL™ Fire Rated Sealants for applications such as smoke barrier and perimeter barrier or curtain wall are briefly reviewed.

Finally, the manual provides application recommendations for the different products from the DOWSIL™ Fire Rated Sealant range.

This manual is mainly focused on the European certifications, both European (EN) and British standard (BS). However, UL testing results are also briefly reviewed with more information available on the UL database or from your local Dow Technical Specialist.

Introduction

Following the growing urbanization of cities, high rise buildings have seen a steady increase in popularity. As high-rise buildings tend to have more occupants who need to travel further to reach the building exits, installation of fire prevention and protection is essential. Compartmentation and active fire protection, such as the use of sprinklers, are measures designed to restrain the passage of fire through a building and allow evacuation and firefighting.

Until recently, building envelopes have largely been manufactured from non-combustible materials such as brick, precast or stone and curtain walls have used materials such as glass, aluminium and traditional insulation such as mineral wool (MW). These materials ensured the building skin did not tend to burn, and the fire load remained mostly internal. The use of newly developed materials with different fire (reaction and resistance) behavior has been cited as a potential reason for the recently observed increase in façade fires. In addition, several factors such as proper detailing and installation have been found to be crucial to ensure that the desired level of fire performance can be achieved.

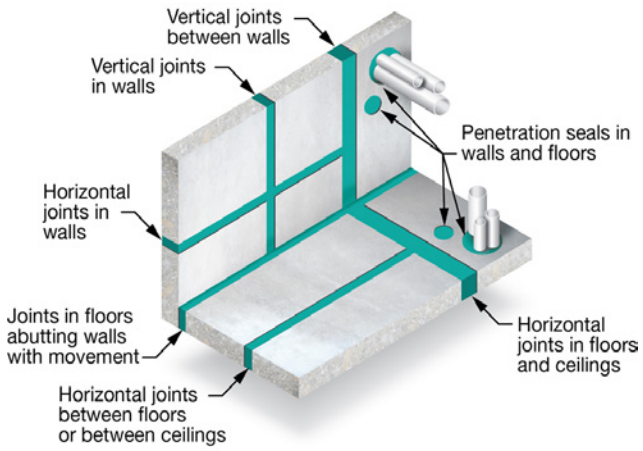


Figure 1: Overview of possible uses of fire rated silicones in walls and floors

Therefore, the behavior in reaction to fire and fire resistance of building materials used for compartmenting or in the building envelope is key in allowing enough time for tenants to exit a building.

Sealants can play an important role in fire protection and help limit the spread of fire and smoke. Thanks to their distinct composition, Dow Building Science Silicones are particularly renowned for their movement capability, adhesion profile, UV and temperature stability and durability. They help protect against water and air intrusion and offer excellent all-round protection and performance against damaging weather conditions. But silicone materials can also be advantageous for passive fire protection as they are non-flame propagating, do not produce flaming droplets and have a limited non-toxic smoke development. These material properties can be especially beneficial in fire rated systems and designs which include joints in penetration and perimeter seals. When selecting fire proofing systems, Dow Building Science offers a range of DOWSIL™ Sealing solutions for vertical and horizontal linear joint applications as well as various penetration designs, fenestrations and building element connections both in walls and floors.

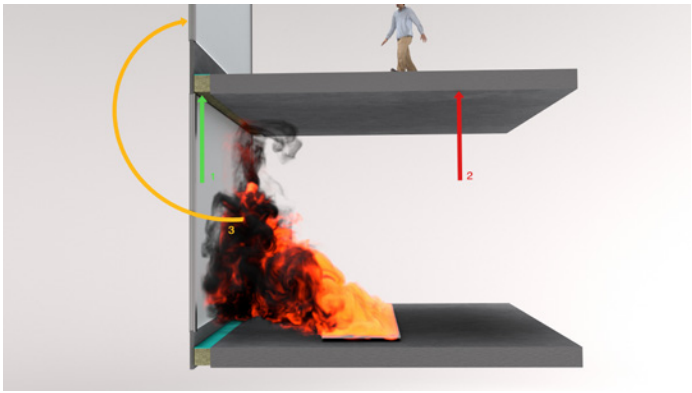
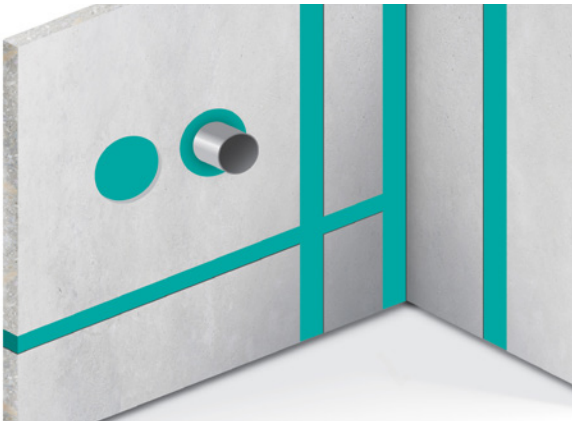


Figure 2: Overview of possible fire resistance through 1) perimeter seals, 2) structure, 3) spandrel panels

Dow's technologies have been certified by accredited fire test institutes in a wide range of configurations. Dow's Technical Specialists look forward to collaborating on future projects and assisting in the selection of our technologies.

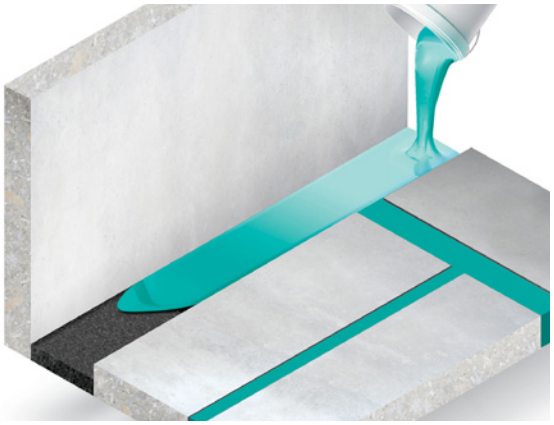
DOWSIL™ Fire Safety Products

The range of DOWSIL™ Fire Rated Sealants offers a choice of gun grade, self-leveling and foam sealants.

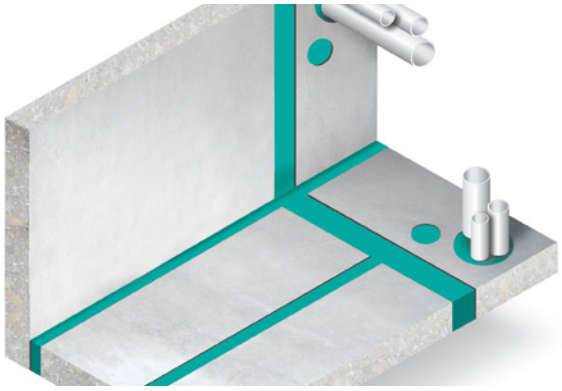


DOWSIL™ Firestop 700 Sealant (EU), DOWSIL™ Firestop 700CN Sealant, DOWSIL™ 813FR Fire Retardant Silicone and DOWSIL™ 790 Building Sealant are principally used for the sealing of fire-resistant linear joints in walls*. Additionally, DOWSIL™ Firestop 700 Sealant (EU) has been certified for small pipe and cable penetration seals in walls. DOWSIL™ Firestop 700 (CN) Sealant has been certified for smoke and heat control applications.

*Please contact your local Dow Technical Specialist to verify availability of these materials in your region.



DOWSIL™ Smoke Seal 800SL is a self-leveling silicone sealant which is particularly suited for the sealing of larger linear joints in fire rated floors and at the connection between a fire rated floor to a wall (requiring shear movement testing). It can be used for smoke barrier applications.



DOWSIL™ 3-6548 Silicone RTV Foam is very suitable for the sealing of larger pipe and cable penetration seals in walls and floors. The low viscosity of the foam when mixed allows easy flow between the penetrants ensuring a tight seal, preventing the passage of hot smoke and gases. A particular feature of the foam is that it will seal more tightly when exposed to a high temperature of fire due to the expansion of the gases within the closed cells of the foam. Its low thermal conductivity offers an excellent barrier in helping protect against the increase in heat. DOWSIL™ 3-6548 Foam is also tested for use in linear joints in floors.

DOWSIL™ Firestop 400 Sealant is an intumescent acrylic sealant, which is paintable and suited for the sealing of small internal perimeter joints in walls, both vertical and horizontal.

	DOWSIL™ FIRESTOP 700 Sealant	DOWSIL™ FIRESTOP 700 (CN) Silicone Sealant	DOWSIL™ 813 FR Fire Retardant Silicone	DOWSIL™ 790 Building Sealant	DOWSIL™ Smoke Seal 800SL	DOWSIL™ 3-6548 Silicone RTV Foam	DOWSIL™ FIRESTOP 400 Sealant
Description	Fire rated elastic neutral cure silicone sealant	Fire rated elastic neutral cure silicone sealant	Fire rated elastic neutral cure silicone sealant	Fire rated elastic neutral cure silicone sealant	Fire rated elastic neutral cure silicone sealant	Fire rated elastic neutral cure silicone foam	Fire rated intumescent acrylic sealant
Application areas	For linear expansion joints in walls, for small pipe and cable penetration seals	For linear expansion joints in walls, for smoke and heat control applications	For linear expansion joints in walls	For linear expansion joints in floors, walls, walls to floor and ceiling	For linear expansion joints in floors and floors abutting a wall	Pipe and cable penetration seals, linear joints in floors	Interior fire retardant applications: filling of cracks, sealing of connection joints
Fire Certificates	ETA, reaction to fire class B,s2,d0, Certifire, DCD approval	EN12101, GB23864-2009 A3, BS 476-20	Reaction to fire class B,s2,d0, Certifire, DCD approval pending	Reaction to fire Class E, ASTM E84	Reaction to fire class E	Reaction to fire class E	Reaction to fire class E
Availability	Global	Greater China	Middle East	Global	Global	Global	Global
Joint Movement capability	+-50%	+-25%	+-50%	+-25%	+-25%	NA	+-7.5%
Working time	15 min	10 min	20 min	31 min	25 min	1.5 min (snap time)	30-45 min
Application temperature	+5 to +40°C	+5 to +40°C	+5 to +40°C	+5 to +40°C	+5 to +40°C	+13-+27°C	+5 to +40°C
Shelf life	12 months	12 months	12 months	12 months	12 months	24 months	12 months

These are typical properties, not to be construed as specifications.

Silicone chemistry

The main raw material needed for the production of silicone is sand (SiO_2). Sand is reduced to silicon metal in a high temperature electrical arc oven using coal.

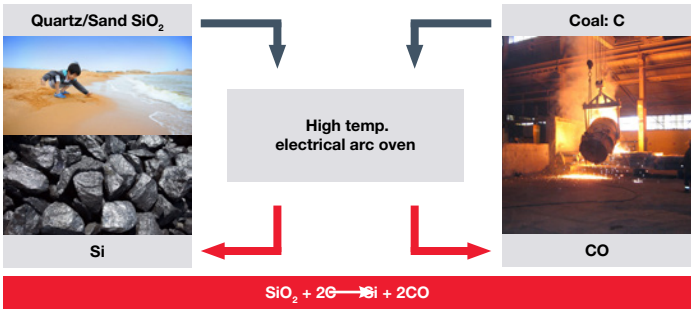


Figure 3: From sand to silicon metal

The silicon metal is subsequently polymerized to obtain polydimethylsiloxane, which has a backbone made of Si-O bonds with two methyl groups on each Si atom. This block is repeated to obtain polymers of different lengths and viscosity. The extremities of the helicoidal polymer chain are terminated with different types of functional groups which impart specific properties to the polymer. In a next step the polymer is formulated into a sealant, adding various elements such as adhesion promotors to develop adhesion on substrates, fillers such as calcium carbonate ($CaCO_3$) to provide mechanical properties such as strength and tear resistance and of course crosslinking elements to connect the polymer chains into a three-dimensional structure, to produce the silicone rubber typically used in sealing applications.

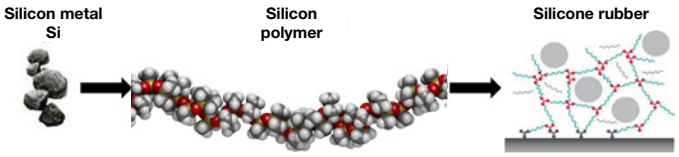


Figure 4: From silicon metal to silicone sealant

During a fire, the cured silicone is exposed to a combination of heat and oxygen. This will eventually result in the re-oxidization of the silicon atom in the polymer into silica (SiO_2), the original raw material. This can be observed through the formation of a silica char on the silicone that has been exposed to heat and oxygen. This silica char will be white, even in the case of a black silicone, as the carbon black pigment will oxidize into CO_2. A by-product of this reaction is water vapor.

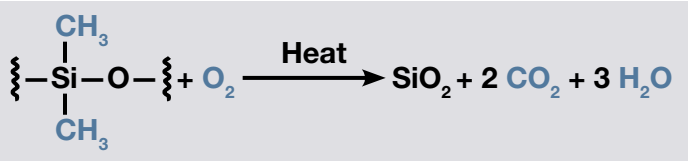


Figure 5: Molecular decomposition under fire exposure

The excellent performance of the DOWSIL™ Silicone Sealants can be observed in a real fire case. The images below show a low-rise residential building with silicone bonded glazed units. An external fire started in the corner of the building. This type of fire can reach 600°C. The glazed units broke due to the thermal shock but the glass shards remained bonded on the aluminium frame. The silicone charred and a white silica crust was observed. Underneath the silica char, the silicone still maintained adhesion to the frame.

Figure 6: Residential building using silicone bonded glazing after external fire. The silicone shows a silica char.

Reaction to fire

Overview

Building fires that affect the façade may be initiated externally from sources outside the building such as trash can fires, careless disposal of cigarette butts, electrical fires from cables running in façade cavities or arson. But fires can also originate from inside a building. When an internal fire outgrows a fire fighter's containment efforts and if the floor slab fire stopping is absent, assuming the fire stop material is not approved or not installed to the required standard, the fire can escape from the openings onto the exterior façade or cavities behind the façade of the building.

At this stage, the reaction to fire of combustible building envelope components is crucial to limit propagation to other floors. Reaction to fire is the measurement of how a material or system will contribute by its own decomposition to the development and spread of a fire, particularly in the very early stages when evacuation is needed.

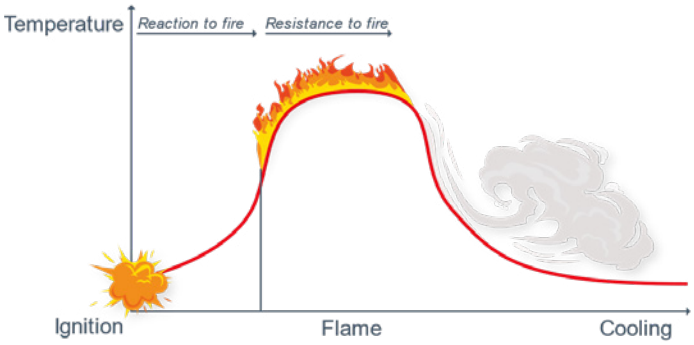


Figure 7: Development phases of fire: indication of importance of reaction to fire behavior in the early stage development and fire resistance in the fully developed stage

Heat release, smoke development, flaming droplets and flame spread are the main parameters being evaluated in this type of testing. Reaction to fire does not include how long a building component can resist a fire and maintain mechanical and potentially thermal protection. These aspects fall under the scope of fire resistance.

European classification standard EN 13501-1 (Fire classification of construction products and building elements Part 1: classification using data from reaction to fire tests) describes the reaction to fire classification procedure for products and construction elements. Construction products are classified according to harmonized test methods into Euroclasses A1, A2, B, C, D, E and F. Testing requirements depend on the class (Table 1).

The EN ISO 1716 test standard evaluates the calorific power of homogeneous materials. The small flame EN ISO 11925-2 test standard evaluates the spread of flames on a material during a certain time and over a certain height. The EN ISO 13823 single burning item test standard evaluates different parameters such as the total heat release developed by the tested material or occurrence of flaming droplets. It is possible to evaluate single materials or a building system assembly.

Figure 8: Left: illustration of the EN ISO 13823 test, right: illustration of the EN ISO 11925 small flame test

Table 1: Overview of European reaction to fire test methods needed to reach a certain classification

Reaction to fire class	EU Test Standard
A1	EN ISO 1182 and EN ISO 1716
A2	EN ISO 1182 or EN ISO 1716 and EN ISO 13823
B	EN ISO 13823 and EN ISO 11925
C	EN ISO 13823 and EN ISO 11925-2
D	EN ISO 13823 and EN ISO 11925-2
E	EN ISO 11925-2

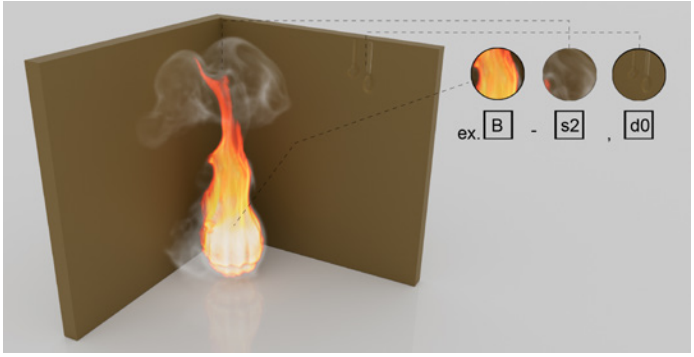


Figure 9: DOWSIL™ Silicones reach class B, s2, d0 in reaction to fire according to EN 13501-1. Please refer to Figure 8 illustration of EN13823 test and the ENO ISO 11925 small flame test

Around 2020, several countries such as the UK (England, Scotland and Wales) and the Middle East Area have been seen to increase their requirements in reaction to fire, whereby the use of non-combustible materials (class A1 or class A2, s1, d_0) is imposed for façades above a certain height. However, a list of exemptions recognizes the vital role that certain (typically combustible) materials currently play in the performance of modern facades, particularly in terms of thermal performance and weathertightness. Seals and sealants which have a weatherproofing function have been excluded from the non or limited-combustibility requirement. Furthermore, there is no limit imposed on their use, i.e. the sealants should not have a minimum reaction to fire category (other exempted materials may have to comply with a minimum reaction to fire classification). Sealants can therefore have any classification from E to B. This requirement could be subject to change as new materials fulfilling the non-combustibility requirement may become available.

Outside of Europe, alternative testing standards can be used to evaluate the reaction to fire of sealants. A few alternatives are listed below:

- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials
- GB 8624 – Classification for Burning Behavior of Building Materials and Products.

Figure 10: Adjacent combustible materials can contribute to the spread of fire. If one of the materials is less combustible, the fire spread can be stopped or slowed down.

Classification of DOWSIL™ Sealants

The table below summarizes the reaction to fire tests and the obtained classifications according to EN13501-1 for DOWSIL™ Fire Rated Sealants. As explained, sealants and seals are typically exempted from the A1 or A2 requirement. However, these materials can be used in assemblies which require the knowledge of the calorific power following the EN ISO 1716. Therefore, the excellent calorific power (MJ/kg) of the DOWSIL™ Fire Rated Sealant Range as well as typical high performance building sealants has been assessed. Please contact your local Dow Technical Specialist to obtain these values.

For the EN13823 sealant material tests, the full corner surface should be covered homogeneously with sealant. To ensure the test results can be used for a range of thicknesses of the sealant, both a minimum and maximum thickness were tested. For the small flame test EN11925, a linear joint was tested.

More information concerning reaction to fire behavior can be obtained from your local Dow Technical Specialist.

Product	EN ISO 1716	EN ISO 13823	EN ISO 11925	ASTM E84	Classification
DOWSIL™ FIRESTOP 700 Sealant	X	X	X	—	Class: B,s2,d_0
DOWSIL™ 813 FR Fire Retardant Silicone	X	X	X	—	Class: B,s2,d_0
DOWSIL™ 790 Building Sealant	—	—	X	E	Class: E
DOWSIL™ Smoke Seal 800SL	X	—	X	—	Class: E
DOWSIL™ 3-6548 Silicone RTV Foam	X	—	X	—	Class: E
DOWSIL™ FIRESTOP 400 Sealant	X	—	X	—	Class: E

Fire resistance

Overview

Fire resistance is intended to control the spread of fire once it has developed. Appropriate levels of fire resistance can increase the time needed for the fire to spread to higher floors and adjacent buildings. This can limit building and material loss from the fire, aid fire fighters in the evacuation of occupants and assist in the efficiency of fighting the fire.

Buildings are typically sub-divided into discrete compartments specifically intended to limit the passage of flames, smoke or heat and prevent the spread of fire to adjacent rooms. These compartments are designed to give occupants enough time to safely evacuate and increase safety margins for fire fighters. A fire compartment consists of fire-resistant walls, floors and doors. Compartment walls and floors form a complete barrier between each unit and are required to provide a minimum degree of fire resistance.

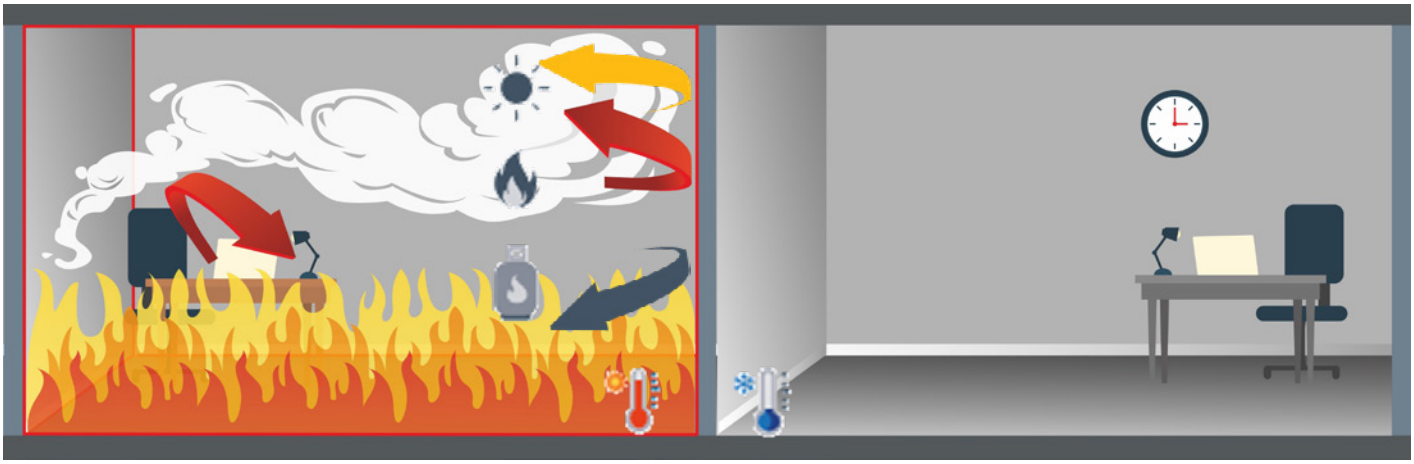


Figure 11: Compartmentation in buildings: fire rated walls and floors prevent the spread of fire (flames, hot gases and smoke) to adjacent rooms

Linear joints and openings in and between fire-separating elements should be sealed with fire retardant materials to maintain the continuity of fire resistance of construction components (wall, floor, door, windows) and be able to achieve the same fire rating as adjacent building elements. The linear joints are prone to thermal movement (shrinking or expanding) during the fire and should stay fully functional. These linear joints can appear either as horizontal or vertical joints in a wall, between walls, between floors or at the connection wall to ceiling/floor.

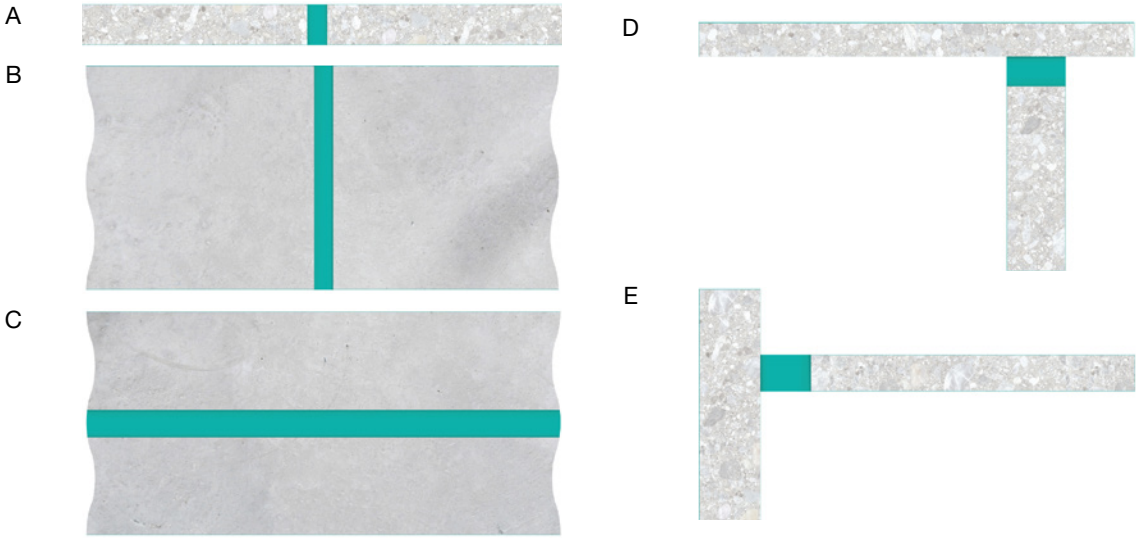


Figure 12: Possible linear joint applications between walls (A), in walls (B, C), between a wall abutting a ceiling (D) and a floor abutting a wall (E)

The walls and floors of a fire compartment can also have openings through which pipes and cables are fed. A fire compartment is not complete until all these openings have been sealed safely using the correct materials.

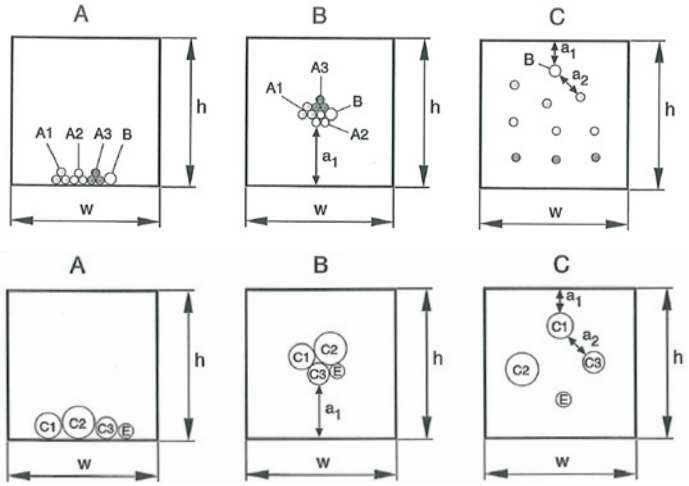


Figure 13: Illustration of different possible penetrant types (eg A1, A2, A3, B, C1, C2) and configurations. The opening's dimensions (w,h), the distance from the penetrant to the edge of the opening (a1), the distance between different penetrants (a2) all influence the fire performance.

In Europe, the relevant standard for testing and classifying the fire resistance of linear joints and penetration seals are respectively the EN1366 testing standard (part 3 and part 4) and the EN13501-2 classification standard. The construction elements are tested within a gas fired furnace which simulates a fire within an enclosed room. The evaluated elements can be mounted on a wall or a floor and the temperature within the furnace rises sharply then gradually starts to level out. Thermocouples (temperature sensors) within the furnace monitor the temperature during the test to ensure the average temperature follows the correct curve. Thermocouples on the tested material follow its temperature increase. The test will assess the integrity (E) and insulation (I) capacity of the seals.

The integrity (E) defines the separation function and hence the capability of a building element, when exposed to fire on one side, to prevent the passage of flames, smoke and hot gases to the unexposed side. The integrity (E) failure is deemed to occur:

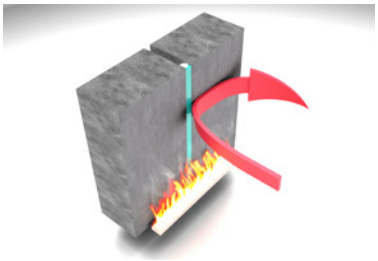
- when collapse or sustained flaming (more than 10s) on the unexposed face of the element occurs
- when openings form and allow flames or hot gases to cause flaming or glowing of a cotton fibre pad, when applied for a maximum of 30s
- when a 6mm diameter gap gauge can penetrate through a gap into the furnace and be moved in the gap for a distance of at least 150mm
- when a 25mm diameter gap gauge can penetrate through a cap into the furnace

The thermal insulating separation function (I) describes the capability of a building element to maintain its required thermal insulation separating function in case of fire. Failure is deemed to occur:

- when the mean unexposed face temperature increases by more than 140°C above its initial value
- when the temperature recorded at any position (including the roving thermocouple) on the unexposed face is in excess of 180°C above the initial mean unexposed face temperature
- when integrity failure occurs

The 180°C temperature is the limit which will lead to spontaneous ignition of materials on the fire averted side and propagate fire. The period given for the insulation failure cannot exceed that for integrity failure. If no integrity or insulation failure occurs, then the result is the time up until the agreed end of the heating period. Based on the time expressed in minutes (15, 20, 30, etc.) during which the joints manage to resist the fire and maintain integrity (E) and/or thermal insulation (I) a classification is obtained. The required classification in E and I depend on the function and location of the building element. Requirements can be less severe for instance in case of an elevator cage (which will not be used in the event of a fire) and more severe on an escape route or stairs. Requirements may differ not only based on the location of the seal in the building, but also the location of the building may impose national requirements. It is recommended that the required performance in fire resistance be verified for each project.

E - Integrity
Separation function: prevent the passage of flames and hot gases to the unexposed side



I - Insulation
Insulating function: prevent the increase of temperature on the non-exposed side

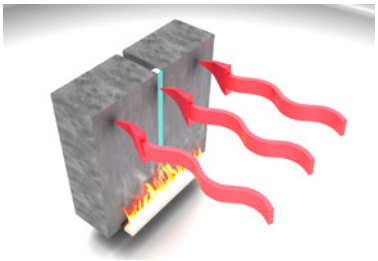


Figure 14: Illustrations of the integrity and insulation fire resistance criteria

Which testing is needed specifically, depends on the product's area of application. Test standard EN1366-4 is relevant for linear joint applications. For penetration seals, the standard EN1366-3 is applicable. The BS476-20 preceded the EN1366 series and sets out the general principles for assessing the fire resistance of construction elements with part 22 addressing the testing specificities for non-load bearing construction elements. These standards provide clear criteria by which an element's loadbearing capacity, fire containment (integrity) and the thermal transmittance (insulation) can be assessed. At the time of writing this manual, the test results obtained according to this BS476 standard series are still valid and accepted in various countries, both in and outside of Europe. It is generally accepted that materials, which have been evaluated in the past according to the BS476-20, will continue to be evaluated according to the BS476 series of standards (for instance in different configurations). Newly developed materials will typically be tested according to the EN1366 standard series. The UL equivalent for linear joints is UL2079, whilst the valid reference for penetration seals is described by UL1479. Besides UL, ASTM also provides ASTM E814 (Standard Test Method for Fire Tests of Penetration Firestop Systems) as testing standard for penetration seals which includes a high pressure hose stream test, and ASTM E1966 for linear joints.

Product group	Description	EU standard	British standard	North America requirement
Firestopping	Penetration seals	EN 1366-3	BS476-20/22	UL 1479, ASTM E814
	Linear joints and gap seals	EN 1366-4	BS476-20/22	UL 2079, ASTM E1966

Additional specific (local/national) test results are available. Please contact your local Dow Technical Specialist for more information related to these reports.

Detailing

Drawings in this guide are typical details of specific seals that have been tested. Seals that differ from these designs may have to be independently tested or assessed to ensure that specific fire ratings are achievable. Indeed, many parameters influence the fire resistance of a sealant both for linear joints and penetration seals.

The joint dimensions, both bite/width and thickness, influence the seal's fire resistance performance. The smaller the joint width, the longer the fire resistance (integrity and insulation) could potentially be. A larger joint thickness will also increase the fire resistance. Fire rated seals can be applied on one side (single joint) of the supporting construction or on both sides (double joint). Double joints typically provide a better fire resistance. For single joints, a different behavior exists between those applied on the exposed (fire side FS) or non-exposed (non-fire side NFS) side of the wall. The joint orientation on a wall can be vertical or horizontal. Vertical joints can reach lower performance than equivalent designs in horizontal orientation due to the gravity which can accelerate any potential failure. Linear joints in a wall, in a floor or between adjacent walls or floors do not have to resist shear movement. However, when a joint is sealing a floor abutting a wall or a ceiling abutting a wall, it is necessary to test the joint under shear movement. In European testing, the shear movement is typically a static shear deformation applied on the cured joint during the fire test. This shear movement adds more severity to the testing condition.

Joint parameters

- Bite and thickness
- Orientation (vertical /horizontal)
- Single or double joints
- Movement or static

Construction parameters

- Wall material and thickness
- Backing material (MW/backer rod)
- Support elements for backing
- Compression and thickness of MW

Penetration parameters

- Diameter
- Separation (grouped/shattered)
- Sheathing material
- Position (corner/middle)

All parameters of the tested system can further influence its performance. Testing in floors is much more onerous than in walls and performance reached by certain joint configurations in walls cannot be extrapolated to a floor set up. The build-up of the supporting (wall or floor) construction, including the material and its thickness, influences the overall performance of the tested system. This effect is more pronounced for the floor test. A thicker construction can limit the heat increase around the linear joints and improve fire resistance in E and I. Forming materials, such as mineral wool or backer rods, allow the liquid applied sealant to form until cure occurs. Mineral wool has inherently excellent non-combustible behavior under fire and contributes to the overall performance of the system by limiting the temperature increase of the seal. The mineral wool specifications (density, thickness, compression, potential use of metal supports) influence the result and therefore are fully part of the tested system. Backer rods made of PU and PE are alternative means to support the sealant during its cure, which will not contribute to the fire resistance of the build-up as they tend to quickly burn away, leaving the sealant exposed to the fire. Both PU and PE have a similar fire resistance, hence testing with one or the other is deemed to be equivalent and test results obtained for one option are generally accepted to cover the other material. Finally, for penetration seals specifically, the cable parameters (sheathing material, diameter, etc), the diameter of the opening (larger being more severe) as well as the position of the cables inside the opening (clustered or spread, centered or edge of the opening) can all influence the fire resistance.

In Europe, rules exist to extrapolate test results for different bite parameters. For linear joints and penetration seals, the European Standard EN15882 respectively part 4 and part 3 describe the principles which apply for the extension of the field of application of a specific test result.

The extended application principles common to all generic joint seal types are as follows:

Component	Variation	Rules
Separating elements- concrete or masonry	Decrease in thickness and/or density	Not permitted
	Increase in thickness and/or density	Permitted
Seal depth	Decrease in seal depth	Not permitted
	Increase in seal depth	Permitted
Joint width (W)	Increase in joint width	Interpolation within the tested range between the maximum and minimum nominal joint width is permitted provided the overall seal depth including the backing material is equal or higher
	Decrease in joint width	Permitted
Material density	Increase in material density	Not permitted
	Decrease in material density	Not permitted
Configuration	Cross section shape of the joint	Permitted only if the area of adhesion remains the same or is increased
	Position of seal within the joint	Distance of the seal from the exposed face in the wall/ floor may not be reduced from that tested but may be increased for masonry/concrete walls/floors
	Orientation (H, V)	The classification for vertical linear joints or horizontal linear joints in a vertical test construction (wall) tested without shear movement doesn't cover other orientations
	Shear movement	The classifications for linear joints in a horizontal test construction (floor) are also valid for a horizontal wall joint abutting a floor, ceiling or roof where shear movement is tested
Backing material for sealant seals	Polyurethane/polyethylene	May be interchanged and may be replaced by glass wool, slag wool, stone wool or ceramic wool (the above rules relate to materials of the same or greater depth)
	Stone wool	No change permitted
	Decrease in backing material depth	Not permitted
	Increase in backing material depth	Permitted for Class A1 and A2 materials

As illustration of the previous concept, the results obtained on a series of linear joints in floors and in walls are provided below.

Case	Width (mm)	Sealant depth (mm)	Backfilling type	Backfilling depth (mm)	EI	E
1	50	≥10	MW	≥100	EI 120-H-X-F-W 50 to W 50	E 240-H-X-F-W 50 to W 50
2	150	≥10	MW	≥100	EI 120-H-X-F-W 150 to W 150	E 240-H-X-F-W 150 to W 150
3	**50 to 150**	**≥10**	**MW**	**≥100**	**EI 120-H-X-F-W 50 to W 150**	**E 240-H-X-F-W 50 to W 150**

Case 1 describes a linear joint of 50mm bite and 10mm depth, which was tested with 100mm mineral wool (MW) backfilling without shear movement in a floor. The linear joint resisted 120min in insulation and 240min in integrity E. The classification describes the testing parameters: horizontal floor application (H), no movement tested (X) for bites (W) of 50mm, on field application (F). Therefore, the joint has the classification EI 120-H-X-F-W 50 to W 50 and E 240-H-X-F-W 50 to W 50. The rules allow increasing the depth of 10mm sealant and increasing the backfilling (mineral wool) depth or its density and compression. The same classification can be obtained for Case 2 which has different bite dimensions and as a range of bite dimensions are tested, with a minimum and maximum value, all intermediate values are extrapolated and have the same classification (case 3). As the joint with 150mm also reached 120 minutes in EI and 240minutes in E, a classification for all bites between 50 and 150mm is obtained: EI 120-H-X-F-W 50 to W 150 and E 240-H-X-F-W 50 to W 150.

When joints are tested with shear movement, for example 10%, an additional code M appears in the classification.

Shear	Sealant width (mm)	Sealant depth (mm)	Backfilling type	Backfilling depth (mm)	EI	E
10%	6	≥2	MW	≥100	EI 240-H-M 10-F-W 6 to W 6	E 240-H-M 10-F-W 6 to W 6
10%	50	≥2	MW	≥100	EI 180-H-M 10-F-W 50 to W 50	E 240-H-M 10-F-W 50 to W 50
10%	**6 to 50**	≥2	**MW**	**≥100**	**EI 180-H-M 10-F-W 6 to W 50**	**E 240-H-M 10-F-W 6 to W 50**

As can be seen from above table extract, the 6mm wide joint passes 240min insulation whilst the 50mm wide joint only reaches 180min insulation. Therefore, the classification for the range of sealant widths between 6 and 50mm is 180min, the highest commonly reached value.

Similar rules can be applied for the penetration seals and are described in EN15882-3. As a rule of thumb, changes to the build-up which are helping the joint to reach or maintain a certain fire resistance will be allowed. For instance, the sealant and backing depth can be increased or the penetration size decreased. Extrapolation rules related to cables type and positioning are more complex and require careful review.

In the current document, only the individual joint test results are provided and do not include the above classifications as these extrapolation rules are for information only. Consultation with an independent third party is strongly advised to determine the possibility of using the test results for the considered project build up in case of deviation from the tested build up.

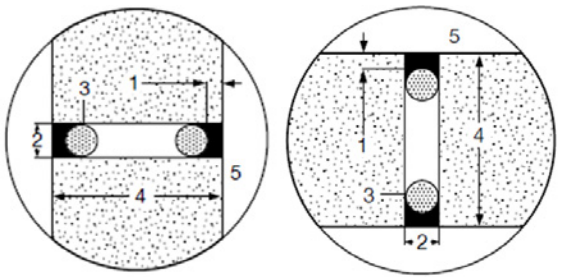
Linear joints test results

The following pages depict the linear joint designs that have been tested to:

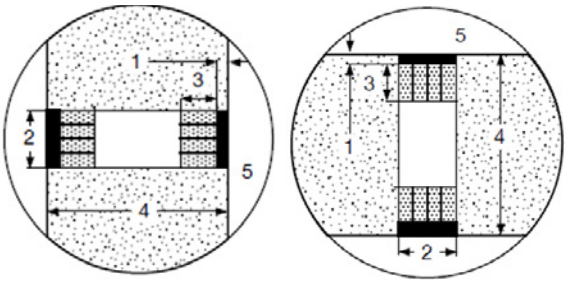
- European standard EN1366-4
- British Standard BS476-20
- UL 2079

All linear joints follow one of the four designs below for wall and floors. In walls, the joints can be both horizontal or vertical.

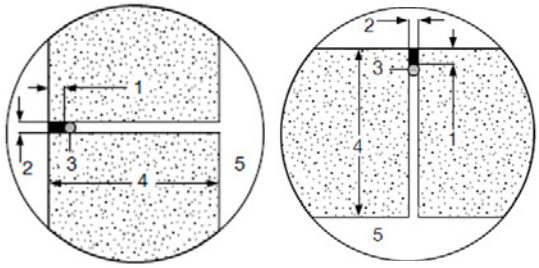
Seal type L1 is a symmetric seal joint supported on both sides of the construction by a backer rod and finished flush with the surface of the supporting construction, wall or floor



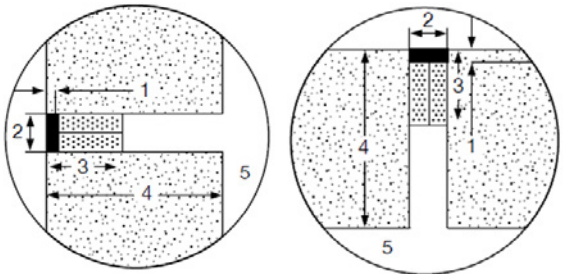
Seal type L2 is a symmetric seal joint supported on both sides of the construction by stonewool and finished flush with the surface of the supporting construction, wall or floor



Seal type L3: single seal joint on a backer rod, finished flush with the surface of the supporting construction, wall or floor. The joint can be on the non-exposed side (non fire side NFS) as illustrated, or on the exposed fire side (FS).



Seal type L4: single seal joint on a stonewool backing, finished flush with the surface of the supporting construction, wall or floor. The joint can be on the non-exposed side (non fire side NFS) as illustrated, or on the exposed fire side (FS).



Legend: 1: sealant depth, 2: sealant width, 3: backfilling depth/diameter, 4: supporting contruction depth, 5: fire side

Linear joints in walls

NFS= single joint on non fire side, FS= single joint on fire side, FS+NFS= double symmetric joint on fire side and non fire side,
CF= ceramic fibre backing, MW= mineral wool backing, PE= polyethylene backer rod, PU= Polyurethane backer rod, CC= Concrete

Silicone	Type	Bite width	Thickness/depth	Orientation (V/H)	Single-double	Backing type	Backing thickness		Density/compression	Wall material	Wall thickness	Tested standard	Integrity (E)	Insulation (I)	Report
700EU	L4	6	10	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L3	10	10	V	NFS	PE	10mm		35kg/m³	Brick	230mm	BS476/22	120	120	J86464-1
	L4	10	10	V	NFS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	120	120	J86464-1
	L1	10	10	V	FS+NFS	PE	10mm		35kg/m³	Brick	230mm	BS476/22	240	180	82973/1
	L2	10	10	V	FS+NFS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	10	15	V	NFS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	10	20	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	15	10	V	NFS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	15	15	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L2	15	15	V	FS+NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	15	20	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	20	10	V	NFS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	20	15	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L3	20	20	V	NFS	PE	20mm		35kg/m³	Brick	230mm	BS476/22	240	180	82973/1
	L4	20	20	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L1	20	20	V	FS+NFS	PE	20mm		35kg/m³	Brick	230mm	BS476/22	240	180	82973/1
	L4	25	15	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L4	25	20	V	NFS	CF	25mm		128kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L3	10	10	V	FS	PE	10mm		35kg/m³	Brick	230mm	BS476/22	240	180	82973/1
	L4	10	10	V	FS	MW	25mm		100kg/m³	Brick	230mm	BS476/22	240	240	82973/1
	L3	25	20	V	FS	PE	25mm		35kg/m³	Brick	230mm	BS476/22	120	60	J86464-1
	L4	50	25	V	NFS	MW	50mm		180kg/m³	Aerated cc	150mm	BS476/20	120	120	211410B
	L4	40	20	V	NFS	MW	25mm		180kg/m³	Aerated cc	150mm	BS476/20	120	60	211410B
	L1	10	10	V	FS+NFS	PU	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L2	10	10	V	FS+NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L2	30	10	V	FS+NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L1	30	10	V	FS+NFS	PU	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	180	240	15546A
	L2	30	10	V	FS+NFS	PE	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	180	240	15546A
	L2	10	10	V	FS+NFS	PE	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L4	30	15	V	NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L2	10	10	V	FS+NFS	PE	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L4	30	15	V	NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L1	10	10	H	FS+NFS	PU	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L2	10	10	H	FS+NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L2	30	10	H	FS+NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L1	30	10	H	FS+NFS	PU	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	180	240	15546A
	L1	30	10	H	FS+NFS	PE	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	180	240	15546A
	L1	10	10	H	FS+NFS	PE	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L4	30	15	H	NFS	MW	60mm		45kg/m³	Aerated cc	150mm	EN1366-4	240	240	15546A
	L1	10	10	V	FS+NFS	PE	10mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	19943B
	L1	30	10	V	FS+NFS	PE	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	19943B
	L1	11	10	H	FS+NFS	PE	11mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	19943B
	L1	30	10	H	FS+NFS	PE	30mm		35kg/m³	Aerated cc	150mm	EN1366-4	240	240	19943B
700 (CN)	L2	25		V	FS+NFS	MW	75mm		64kg/m³	Aerated cc	125mm	UL2079	90	90	WW S 0007
	L3	12.5		V	FS	Ultrablock	9.375mm			Aerated cc	112.5mm	UL2079	120	120	WW S 0013
	L2	25		V	FS+NFS	MW	75mm		64kg/m³	Aerated cc	102mm	UL2079	180	180	WW S 0038
	L2	12.5	12.5	V	FS+NFS	PE/PU	NA			Aerated cc	102mm	UL2079	180	180	WW S 0049
	L2	75	12.5	V	FS+NFS	MW	75mm		64kg/m³	Aerated cc	125mm	UL2079	120	120	WW S 1019
	L2	10	200	V	NFS	NA	NA		NA	Aerated cc	200mm	GB 23864	180	180	2019601127
	L3	60	200	V	NFS	NA	NA		NA	Aerated cc	200mm	GB 23864	180	180	2019601127
	L2	10	200	V	NFS	NA	NA		NA	Aerated cc	200mm	GB 23864	180	180	2019601127
	L3	60	200	V	NFS	NA	NA		NA	Aerated cc	200mm	GB 23864	180	180	2019601127
	L4	100	10	V	NFS	MW	100mm		100kg/m³	Concrete	200mm	BS476-20	120	120	R22H20-1A
	L4	100	10	V	NFS	MW	100mm		100kg/m³	Concrete to steel	200mm	BS476-20	120	120	R22H20-1A
	L4	50	6	V	NFS	MW	100mm		100kg/m³	Concrete	200mm	BS476-20	120	120	R22H20-1A
	L4	50	6	V	NFS	MW	100mm		100kg/m³	Concrete to steel	200mm	BS476-20	120	120	R22H20-1A
	L4	50	10	V	NFS	MW	100mm		100kg/m³	Concrete	200mm	BS476-20	120	120	R22H20-1A
	L4	30	10	V	NFS	MW	100mm		100kg/m³	Steel to steel	200mm	BS476-20	120	120	R22H20-1A

These are typical properties, not to be construed as specifications.

Silicone	Type	Bite width	Thickness/depth	Orientation (V/H)	Single-double	Backing type	Backing thickness		Density/compression	Wall material	Wall thickness	Tested standard	Integrity (E)	Insulation (I)	Report
813FR	L4	6	6	V	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	10	6	V	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	30	10	V	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	120	19943A
	L4	50	10	V	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	10	6	V	FS+NFS	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	30	10	V	FS+NFS	PE	30mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	180	19943A
	L2	6	6	V	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L2	30	6	V	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L2	30	10	V	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L1	10	6	V	NFS	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	6	6	H	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	10	6	H	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	30	10	H	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L4	50	10	H	FS+NFS	MW	2x30mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L3	10	6	H	FS+NFS	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19943A
	L3	30	10	H	FS+NFS	PE	30mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	180	19943A
	L2	6	6	H	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L2	30	6	H	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L2	30	10	H	NFS	MW	60mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19943A
	L1	10	6	H	NFS	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19943A
790	L3	10	10	V	FS	PE				Aerated CC	120mm	BS476/20	180	180	FSP0156
	L3	15	15	V	FS	PE				Aerated CC	120mm	BS476/20	180	180	FSP0068
	L3	20	15	V	FS	PE				Aerated CC	120mm	BS476/20	180	180	FSP0068
	L3	10	10	V	NFS	PE				Aerated CC	120mm	BS476/20	120	120	FSP0121
	L3	15	15	V	NFS	PE				Aerated CC	120mm	BS476/20	120	120	FSP0089
	L1	10	10	V	FS+NFS	PE				Aerated CC	120mm	BS476/20	120	120	FSP0089
	L1	15	10	V	FS+NFS	PE				Aerated CC	120mm	BS476/20	120	120	FSP0089
	L1	15	15	V	FS+NFS	PE				Aerated CC	120mm	BS476/20	180	180	FSP0095
	L1	20	10	V	FS+NFS	PE				Aerated CC	120mm	BS476/20	120	120	FSP089
	L1	20	15	V	FS+NFS	PE				Aerated CC	120mm	BS476/20	180	180	FSP0095
	L3	15	15	V	FS	PE				Aerated CC	120mm	BS476/20	240	240	FSP0040
	L1	25	25	V	FS+NFS	PE				Aerated CC	170mm	BS476/20	240	240	FSP0246
	L1	25	13	V	FS+NFS	MW	75mm			Aerated CC	220mm	UL263/ASTM E119	2hours		
	L1	75	13	V	FS+NFS	MW	75mm			Aerated CC	220mm	UL263/ASTM E119	2hours		
	L2	25	37.5	V	FS+NFS	MW	75mm		64kg/m³	Aerated CC	125mm	UL2079	90	90	WW S 0007
	L3	12.5	12.5	V	FS	Ultrablock	9.375mm			Aerated CC	112.5mm	UL2079	120	120	WW S 0013
	L2	25	12.5	V	FS+NFS	MW	75mm		64kg/m³	Aerated CC	102mm	UL2079	180	180	WW S 0038
	L2	12.5	12.5	V	FS+NFS	PE/PU	NA			Aerated CC	102mm	UL2079	180	180	WW S 0049
	L2	75	12.5	V	FS+NFS	MW	75mm		64kg/m³	Aerated CC	125mm	UL2079	120	120	WW S 1019
400	L3	10	10	V	FS+NFS	PE	10mm		35kg/m³	Brick	230mm	BS476/22	120	120	J86464-1
	L3	20	10	V	FS+NFS	PE	20mm		35kg/m³	Brick	230mm	BS476/22	120	120	J86464-1
	L1	25	15	V	FS	PE	25mm		35kg/m³	Aerated CC	150mm	BS476/20	240	60	135628
	L2	20	10	V	FS	MW	50mm		165kg/m³	Aerated CC	150mm	BS476/20	240	90	135628
	L2	10	6	V	FS	MW	50mm		165kg/m³	Aerated CC	150mm	BS476/20	240	60	135628
	L3	6	6	V	FS+NFS	PE	6mm		35kg/m³	Aerated CC	150mm	BS476/20	240	180	135628
	L3	10	6	V	FS+NFS	PE	10mm		35kg/m³	Aerated CC	150mm	BS476/20	240	240	135628
	L3	20	10	V	FS+NFS	PE	20mm		35kg/m³	Aerated CC	150mm	BS476/20	240	240	135628
	L3	25	13	V	FS+NFS	PE	25mm		35kg/m³	Aerated CC	150mm	BS476/20	240	240	135628
	L3	20	10	V	FS+NFS	PE	20mm		35kg/m³	Brick	215mm	BS476/22	120	120	J89235-1
	L1	10	6	V	FS+NFS	PE	12mm		NA	Aerated CC	150mm	EN1366-4	240	240	20975B
	L1	30	6	V	FS+NFS	PE	35mm		NA	Aerated CC	150mm	EN1366-4	180	90	20975B
	L3	10	6	V	NFS	PE	12mm		NA	Aerated CC	150mm	EN1366-4	240	180	20975B
	L1	30	6	H	FS+NFS	PE	35mm		NA	Aerated CC	150mm	EN1366-4	240	180	20975B

Linear joints in floors

Material	Drawing	Bite width	Thickness/depth	Single-double	Shear movement	Backing type	Backing thickness		Density/compression	Wall material	Wall thickness	Tested standard	Integrity (E)	Insulation (I)	Report
800SL	L4	6	2	NFS	0	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	50	2	NFS	0	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	50	10	NFS	0	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	100	10	NFS	0	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	120	19921A
	L4	150	10	NFS	0	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	90	19921A
	L4	6	2	NFS	10%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	50	2	NFS	10%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	180	19921A
	L4	6	6	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	180	120	19921A
	L4	20	6	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	50	10	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	240	19921A
	L4	100	10	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	180	120	19921A
	L4	150	10	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	240	120	19921A
	L3	10	6	NFS	0	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19921A
	L3	20	6	NFS	0	PE	20mm		35kg/m³	Aerated CC	150mm	EN1366-4	60	15	19921A
	L3	30	6	NFS	0	PE	30mm		35kg/m³	Aerated CC	150mm	EN1366-4	60	15	19921A
	L3	10	6	NFS	25%	PE	10mm		35kg/m³	Aerated CC	150mm	EN1366-4	240	240	19921A
	L3	20	6	NFS	25%	PE	20mm		35kg/m³	Aerated CC	150mm	EN1366-4	60	15	19921A
	L3	30	6	NFS	25%	PE	30mm		35kg/m³	Aerated CC	150mm	EN1366-4	60	NA	19921A
	L3	100	6	NFS	0	MW	120mm		110kg/m³/10%	Aerated CC	200mm	EN1366-4	120	120	P110312-1006
	L3	50	6	NFS	NA	MW	100mm		100kg/m³/33%	Aerated CC	115mm	UL2079	2-3hour	FT	XHBN FF S0040
	L3	150	6	NFS	NA	MW	100mm		100kg/m³/33%	Aerated CC	115mm	UL2079	2-3hour	FT	XHBN FF S 1043
790	L3	10	15	FS	NA	PE	10mm		35kg/m³	Aerated CC	120mm	BS476/20	120	120	FSP0040
	L3	15	15	FS	NA	PE	15mm		35kg/m³	Aerated CC	120mm	BS476/20	120	120	FSP0040
	L1	10	15	FS+NFS	NA	PE	10mm		35kg/m³	Aerated CC	120mm	BS476/20	180	180	FSP0095
	L1	15	15	FS+NFS	NA	PE	15mm		35kg/m³	Aerated CC	120mm	BS476/20	180	180	FSP0095
	L1	20	15	FS+NFS	NA	PE	20mm		35kg/m³	Aerated CC	120mm	BS476/20	180	180	FSP0095
	L3	10	15	FS	NA	PE	10mm		35kg/m³	Aerated CC	120mm	BS476/20	240	240	FSP0040
	L3	15	15	FS	NA	PE	15mm		35kg/m³	Aerated CC	120mm	BS476/20	240	240	FSP0040
	L3	25	10	NFS	NA	PE+CF	10mm+60mm		35+100kg/m³	Aerated CC	170mm	BS476/20	240	240	FSP0246
	L1	25	25	FS+NFS	NA	PE	25mm		35kg/m³	Aerated CC	170mm	BS476/20	240	240	FSP0246
3-6548	L4	50	10	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-4	120	120	19921A
	L4	100	10	NFS	25%	MW	100mm		45kg/m³/10%	Aerated CC	150mm	EN1366-5	120	120	19921A

These are typical properties, not to be construed as specifications.

Penetration seals test results

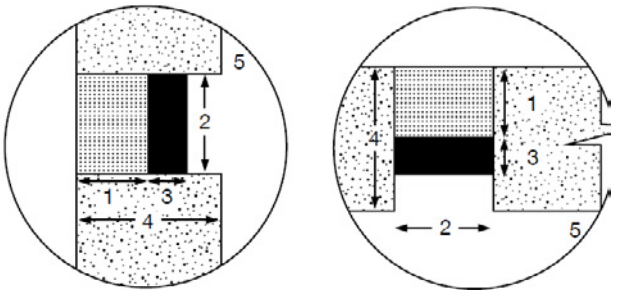
The following pages depict the linear joint designs that have been tested to:

- European standard EN1366-3
- British Standard BS476-22

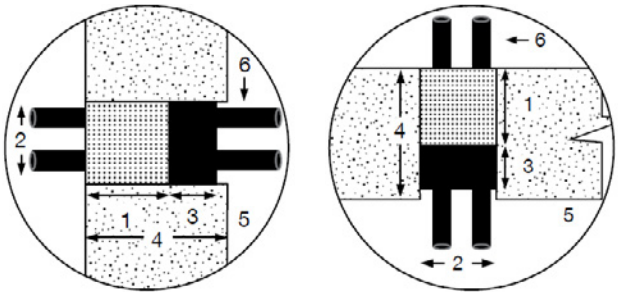
Both penetration seals in floors and walls are described. The illustrated drawings are typical details of specific seals that have been tested. Seals that differ from these designs may have to be independently tested or assessed to ensure that specific fire ratings are achieved. A series of penetration seals have the same build up, yet different dimensions. For these seals, reference is made to one of the generic drawings below.

DOWSIL™ Sealants have been assessed according to additional standards such as UL1479. More details are available on the UL database. Please contact your local Dow Technical Specialist for more information.

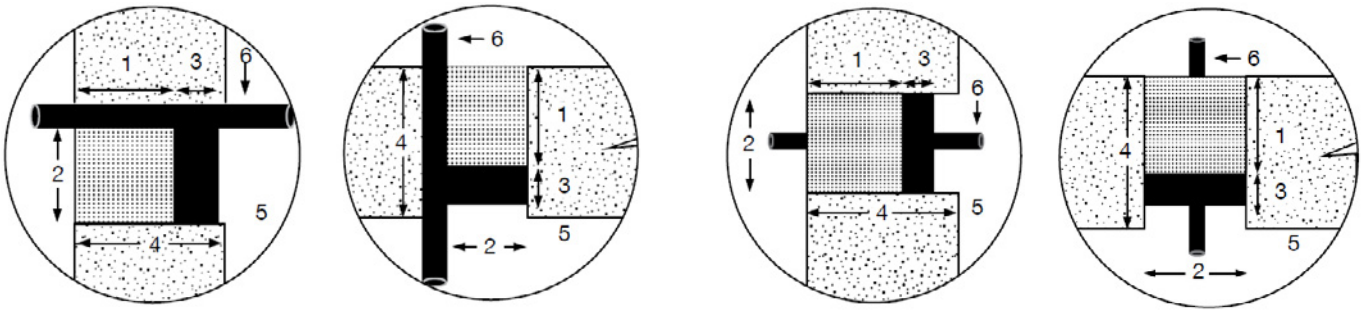
P1: penetration (square or round) without penetrants (blank seal), wall or floor



P2: penetration with several dispersed penetrants, wall or floor



P3: penetration (square or round) with single penetrant, wall or floor centered or not



Legend: 1: backfilling depth; 2: penetration size; 3: sealant depth; 4: supporting construction depth; 5: non fire side

Contact your local Dow Technical Specialist for specific information related to positioning of penetrants

Penetration seals in walls

Product	Thickness/ depth	Backing type	Backing thickness	Density	Penetration size	Penetrants	Material	Thickness	Standard	Integrity (E)	Insulation (I)	Drawing	Report
700	6mm	NA	NA	NA	15mm diameter	1X13A cable	Brick	230mm	BS476/22	120	120	P3	J86464-1
	6mm	NA	NA	NA	20mm diameter	1x13A flex	Brick	230mm	BS476/22	120	120	P3	J86464-1
	6mm	NA	NA	NA	25mm diameter	2x13A cable	Brick	230mm	BS476/22	120	120	P2	J86464-1
	6mm	NA	NA	NA	30mm diameter	2x30A cable	Brick	230mm	BS476/22	120	120	P2	J86464-1
	6mm	NA	NA	NA	50mm diameter	5x30A cable	Brick	230mm	BS476/22	120	120	P2	J86464-1
	10mm	MW	75mm	100kg/m^3	150x 150mm^2	100mm diameter steel pipe	Brick	230mm	BS476/22	240	60	P3	J82973/2
	10mm	MW	75mm	100kg/m^3	150x 150mm^2	25mm diameter steel pipe	Brick	230mm	BS476/22	240	210	P3	J82973/2
	20mm	MW	25mm	100kg/m^3	150x 150mm^2	25mm cable	Brick	230mm	BS476/22	120	60	P3	J82973/2
	20mm	MW	75mm	100kg/m^3	150x 150mm^2	25mm steel pipe	Brick	230mm	BS476/22	240	240	P3	J82973/2
	10mm	MW	75mm	100kg/m^3	150x 150mm^2	1x25mm, 4x12.5mm cables	Brick	230mm	BS476/22	240	90	P2	J82973/2
	20mm	MW	75mm	100kg/m^3	150x 150mm^2	1x25mm, 4x12.5mm cables	Brick	230mm	BS476/22	240	240	P2	J82973/2
	10mm	MW	75mm	100kg/m^3	150x 150mm^2	None (blank seal)	Brick	230mm	BS476/22	240	90	P1	J82973/2
	20mm	MW	50mm	100kg/m^3	150x 150mm^2	None (blank seal)	Brick	230mm	BS476/22	240	90	P1	J82973/2
	20mm	MW	25mm	100kg/m^3	50mm diameter	25mm cable	Brick	230mm	BS476/22	240	240	P3	J82973/2
	20mm	MW	25mm	100kg/m^3	50mm diameter	None (blank seal)	Brick	230mm	BS476/22	240	240	P1	J82973/2
	200mm	NA	NA	NA	510mm 110mm	6 cables (6*1.5)mm^2 3 cables (2*50+1*25)mm^2 4 cables (3*50+1*25)mm^2 42mm outer diameter steel tube	Aerated cc	200mm	GB 23864	120	120	P2	2020600061
3-6548	200mm	NA	NA	NA	150x 150mm^2	None (blank seal)	Brick	230mm	BS476/22	240	240	P1	J89273/2
	50mm	MW	50mm	100kg/m^3	300x 150mm^2	None (blank seal)	Brick	230mm	BS476/22	180	60	P1	J89273/2
	50mm	MW	75mm	100kg/m^3	150x 150mm^2	114mm steel pipe	Brick	230mm	BS476/22	240	90	P3	J89273/2
	50mm	MW	75mm	100kg/m^3	150x 150mm^2	1x30mm, 2x11mm, 2x17mm cables	Brick	230mm	BS476/22	240	180	P2	J89273/2
	50mm	MW	50mm	100kg/m^3	300x 150mm^2	3x30mm PVC sheathed cables	Brick	230mm	BS476/22	120	90	P2	J89273/2

These are typical properties, not to be construed as specifications.

Penetration seals in floors

DOWSIL™ 3-6548 Silicone Foam:

Product	Thickness/ depth	Penetration size	Penetrants	Floor thickness	Standard	Integrity (E)	Insulation	Drawing	Report
3-6548	100mm	Square 200x200mm^2	None (blank seal)	3-6548	EN1366-3	60	60	P1	19921B (25)
	100mm	Square 30x30mm^2	Small diameter cable (B and E)	3-6548	EN1366-3	120	120	P2	19921B (23-24)
	100mm	Square 200x200mm^2	Small diameter cables (3x A1+, 3x A2+, 3X A3+, 1x B)	3-6548	EN1366-3	60	60	P2	19921B (26)
	100mm	Square 200x200mm^2	Medium diameter cable (39 x F)	3-6548	EN1366-3	60	60	P2	19921B (27)
	100mm	Square 200x200mm^2	Medium diameter cable (C1, C2, C3 and E)	3-6548	EN1366-3	60	60	P2	19921B (28)

These are typical properties, not to be construed as specifications.

Smoke barriers

Smoke is a gas phase effluent consisting of solid particles, liquid droplets, gases and vapors. It is the factor which kills most in fire events, with 75% of all fire deaths caused by smoke inhalation. Furthermore, smoke reduces visibility, making it difficult to see the exit which can increase the time required to escape. Therefore, the amount of time for people to escape safely can be increased by preventing spread of smoke.

A crucial construction element is the connection between the floor and wall which is typically packed with mineral wool, to help ensure adequate blocking of heat and flames. By using a highly compressed material it is possible to limit the passage of smoke and hot gases through the mineral wool. Once in position, mineral wool should be fixed to avoid falling down due to building movements during service life or in the event of a fire. Due to its limited movement accommodation capacity using only mineral wool could lead to smoke leakage. To ensure full tightness, further safety measures might be required. Metal strips such as galvanized sheets which can be bent on site and fixed to the top surface of the floor slab are commonly used to fix fire stops and fire stop suppliers give guidance on frequency of fixings. If a metal sheet is used as smoke stop, an appropriate DOWSIL™ Fire Rated Sealant can be used at the interfaces with the back of the wall or floor to ensure smoke tightness. Self leveling silicone seals can be used as an alternative to metal sheeting to cover the mineral wool and increase protection against smoke leakage. The sealing ensures that the gas is contained even in case of movement of the mineral wool.

Finally, silicone can be used to seal the perimeter of windows and doors for smoke seal application.

Specific DOWSIL™ Fire Rated Silicone sealants have been successfully evaluated according to EN 12101:1 for smoke leakage prevention at room temperature and at elevated temperature (200°C), “Smoke and heat control systems - Part 1: Specification for smoke barriers”. Please contact your local Dow Technical Specialist to learn more about the use of DOWSIL™ Silicones in smoke barriers.

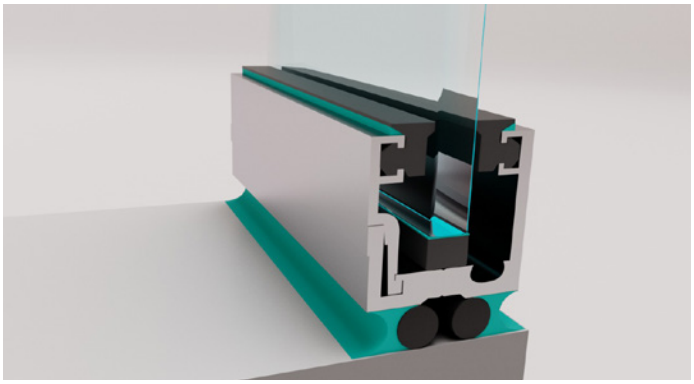


Figure 15: Windows and doors perimeter smoke sealing using fire rated silicone

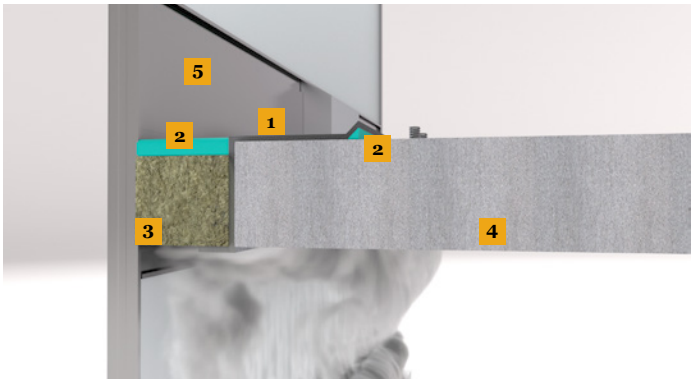


Figure 16: 1) Metal sheet, 2) Fire rated silicone, 3) Mineral wool, 4) Concrete slab, 5) Fire rated wall

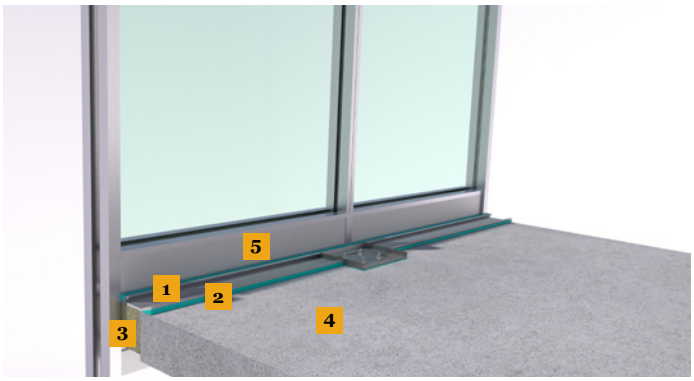


Figure 17: 1) Metal sheet, 2) Fire rated silicone, 3) Mineral wool, 4) Concrete slab, 5) Fire rated wall

Curtain wall fire resistance

Aluminium curtain walls are normally used for areas of the building envelope that are not required to be fire resisting. However they still require appropriate detailing to limit the spread of fire and smoke. Where an external wall, such as a curtain wall, abuts a fire-resistant compartment floor, it is necessary to provide fire stopping between the external wall and the compartment floor to restrict fire and smoke spread through the junction.

Protecting the perimeter also requires the extension of the rated floor to the exterior wall surface. The perimeter fire barrier system, the sealing of the perimeter joint and extension of the rated floor provides structural protection and maximizes the integrity of the wall system. This can help to keep the wall and window system intact for a longer period of time.

Evaluation of the fire resistance performance of the perimeter fire barrier and its ability to maintain a seal to prevent fire from spreading among an exterior wall assembly and floor assembly can be carried out using ASTM E2307 or EN1364-4. Through this test, the deflection and deformation of material that compose the curtain wall can be seen. This fire test simulates an indoor fire located near a window. DOWSIL™ Sealants can be implemented in these types of perimeter barrier systems as a smoke seal. Please contact your local Dow Technical Specialist to learn more about the use of DOWSIL™ Silicones in perimeter barrier systems.

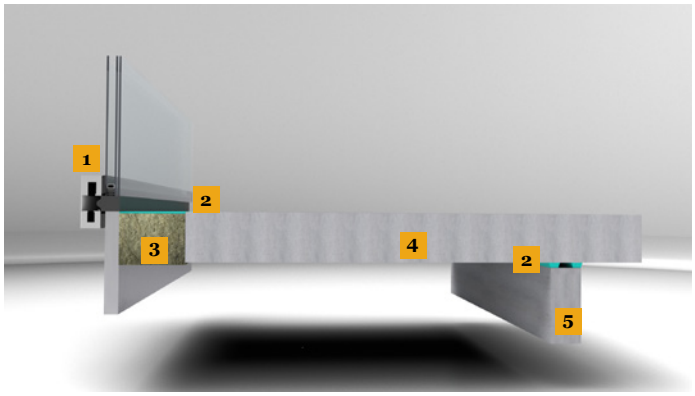


Figure 18: Curtain wall and fire-resistant floor and walls with indication of the use of fire resistant silicone for linear joints in compartments and on top of the mineral wool in the perimeter barrier system between floor and curtain wall.

1) Curtain wall, 2) Fire rated silicone, 3) Mineral wool, 4) Concrete floor slab, 5) Fire rated wall

Application guidelines

The following application guidelines for linear joints or penetration seal systems for new building construction or in sealing and upgrading the capabilities of older existing building structures is provided for the convenience of the architect/specifier. The followed application guidelines can be incorporated in the detailed specification covering application and quality control procedures of the selected seal system installer. Any substantial deviations from this manual can be referred to by the manufacturer or its representative.

The following guidelines focus on specific information related to the application of DOWSIL™ Fire Rated Silicones which is different to the general rules provided in the Dow Building Envelope Weatherproofing Manual EMEAI. Please refer to this manual for information related to surface preparation (e.g. cleaning, priming), joint shaping and other aspects such as testing in the Dow laboratory. Please contact your local Technical Specialist for further information related to these aspects.

General observations

Materials

- Supporting construction: walls and floors made of new concrete, or cementitious substrates, should be at least 7–28 days old and have a moisture content not exceeding 5%. Laitance deposits are best removed by compressed air, light grit blasting or grinding. To determine the need to clean new concrete, use a clean cloth or finger to pass on the substrates to which adhesion needs to be developed. Repeat the cleaning procedure until the cloth/finger shows no residual dust or dirt.
- Mineral fiber board, mineral fiber matting, and mineral fiber putty: forming and damming materials used to contain the liquid silicone prior to and during curing: fire tested and functionally approved forming materials can be left in place to become an integral part of the seal. To form a good seal, fire stops generally need to be compressed and hence the width of this element must be sufficient to ensure adequate compression, allowing for construction tolerances. Tolerances can occur because the gap between the facade and the structure is greater than anticipated or the fire stop is cut smaller than required, or because the façade bows away from the structure. Potential movements should be evaluated and due allowance made. Compression should occur in the direction of building movement to allow expansion as joints expand. The amount of compression required depends on the nature of the fire stop materials and should be as required by the fire stop manufacturer. Fire stops may be supplied as pre-cut strips of specified width or may be site cut from slabs. If pre-cut strips are used it may be necessary to have a range of sizes available to allow for variation in the gap width between the floor edge and the facade. Alternatively, strips can be supplied at the upper end of the range likely to be required and trimmed where necessary. If site cut strips are used, allowance for cutting tolerances must be made.
- Plywood sheet, particle board or other combustible forming materials are forming and damming materials used for containment during curing only and must be removed from the final completed seal system.

Preparation

Preparation shall include but is not limited to:

- Removing all incidental combustible materials and loose impediments from the penetration or linear joint opening and involved surfaces.
- Removal of free liquids or oil from all involved surfaces and penetration components
- Installation of the specified damming materials to accommodate and help ensure the proper thickness/fire rating requirements and offer containment during foaming where needed
- Removal of all combustible damming materials or materials not intended for the final seal system

Repair

If freshly applied sealant will be applied within 1 hour after cutting the cured compatible sealant, solvent cleaning of the existing silicone surface will not be necessary. Since new silicone sealant fully adheres to cured silicone sealant, no priming is required for silicone sealant to adhere to silicone sealant. If the existing silicone is solvent cleaned, allow the absorbed solvent to evaporate before application of the new sealant.

Material specific observations

Gun grade sealants

The application of gun grade sealants such as DOWSIL™ Firestop 700 Sealant (EU), DOWSIL™ Firestop 700 (CN) Sealant, DOWSIL™ 813FR Fire Resistant Silicone and DOWSIL™ 790 Building Sealant, follows the general rules provided in the Dow Building Envelope Weatherproofing Manual EMEAI. No additional application guidelines must be followed to ensure proper performance.

As far as DOWSIL™ Firestop 400 Sealant is concerned, application is similar. However, this acrylic based sealant has a higher shrinkage percentage than silicone sealants. It is recommended to verify that the obtained seal dimensions respect the dimensions required for the fire resistance level after cure. Where needed, it is recommended to correct by a second application.

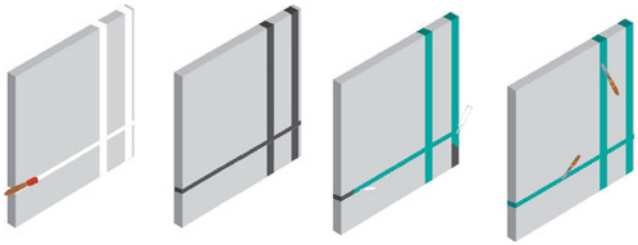


Figure 19: Typical installation in a wall of a linear joint using a gun grade sealant, from left to right: clean the supporting construction, install the backing element, dispense the sealant and tool it.

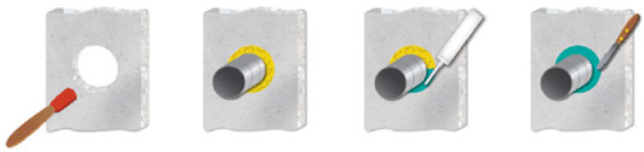
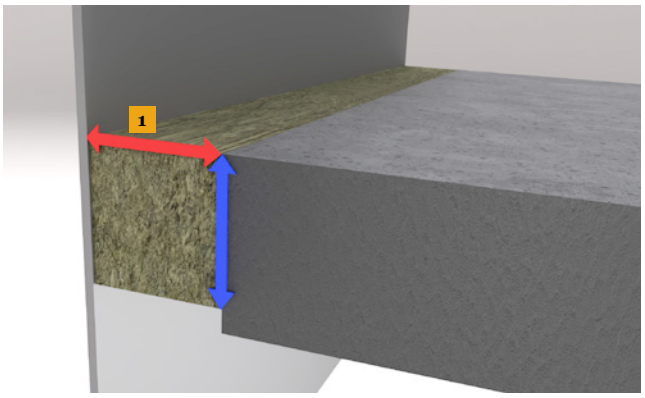


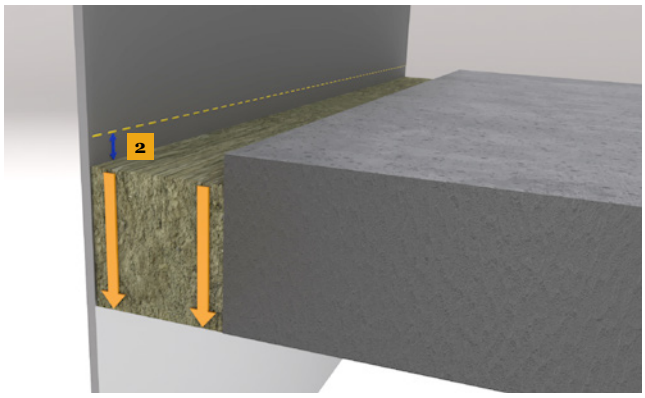
Figure 20: Typical installation in a wall of a penetration seal, using a gun grade sealant, from left to right: clean the supporting construction, install the backing element, dispense the sealant and tool it.

Self leveling sealants

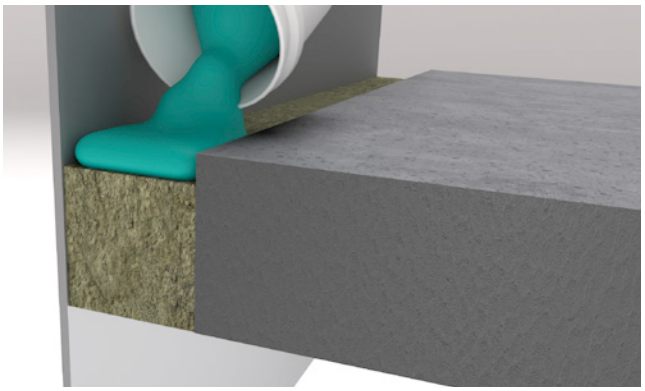
When using a self leveling sealant such as DOWSIL™ Smoke Seal 800SL as a linear joint in floors, it is necessary to use a damming material such as mineral wool. Please refer to the specific instructions in this manual to install these damming materials. The thickness and width of the damming material specified in the test reports needs to be respected to achieve the required fire resistance performance.



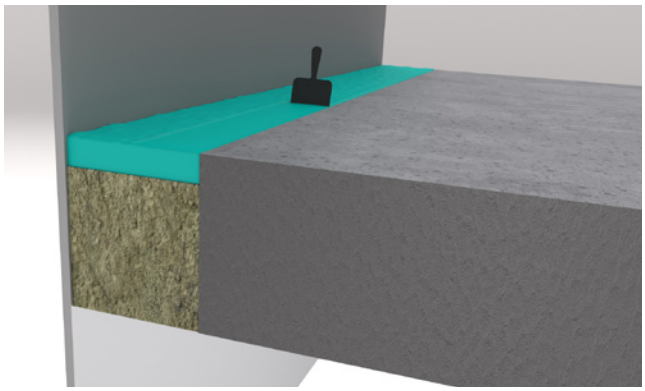
1. Insert the mineral wool between wall and floor, making sure the mineral wool is compressed in the width (1) direction to ensure expansion of the mineral wool following the movement of the building.



2. Push the mineral wool down into the opening, to create the recess space at the required thickness of DOWSIL™ Smoke Seal 800SL (2).



3. Clean both sides of wall and floor surfaces prior to pouring DOWSIL™ Smoke Seal 800SL into the formed recessed space. Apply directly from the container (such as pail) or take a small quantity in a cup to facilitate dispensing. The DOWSIL™ Smoke Seal 800SL is a self leveling mono component material which does not require mixing nor tooling.



4. Where needed, use a spatula to speed up the self leveling of the sealant along the length of the joint. Pay special attention to the corners and edges. It is essential to ensure the sealant fills these completely to ensure good contact and help avoid any risk of smoke leakage.

After full cure of the sealant, apply light manual pressure along the sealant bonding line, to check good adhesion of the sealant to the substrates. If needed, cut a small piece of cured sealant out to inspect the thickness, following the normal procedure of checking a sealant in situ, as described in the ‘Field adhesion test method’ in the Dow Building Envelope Weatherproofing Manual EMEAI.

Foam

Foam mixing and dispensing equipment use

DOWSIL™ 3-6548 RTV Silicone Foam Part A and Part B must be used as supplied by Dow. Other ingredients should not be added unless their specific mixture has been qualified with appropriate testing. Prior to use, containers of DOWSIL™ 3-6548 RTV Silicone Foam Part A and Part B, must be thoroughly agitated by stirring or recirculation in order to re-disperse any solid filler or pigment that may have settled during storage or after standing longer than four hours. The Part A and Part B liquid components of DOWSIL™ 3-6548 Foam should be thoroughly blended in a one to one ratio by either weight or volume. Material may be mixed using suitable pumping systems but can also be hand mixed as illustrated in Figure 20.

- Remove clinch band and discard,
- Pull dasher rod towards the neck of the cartridge. This releases the foil barrier from the mixing head,
- Press cartridge slightly in the area of the clinch band to deform the foil barrier,
- Push dasher rod to the bottom of the cartridge. Rotate dasher rod in a clockwise direction while moving it up and down the cartridge. Be sure to move dasher rod all the way to the top and bottom of the cartridge while mixing. Mix material for 25 strokes, but for no longer than 2 minutes. On the last stroke, the dasher rod should be fully extended.
- Unscrew the dasher rod by gripping the cartridge and turning the dasher rod in an anticlockwise direction.
- The foam should be dispensed from the cartridge by placing the dasher rod into the plunger at the base of the cartridge and applying pressure. If using the 600ml cartridge the foam may also be dispensed by using the cartridge in conjunction with an applicator gun.

Table 2: Four step quality control requirements for checking DOWSIL™ 3-6548 Silicone RTV Foam and dispensing equipment* Standard procedures for measuring snap time and free foam density are available from Dow upon request

Snap Time, minutes*	1-3
Free Foam Density, kg/m3*	220- 320
Color chart comparison	Pass
Cell structure chart comparison	Pass

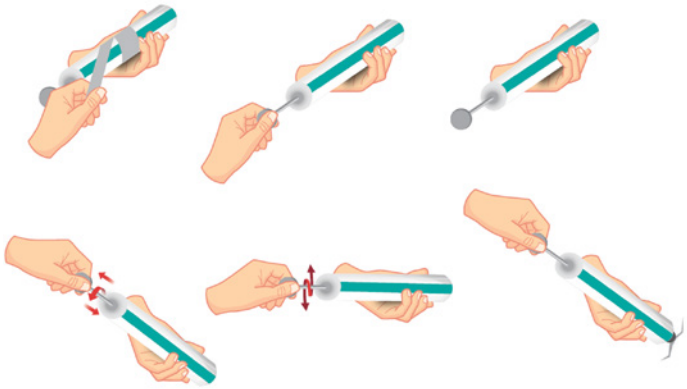


Figure 21: Illustration of the pump mixing of the foam. From left to right and top to bottom.

Specific equipment handling and operating procedures should be as specified in the foam applicators quality control and operating procedures manual. These procedures must include but are not limited to:

- Automatic mixing and dispensing equipment shall be checked a minimum of once daily (prior to start up) to ensure a proper ratio balance and thorough mixing.
- A four step, in-line quality control check (see Table 1) should be made at least once daily, or upon changing to a new lot of material to ensure the performance of both dispensing equipment and foam product prior to installing penetration seals

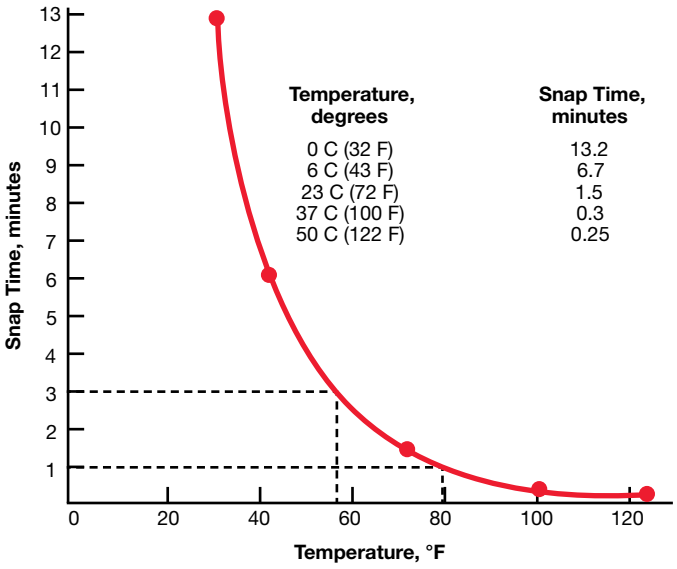
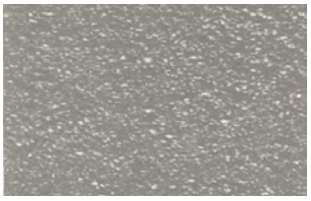


Figure 22: Evolution of snap time as function of temperature

Unacceptable color range

1.

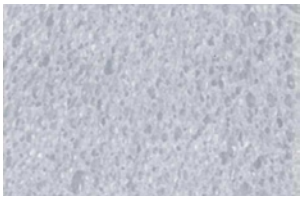
2.



The cured foam color is too light in both samples 1 and 2. If the foam sample is in this color range or is marbled, check your equipment mix ratio. You should also check the original A and B containers and/or the equipment A and B containers of foam to ensure that the fillers and pigments were well dispersed before pouring or mixing.

Acceptable color range

3.



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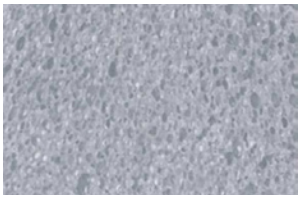
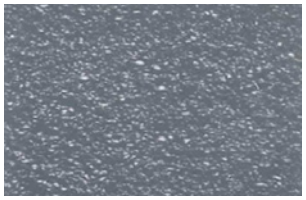


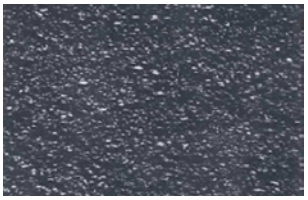
The proper mix ratio and correct dispersion of fillers and pigments result in a more acceptable color range, as illustrated in samples 3 and 4.

Optimal color change

5.



6.

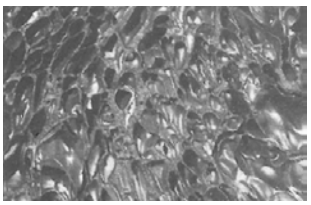


DOWSIL™ 3-6548 Silicone RTV Foam, when properly mixed and cured, has an optimum color range as shown in samples 5 and 6.

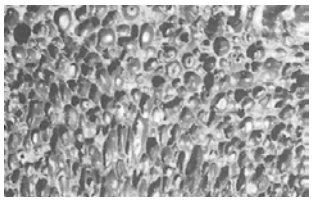
Figure 22: silicone foams color comparison chart

Unacceptable cell structure range

1.



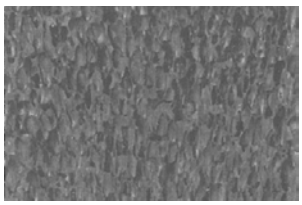
2.



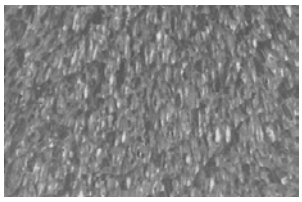
The cured foam cell structure is too large and non-uniform in both samples 1 and 2. Check the equipment mix ratio. The temperature of the A and B liquid components before and after mixing may also be checked. These temperatures should be between 55°F and 80°F and the snap time between 1 and 2 minutes for optimum results.

Acceptable cell structure range

3.



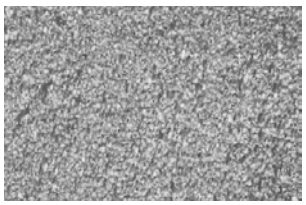
4.



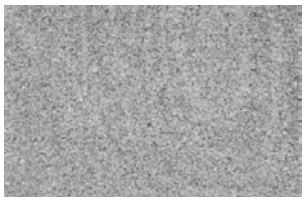
The proper mix ratio, controlled temperature of components and correct snap time result in a more uniform, acceptable cell structure, as illustrated in samples 3 and 4.

Optimum cell structure change

5.



6.



DOWSIL™ 3-6548 Silicone RTV Foam, has an optimum cell structure range as shown in samples 5 and 6.

Figure 23: DOWSIL™ 3-6548 Silicone RTV Foam cell structure comparison chart

Surface preparation

Priming of surfaces and penetrating components is usually not required since the DOWSIL™ 3-6548 RTV Silicone Foam develops considerable compression and forms a tight mechanical seal when properly installed.

Foam installation

- Properly mixed and dispensed Part A and B liquid mixture should be added (injected) into a properly formed and dammed penetration opening producing a tight roamed-in place penetration seal.
- The DOWSIL™ 3-6548 Foam liquid mixture should not be continuously added for a time interval (shot) that exceeds its measured snap time (three minutes maximum).
- Smaller penetration openings can often be completely foam sealed with one shot applications.
- Larger penetration openings may require several separate shots. Each shot should be given a minimum of fifteen minutes cure time before the next shot is added.
- Sufficient liquid DOWSIL™ 3-6548 Foam mixture should be added to ensure that the penetration opening is completely filled and tightly sealed with the cured foam elastomer.
- After a foam penetration seal has been installed, a minimum of 24 hours is required before any damming forms are removed or the cured foam is trimmed.
- After a minimum of 24 hours, the final penetration seal must be inspected for tightness of seal of the cured foam. Should an area of non-tight seal exist, the affected area should be injected with freshly applied DOWSIL™ 3-6548 Foam liquid mixture and foamed to ensure a tight seal.

Retrofit and maintenance

Changes, modification, repairs to damaged foam, removal of penetrating components, or addition of a new penetrating component can be readily made to existing foam penetration seals. The cured elastomer foam can be easily removed or poked-through and re-foamed and sealed with the injection of freshly mixed DOWSIL™ 3-6548 Foam liquid components.

Clean up

A high-flash mineral spirit solvent is recommended for clean-up of the DOWSIL™ 3-6548 Foam Part A and B liquid components.

The cured foam can be cut and trimmed with a sharp knife or blade.

Application and mixing equipment must be in good, clean operating condition. Daily cleaning of the mixing and dispensing gun assemblies is essential.

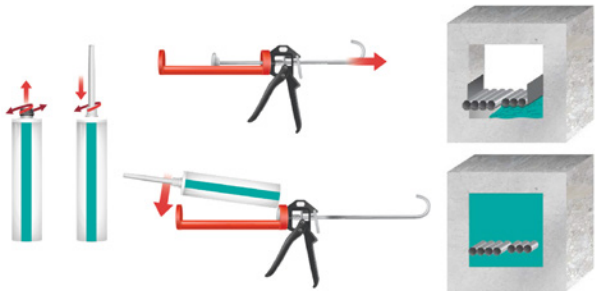


Figure 24: Illustration of the foam installation in a penetration seal in a wall using hand mixed cartridges

Literature

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EN ISO 1716:2010, Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value)

EN ISO 11925-2:2002, Reaction to fire tests - Ignitability of building products subjected to direct impingement of flame - Part 2: Single-flame source test.

EN 13823:2010, Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item

EN 13501-2:2007, Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services

EN1366-3: 2009, Fire resistance tests for service installations. Penetration seals

EN1366-4: 2009, Fire resistance tests for service installations. Linear joint seals

EN15882-3:2012, Extended applications of results from fire resistance tests for service installations. Penetration seals

EN15882-4:2012 , Extended application of results from fire resistance tests for service installations. Linear joint seals

EN12101-1:2005: Smoke and heat control systems - Part 1: Specification for smoke barriers

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Fire safety: Approved Document B, volume 1, volume 2, amendments

UL1479:2015, Standard for Fire Tests of Penetration Firestops

UL 2079: 2015, Standard for Tests for Fire Resistance of Building Joint Systems

ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems

ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials

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