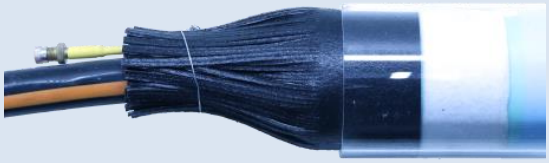
F-Q*/V L F-ZK*/V L
Fire-resistant sealing cushions

Multifunctional sealing for cable entry points
to protect against water, smoke and fire

Sealing cushions manufactured with fire-resistant tape made of foaming expandable graphite.

For sealing cable entry points with or without cable(s), for use with power cables, telecommunication cables or microducts.

Prevents the passage of water, smoke or fire, or rodent entry.



General

Fire-resistant sealing cushions are reusable inflatable sealing elements with a valve, fitted with fire-resistant tape made of foaming expandable graphite, fire resistance class F60 or F90.

In addition to sealing against water and gas diffusion, the sealing cushions also prevent smoke and fire from penetrating the cable duct.

In the event of fire, the sealing element will be destroyed, but from a temperature of 145°C the foaming expandable graphite forms a stable, pressure-tight mass, thus providing effective closure of the cable duct and preventing the smoke and fire from spreading into it.

Description of the individual components

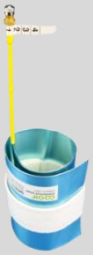
Component 1: Fire-resistant tape F60 or F90

High-quality, strong expandable graphite tapes, class F60 or F90, developed by Industrie-Produkte Graf von Rex GmbH have been further developed by Wolf GmbH for specific applications. Their use in combination with Wolf sealing cushions is patent-protected. The following options are available:

Group 17.x	Fire-resistant tape F60 or F90 ("fringed"), attached to sealing cushions for round or oval cable entry points
Group 18.x	Fire-resistant tape F60 or F90 ("fringed"), attached to sealing cushions, for rectangular cable entry points and gaps between movable surfaces.
Group 66 - 67.x	Fire-resistant tape F60 or F90, attached to joint-sealing cushions

Component 2: Wolf GmbH sealing cushions

The following sealing cushions from Wolf GmbH can be manufactured with fire-resistant tape F60 or F90:

	Duct sealing		Joint sealing
Temperature range	-30°C to +45°C (+70°C)	-15°C to +30°C (+45°C)	-30°C to +45°C (+70°C)
For duct Ø	40 - 300 mm	40 - 150 mm	Lengths1 to 23 m
Swelling-material coating			
Sealing cushion type	QAK/V	QADE/V	QADK/V
Cellular rubber coating			
Sealing cushion type	ZKAK/V	ZKADE/V	ZKADK/V

Advantages of our air-filled sealing systems

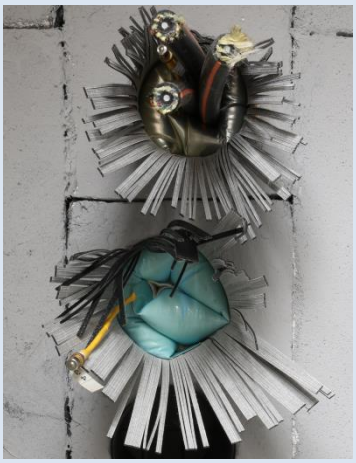
- Long service lifetime, due to their extremely low leak rate
- Patented CO2-neutral inflation technology; the cushions are only filled with air
- Filling pressure can be monitored and topped up if necessary for cushions with a valve (/V)

Application-specific environment tests for the combination of fire-resistant tape (F60 or F90) and sealing cushions/valve

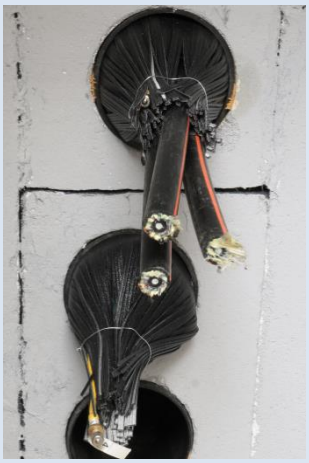
As no appropriate application-specific standards or testing institutes were available, Wolf GmbH commissioned Fibre Optics CT GmbH with the development of an internal setup and method for testing the combination. Fibre Optics CT was also given the task of optimising it and providing suggestions for standardisation.

Example: The Fibre Optics CT GmbH fire-resistant test setup for duct-sealing

Setup for testing cable and joint sealing



Sealed cable entry



FB fire-resistant tape, held in place with binding wire

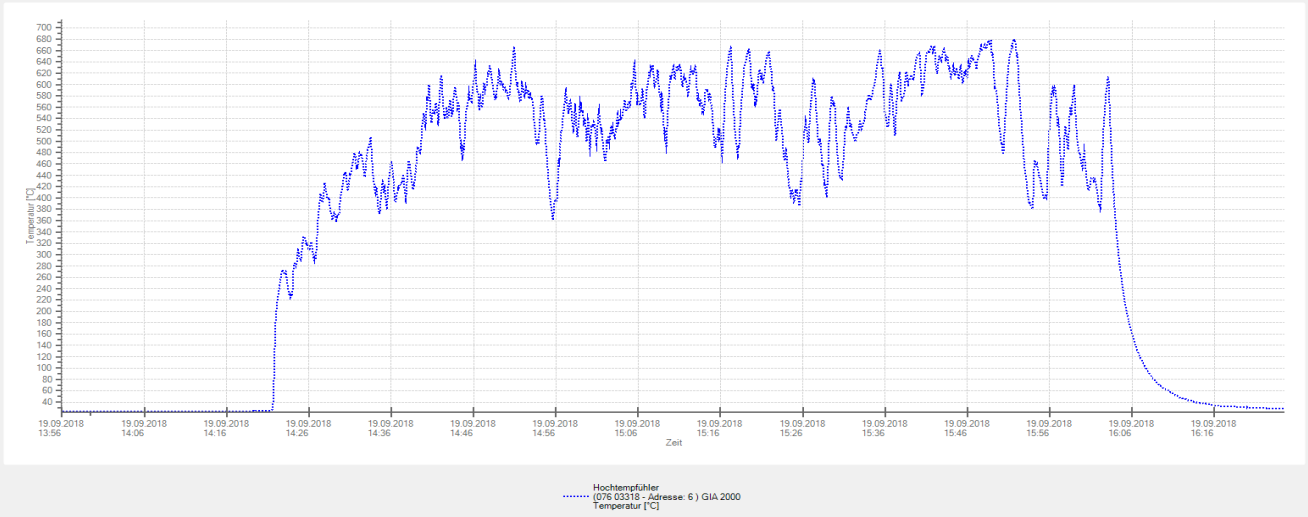
Example: The Fibre Optics CT GmbH fire-resistant test setup for sealing joints in bridges and tunnels

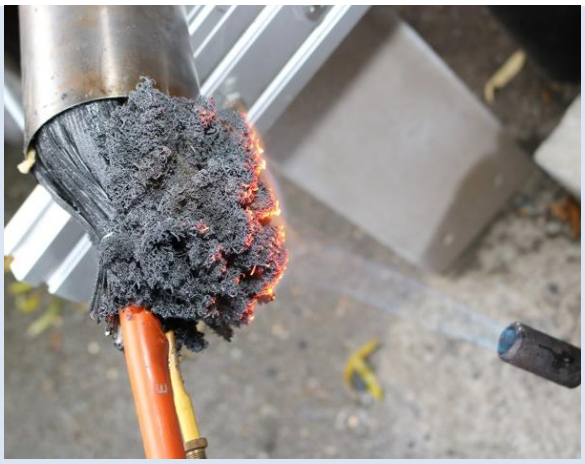
Joint-sealing cushion
(1) QADK/V S 2 m
for joint widths 2-16 cm

Results of the pre-test

Application-specific environment tests for the combination of fire-resistant tape (F60 or F90) (fringed tape made of expandable graphite) for Wolf sealing cushions with a valve

Function test 680 °C / 110 min.




After 15 minutes


After 16 minutes


After 17 minutes


After 1 hour

1. Wolf sealing cushions

The service lifetime values are based on total leak rate (diffusion) measurements carried out by the GEMTEC testing institute and ageing tests carried out in the Fibre Optics CT GmbH testing lab.

Extract from the GEMTEC test report (the complete test report is available on request)

1.1 "Determination of the total leak rate of sealing elements"

Test procedure:
The test sample was inserted into a plastic duct provided by the customer and filled with test gas (100 % SF_6) at a filling pressure of 2.8 bar (absolute).

Swelling Sealing Bags SSB/SSB2
Test samples A and B. The filling tube was inflated and then crimped with the original crimping tool, in accordance with the instructions provided

Sealing cushions with a valve
Test sample D was alternately tested with and without a valve end-cap after inflation. (Note: The installation instructions state that an end-cap is required!)

Videos showing installation, www.wolf-systems.com

Test sample	Measurement					
	No. 1 L [mbarl/s]	No. 2 L [mbarl/s]	No. 3 L [mbarl/s]	No. 4 L [mbarl/s]	No. 5 L [mbarl/s]	No. 6 L [mbarl/s
Measured after	< 10 min.	< 30 min	24 h	25 h	12 days	12 days
Storage of test samples	without end-cap	with end-cap	with end-cap	without end-cap	with end-cap	without end-cap
D	3.8×10^{-6}	2.3×10^{-8}	2.3×10^{-8}	5.2×10^{-6}	$< 2.3 \times 10^{-8}$	4.9×10^{-6}

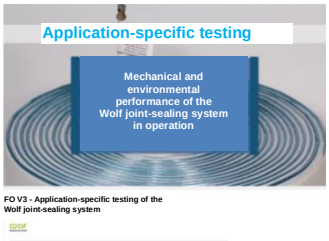
Resulting leak rate value:
With valve end-cap (in acc. with the installation instructions):
Test sample D: $L = < 2.3 \times 10^{-8}$ mbarl/s (0.73 mbarl/year)

Without valve end-cap: (Note: These values show clearly the importance of the end-cap)
Test sample D: $L = 4.9 \times 10^{-6}$ mbarl/s (155 mbarl/year)

Without end-cap

With end-cap

Application-specific tests:
See Video www.youtube.com/channel/UCZ2Uw4naLRCuQmXGiQW8FqA
FO V3 - Application-specific testing of the Wolf joint-sealing system



1.2 Calculation of the service lifetime of air-filled sealing elements

Relevant factors:

1. **Total leak rate (diffusion)**
2. **Filling pressure p**
3. **Filling volume V** (this depends on the size of cushion and the cable configuration)
4. **Min. filling pressure requirement for sealing: 5 m water column**
   (= 1 bar (value for a practical experiment))

Table 1: Comparison of the total leak rate (diffusion rate) of various sealing cushions

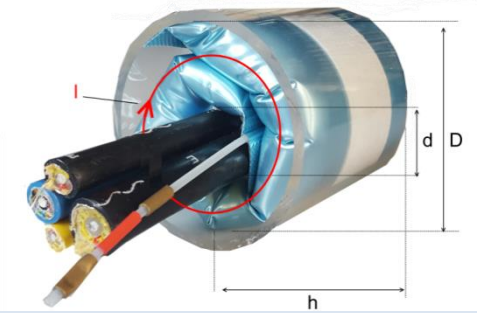
[Unit]	Wolf GmbH		T-Com requirement (current state of technology)	Competitors CO2
	SSB2Q	QADK/V (valve) with end-cap		
mbarl/sec	* < 2.3×10^{-8}	* < 2.3×10^{-8}	≤ 4.4×10^{-6}	≤ 6.5×10^{-6}
mbarl/year	0.73	0.73	138.8	205.0

*Measurements from Gemtec 10/2016

Table 2:

Calculation of the service lifetime of inflatable cable seals for duct ID 105 mm
Requirement: "Tightness 5 m water column"

Sealing cushion Type L100:
Uninflated Length l: 33.0 cm
Height h: 13.5 cm



Duct Ø [D] [cm]	Config. Ø [d] [cm]	Inflatable length l [cm]	Resultant "height" h [cm]	Resultant width b [cm]	Filling volume V [cm]	Sealing cushion filling pressure p			Calculated service lifetime T		
						During installation	Min. reqd.	Permissible loss	Wolf GmbH SSB2-100	Wolf GmbH QADE/V L100	Reqd. T-Com ADE 100
						[bar]	[bar]	mbarl	Total leak rate L (mbarl/year)		
				b=(D-d)/2	V=l*h*b	p1	p2	Δp=(p1-p2)	T= Δp/L		
						2.8	**1.0**		**0.73**	**66.23**	**138**
10.5	0	33	5.1	5.25	884	2474	884	1590	>20 years	24	11
10.5	2.9	33	7.8	3.8	978	2739	978	1761		27	13
10.5	6.5	33	10.5	2	693	1940	693	1247		19	9
10.5	7.5	33	11.2	1.5	554	1552	554	996		15	7
10.5	8.5	33	12	1	396	1109	396	713		11	55

2. Fire resistant tape F60 or F90 (“fringed”)

Application

Fire protection in joints, crevices and openings configured with cables.

The fringed tape, fitted onto Wolf sealing systems or screwed onto special components, reacts from a temperature of +145°C, forming a spherical structure with strong foaming pressure and creating a pressure-tight, stable mass with considerable fire resistance.

Properties

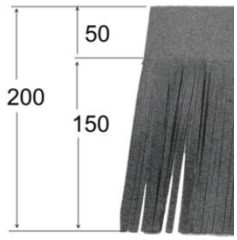
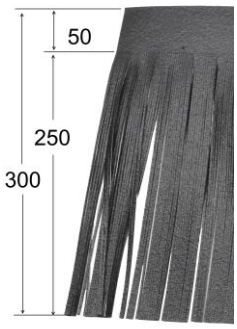
Fire behaviour as in DIN 4102 B2 (As approved by the German Institute for Building Technology, Berlin, Z-19.11-1173)		
Resistant to • ageing • UV • water • freeze-thaw cycles- • chemicals and solvents:	calcium sulphate solutions calcium hydroxide solutions cement slurry cleaning agent solutions with tensides	
Dripping behaviour	Non-burning droplets	
Direction of effect / Direction of expansion	Three-dimensional/ Spherical expansion in all directions	
Resulting inflated structure	Pressure-tight, stable mass	
Density	1000 kg/m³	
Start of expansion	At approx. 145 °C	
Foam factor - at 300 °C - at 450 °C	 13.7-fold 18.5-fold	
Static puncture resistance dry/ expanded / dry EN ISO 12236	1.7 / 1.0 / 1.6 mm	
Swelling pressure	Approx. 170 kN/m²	
Foaming pressure at 300 °C Thickness of fringed material [mm] [N/mm²]	F 60 1.5 mm 1.5 – 2.3	F 90 2.0 mm 1.75 – 2.5

Foaming behaviour

Product range Fire-resistant sealing cushions

Product group		Fire resistance class F60/F90 FR tape	Coating of cushion	Cable entry point Ø [mm]	Operational temperature cushion
17.2	F60- QAK/V L	F60	Swelling material	> 50 ≤ 300	-30 °C to +45 °C (+70 °C for a short period) **For power cables**
	F90- QAK/V L	F90			
17.3	F60- ZKAK/V L	F60	Cellular rubber		
	F90- ZKAK/V L	F90			
17.4	F60- QADE/V L	F60	Swelling material	> 50 ≤ 150	-15 °C to +30 °C (+45 °C for a short period) **For telecom cables**
	F90- QADE/V L	F90			
17.5	F60- ZKADE/V L	F60	Cellular rubber		
	F90- ZKADE/V L	F90			

Types: **Fire-resistant tape** (fringed) or **brush strip** for cable troughs, doors etc.

Fringed tape for round or square cable entry points		Brush strip for cable troughs
round: Ø 50 up to125 mm	round: Ø 150 up to 300 mm	
		
F60: 1,5 x 150 x 200 F90: 2,0 x 150 x 200	F60: 1,5 x 200 x 250 F90: 2,0 x 200 x 250	2 sizes, fringe depth fringe depth

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