Fire protection in electrical technology – a guide to fireproof building installations

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THINK CONNECTED.

Protecting lives. Protecting goods.

Nowadays, fire protection presents many planners and installation engineers of building equipment with almost insurmountable obstacles. Installations run like networks through complex building structures. The art of the planner is to harmonise the various networks, such as supply and disposal, heating, ventilation and air-conditioning, with the electrical installation. That in itself is difficult. In addition, the thought of building safety has now been at the forefront for several years now. The sensitivity towards fire protection in buildings is growing.

As soon as the first step towards fire protection planning has been completed, the appropriate systems and components are installed. Here, too, installation engineers are confronted with requirements which cannot be implemented without further work.

After erection, the fire protection building equipment must be ready for acceptance. All the installations must be executed properly and the appropriate fire protection proofs must be available.

In this small brochure, we wish to explain the interconnections of fire protection in technical building equipment. Perhaps you will find some new aspects which can help you in the planning or implementation of fire protection systems.

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Chapter 1
General introduction

Fire

Fire is a caring power,
how it cares for people, guards them
and that which they create
thanks to this heavenly force.
But this force will become fearsome
when it bursts its bonds –
it will take its own course,
this free daughter of nature.

Friedrich Schiller, 1799

1.1 Construction law

City fire in Hamburg 1842

The catastrophic city fires of the Middle Ages ensured early on that people began to think about the way they built their cities. The closeness of the buildings slowly disappeared and so-called town planning laws were introduced. Even today, these laws define, among other things, the necessary distances between buildings, in order to prevent direct spreading of fires. For this reason, only non-combustible materials may now be used for the basic structure of buildings and roofs.

Building regulations

In Germany, the model building regulations serve as a basis for the erection of structures and the use of construction products. As construction law is the business of the federal states, in German states this basis was introduced as state construction regulations in the appropriate law. There are currently no standard European regulations. National regulations should be complied with. However, one thing is certain: fires in Spain are the same as fires in Germany.

General requirements

Construction requirements place basic requirements on construction systems. According to them, a construction project is to be "arranged, erected, modified and maintained in such a way that public safety and order, and in particular life, health and natural requirements for life, are not endangered."[1] This means people and property and their surroundings. Depending on the area concerned, the responsibilities lay with the planner, craftsman or operator.

Fire protection in the construction regulations

The first fire protection requirements are, for example, defined in §14 of the German MBR. The building must have been erected as already described in the general requirements, in order to "prevent the creation of fires and the spread of fire and smoke, and allow the rescue of people and animals as well as effective extinguishing measures."[2] This sets three important protection aims.

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Guidelines for electrical installations

Besides the basic national requirements from construction law, there are also requirements from the field of electrical engineering. These are specified by, for example, VDE, ÖVE, KEMA-KEUR and other institutions. However, with regard to fire protection, only the technical systems are described here. Additional construction regulations specify which construction measures must be applied. In Germany, the master cable installation guideline (MLAR) [3] was introduced as a technical construction regulation to the applicable construction law of the German federal states. This directive specifies the fire protections requirements for installations in buildings. It applies to electrical, sanitary and heating cable systems, but not to ventilation systems. The MLAR applies to installations in emergency routes, cable routing through walls completing a room and ceilings, as well as to systems with electrical function maintenance in case of fire. Thus, the protection aims according to the construction regulations are implemented in practice. There are similar regulations or directives in other European countries, which are dedicated to the topic of fire protection in buildings.

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1.2 What is fire protection?

General fire protection consists of four main pillars: the construction, systems and organisational fire protection and combative fire protection. This division means that the different areas and their aims can be defined more accurately.

Construction fire protection

Depending on the type of use of buildings, the building regulations and special building regulations of the German federal states place different requirements on construction protection. On the construction side, fire sections are formed, fire-resistant components defined or the position and length of escape routes specified.

Four pillars for comprehensive fire protection

Preventive and combative fire protection

System fire protection

The use of special systems minimises fire risks, protects emergency and escape routes and maintains functions. These systems, e.g. sprinkler, fire alarm or safety lighting systems, are either required by construction law or are installed for private interests.

Company organised fire protection

This area includes the known escape route plans, fire protection ordinances or behaviour instructions for people in case of fire. This is to ensure that controlled procedures are carried out should an emergency occur, in order to minimise the risks to personnel and visitors, who often know little about the building. The creation of a company or plant fire brigade is also a part of the organisational measures. The tasks are of course part of combative fire protection.

Combative fire protection

The creation, organisation and maintenance of a fire brigade is part of the field of preventive fire protection. All the vehicles and devices, and also the functions and deployment tactics of the personnel employed, are specified. The tasks of the fire brigade are primarily fire-fighting and technical assistance. Fire brigades can be both public and private. Each town is obliged to maintain a fire brigade. In business, plant or company fire brigades may exist and usually carry out preventive fire protection within companies.

All four areas must achieve the set protection aims within a specific framework. This can be done in various ways. However, 100% safety cannot be achieved, not least because all the fire protection measures must also be economically viable.

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1.3 Fire protection concepts

Observe fire protection, even during the planning phase

When planning a building project, one must ask oneself the question of which protection aims are actually required. Is personal protection the key aim, e.g. in meeting places, or is it protection of property? The possible risks and dangers must be weighed up.

Economic aspects

It wise to combine the maximum of risk reduction with the minimum of financial cost. A production facility in the chemical industry, must be protected against failure for the sake of the operator, though there is no public interest. However, the insurance companies may require special fire protection measures.

Planning basics

The fire protection concept is used to view a building in its entirety and to record all the risks and dangers. The fire protection concept specifies the protection aims for the building and special and general fire protection measurements, and implementation of the same for the operation of the building. The most important basic principle is that safe, risk-free operation must be possible.

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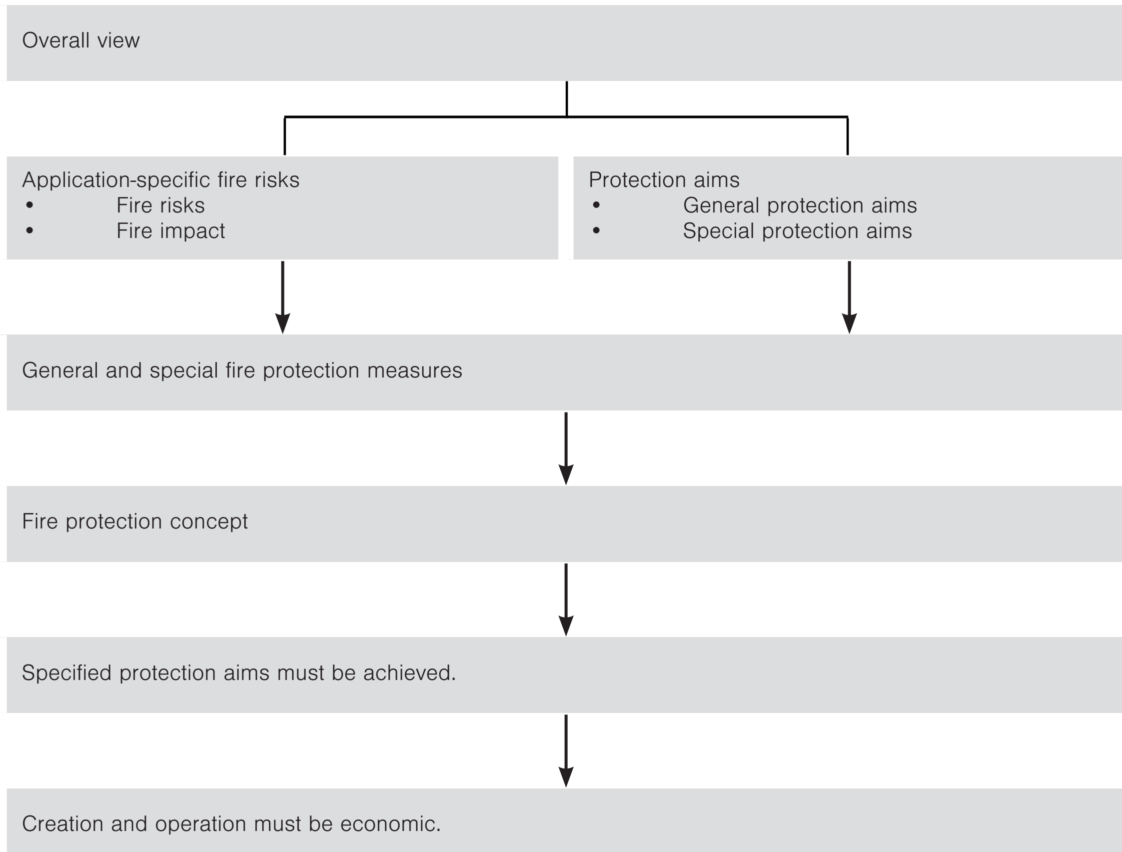

Overall view
Application-specific fire risks
• Fire risks
• Fire impact
Protection aims
• General protection aims
• Special protection aims
General and special fire protection measures
Fire protection concept
Specified protection aims must be achieved.
Creation and operation must be economic.

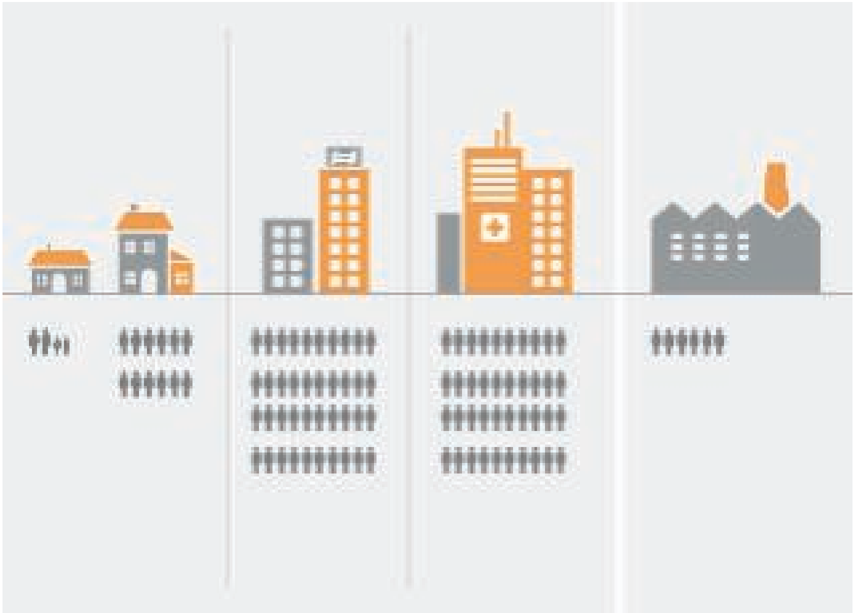
1.4 Building types

Increasing requirements depending on building type and use

Not every building is subject to the high fire protection requirements. Therefore, in Germany the MBO makes a distinction between various building classes, which each have different fire protection requirements.Classes 1 to 3 mostly contain smaller buildings, in which usually few people are to be found. Higher buildings below the tower block limit of 22 metres are to be found in classes 4 & 5.

Special constructions

Requirements increase as construction systems get larger.Special structures such as industrial buildings, tower blocks or meeting places are subjected to particularly high requirements, regulated by special specifications. It is possible that a building complex may be divided into various sections, the fire protection of which is viewed and evaluated in different ways according to the type of use. If there are no special regulations for a building, the minimum requirements of the appropriate state building regulations apply.



Different objectives: Protecting people or property

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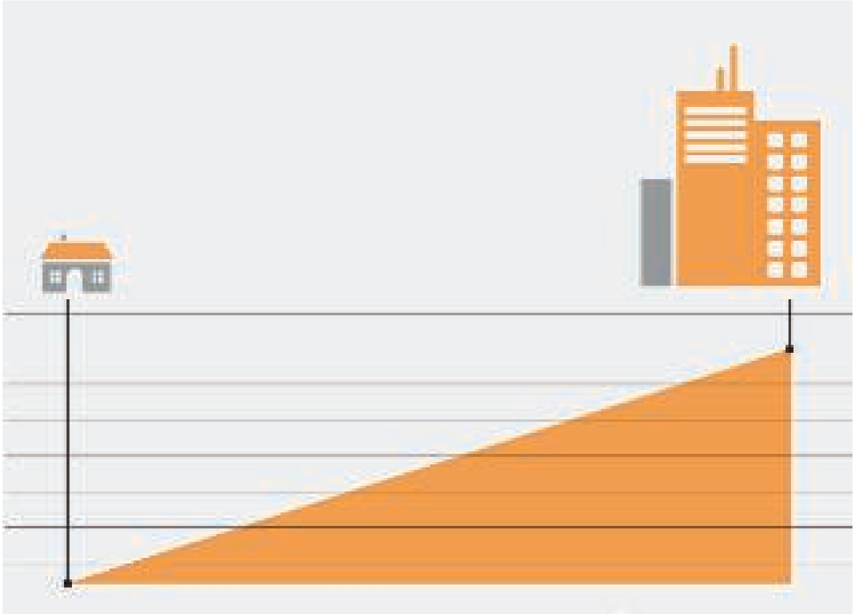
Construction law – state law – European law?
The building regulations and specifications to be complied with can vary between the German federal states and place different requirements on the fire protection of buildings. This also applies for the master cable installation guideline (MLAR): the states can decide for themselves whether they wish to make changes or to accept the suggestion in the MLAR completely. For this reason, the regulations valid at the appropriate location must always be observed when planning a construction project. A standard European construction law is currently not in sight, although there have been many attempts to harmonise construction products.



Schematic drawing: fire protection requirements

1.5 What happens during a fire?

Often, it is just carelessness – a forgotten candle, an unextinguished cigarette or a technical defect – which triggers a catastrophe. Often, it only takes a moment for a flame to become a fire, from the first glow to a huge inferno. Electrical installations pose an especially high risk potential, as the materials used are often combustible and the electrical current is a potential source of ignition. For this reason, electrical installations are the no. 1 cause of fire.

Damage to people and property

In Germany alone, around 200,000 fires each year cause damage running to billions of euros. Every year, around 600 people die as a result of a fire and 60,000 are injured, of which 10% are seriously injured.

Electricity is by far the main cause of fire!

The catastrophic impact of the highly toxic and aggressive fire gases is often underestimated. Estimates suggest that around 95% of fire victims die not due to the immediate effects of the fire, but of poisoning from the smoke. In addition, the corrosive fire gases created during fires cause immense damage to property and can permanently damage the structure of a building.

Approximately 95% of all deaths during fires are caused by smoke poisoning!

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Risk 1: Rapid spread of the fire

If a fire starts, then it may get out of control very quickly. In a moment, the flames ignite all combustible materials, temperatures rise and the fire spreads in an explosive manner. Therefore, if there is a fire, the fire brigade do not only need to fight the flames. The main task of the fire brigade is much more to limit damage by preventing the flames from spreading to neighbouring buildings or building sections.

Construction components such as fire walls, fire-resistant ceilings, fire doors, cable insulation and other measures for preventive fire protection can help to prevent the spread of a fire or at least slow it down.

Risk 2: Heavy smoke creation

The creation of smoke and soot are an often underestimated source of danger. Depending on which materials catch fire, the combustion process also creates the following toxic gases:

- Carbon monoxide
- Carbon dioxide
- Sulphur dioxide
- Water vapour and soot

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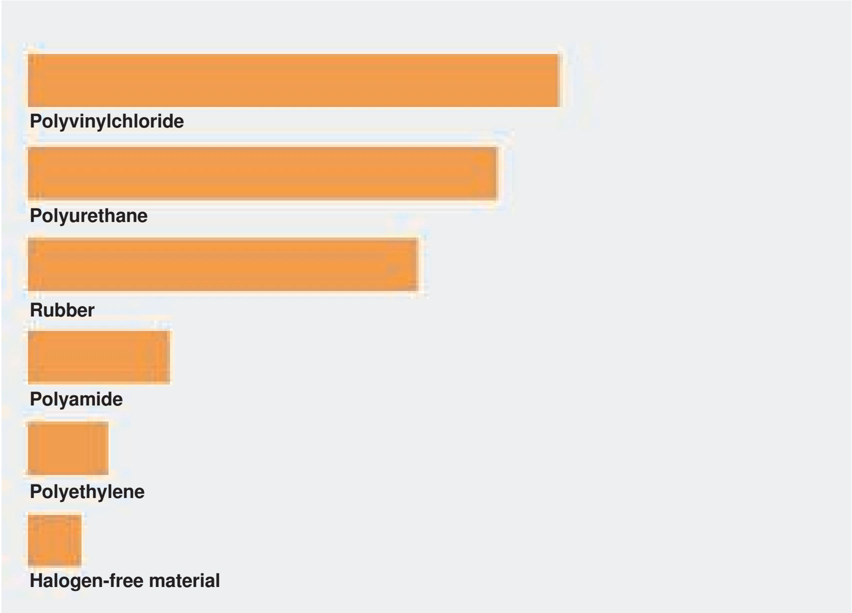
Heavy smoke creation in a burning building is not just a risk to the lives and well-being of those affected. The smoke also makes fire-fighting more difficult, because the fire brigade has difficulty in localising the source of the fire.
One aim of preventive fire protection must therefore also be to limit smoke creation to the area immediately affected.

Danger from PVC as an insulation material

In Germany, 95 per cent of all cable insulation in building installations are made from PVC. There is no statutory requirement for halogen-free insulation materials. By contrast, in Luxembourg, for example, halogen-free cables are required for public buildings.



Relative smoke volume of various insulation materials per minute

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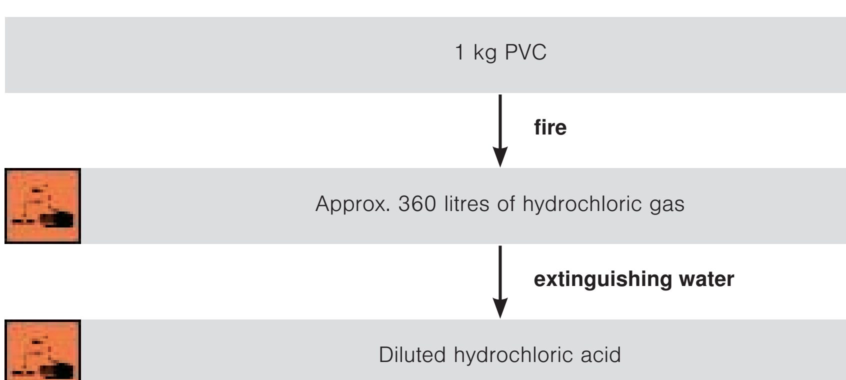
Risk 3: Creation of corrosive combustion gases

The subsequent damage of fires, and particularly of cable fires, should not be underestimated. For example, if PVC cable insulation burns, this creates chlorine gas, which, together with the extinguishing water, creates aggressive hydrochloric acid. This acid enters the concrete, attacks steel reinforcements, and thus damages the building structure, sometimes to a great extent. Often, such subsequent damage considerably exceeds the actual fire damage.

Corrosive fire gas products:

- Hydrochloric acid
- Cyanide
- Sulphur dioxide
- Carbon dioxide
- Ammoniac
- Carbon monoxide
- Soot

1 kg of PVC will fill a volume of 500 m³ with thick, black smoke



Components destroyed by hydrochloric acid

1.6 Construction law protection aims

The three protection aims

Measures must be taken for buildings in which many people meet regularly, so that, if there is a fire, no-one is injured through fire and smoke It must be certain that the building can be exited quickly and safely.During emergencies, it is people who are non-local who have great difficulty in correctly estimating the risks and leaving the building using the most direct route. For this reason, the three construction protection aims for the effective fire protection of construction systems must always be observed.

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First protection aim
Limit the spread of the fire

Second protection aim
Protect escape and rescue routes

Third protection aim
Function maintenance – important electrical systems must continue to function

Chapter 2
Maintenance of the fire secti-ons – First protection aim

The division of building into fire sections protects unaffected building sections against the spread of fires for specific periods of time.Insula-tion maintains the fire sections, thus limiting the spread of fire and smoke.
These constructive measures protect people and property, allowing fi-re brigades to prevent the spread of fires to other parts of the building through extinguishing measures.

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2.1 Components closing rooms, fire walls

Function of fire walls

Fire walls should ensure that a fire cannot pass to neighbouring buildings or building sections. This creates so-called fire sections. The construction design of these fire walls – materials, fire resistance classes, stress values – is regulated by the building regulations and standards.

2.2 Requirements for cable penetrations

Prevention of fire spread

Electrical cables and pipes may only be run through walls and ceilings at the ends of rooms when there is a guarantee that they do not present an opportunity for fire and smoke to spread. Insulation systems reliably seal the ceiling and wall penetrations required for installations against fire and smoke.

Special requirements

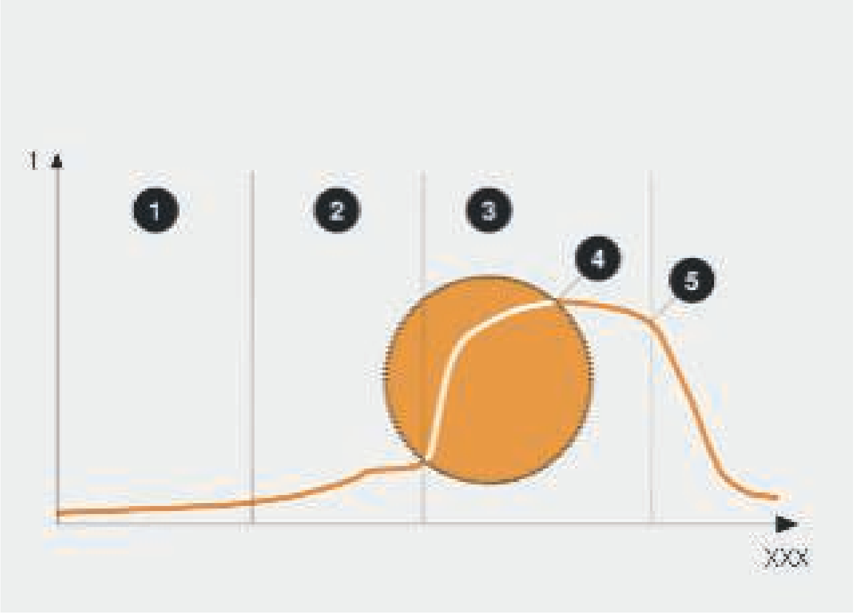
The following requirements apply to cable penetrations with cable insulation:

- The spread of fire and smoke must be prevented.
- Room closure must be guaranteed.
- On the side of the insulation away from the fire, the surfaces of cables, pipes, cable support systems and the surface of the insulation may not heat up to an impermissible level.

2.3 Proofs of applicability

2.3.1 Tests

Before insulation systems can be used as a construction product, their statutorily required impact must be proven through fire tests. These fire tests are carried out by official materials' testing institutes and accredited testing institutes all over Europe on the basis of testing standards. Besides the testing norm EN 1366 "Fire resistance tests for installations, Part 3 – Insulation" [4] of 2009, there are additional national standards, according to which such systems are tested and approved.



Natural course of a fire – Development of the testing temperature curve: 1 = Start of the fire; 2 = Fire creation phase; 3 = Flash-over; 4 = Fully-developed fire; 5 = Start of the cooling phase

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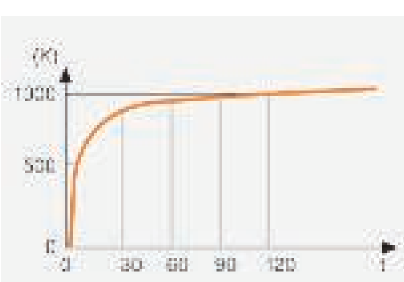
Strict testing criteria

The cable insulation is tested in a special testing furnace, in which the sample installation being tested is heated up according to a standard temperature-time curve. This curve is internationally standardised according to ISO 834-1 [5] and used around the world for fire tests. It forms the so-called "flash-over", which is the most critical phase of a fire.

After the smouldering phase all flammable gases within the incendiary space ignite abruptly, causing the temperature to rise very quickly. The built-in installations have to endure this fully developed fire. Depending on the intended classification, the test period takes between 15 and 120 minutes.
Within the framework of the test, the fire protection has to prove that it prevents fire and smoke escaping from the incendiary space. A further test criterion is that the surface temperature of the fire protection side facing away from the fire must not rise higher than 180 Kelvin above the starting temperature.
The test is carried out categorically under the least favourable conditions (i.e. least thickness of the insulation, largest insulation height or width). In addition to the temperature, the pressure in the oven is set to standard.



Standard temperature-time curve (ETK) according to ISO 834-1 and DIN 4102 Part 2

Time in minutes	Temperature increase in Kelvin
5	556
10	658
20	761
30	822
60	925
90	986
120	1,029

Use only approved construction products!

2.3.2 Classifications and certificates

Successfully passed tests are documented by the testing institutes and the systems classified according to the results of EN 13501 [6]. In most European countries, this classification report can be used in conjunction with the manufacturer's mounting instructions. However, some countries require a general construction approval. This can be applied for with the testing documentation and classification report at an approval office accredited by the European Organisation for Technical Approvals (EOTA).

Fire protection classifications and abbreviations according to EN 13501

Short code	Description	Application examples
R	Load-bearing capacity	Description of the fire resistance ability of components and installations
E	Room end (Étanchéité)	Description of the fire resistance ability of components and installations
I	Heat insulation	Description of the fire resistance ability of components and installations
P	Electrical function maintenance (power)	Cable systems
15.20...120	Fire resistance period in minutes	

Indi-ces	Description	Application examples
ve ho	Vertical/horizontal installation possible	Ventilation flaps, installati-on ducts
-S	Limitation of the smoke leakage rate	Doors, ventilation flaps
i→o	Impact direction of the fire resistance length (inside/outside)	Ventilation flaps, installati-on ducts
i←o	Impact direction of the fire resistance length (inside/outside)	Ventilation flaps, installati-on ducts
i↔o	Impact direction of the fire resistance length (inside/outside)	Ventilation flaps, installati-on ducts
U/U	Closing of pipe ends (uncapped/capped)	Pipe insulation
U/C	Closing of pipe ends (uncapped/capped)	Pipe insulation
C/U	Closing of pipe ends (uncapped/capped)	Pipe insulation

During labelling, it is important to note according to which classification standard the component was classified. Otherwise, misunderstandings are inevitable.

The abbreviations, according to EN; standard for the fire protection properties (classification) of a component.By contrast, the German abbreviations, according to DIN; name the component directly.

Contents of the approvals
The certificates of approval specify the following criteria, among other things, for the application area and installation:
- Fire resistance class (e.g. EI90)
- General installation conditions (e.g. installation in concrete walls)
- Maximum insulation dimensions
- Minimum cable insulation thickness
- Minimum ceiling/wall thickness
- Materials approved for creation of the insulation
- Installations to be carried out (e.g. cables or cable support systems)
- Sequence and type of installation
- Execution of a retroinstallation
- Details of the obligation to train processors on the part of the manufacturer

Table 1: Comparison of the labels according to EN and DIN

Installation	Classification to EN 13501	Classification to DIN 4102
Cables/combination insulation	EI90	S90
Pipe insulation	EI90 U/U	R90
Installation ducts	EI90 (ve ho i↔o)	I90
Ventilation flap	EI90 (ve ho i↔o)-S	K90
Electrical function maintenance	P90	E90

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Currently, various documents are valid proof of application: national proof documents such as the German "General construction approval" according to DIN 4102 Part 9 [7] or approval documents of the Association of Cantonal Fire Insurers VKF in Switzerland. In the coming years, the European Technical Approvals (ETA), based on EN tests, will succeed evermore national approvals. Systems tested according to the European standard can be used in all 30 member states of the European Standardisation Organisation for Construction CEN and also in other countries accepting this standard.

European approvals replace national approvals!

2.3.3 Obligation to labelling

Each piece of insulation must be permanently labelled with a sign. This labelling must contain the following information:

- Name of the erection engineer of the insulation (installation engineer)
- Head office of the installation engineer
- Insulation designation
- Approval number, issued by the accredited testing office
- Fire resistance class
- Year of manufacture

Identification of the installed system

The labelling is set against the background that the systems were constructed and tested with different materials. The function of these material combinations has thus been proven. If systems are combined with other components which do not belong to the system, then this can have a negative impact on system behaviour if there is a fire. This must be avoided. The requirement of the approval offices for processor training courses is derived from this. It must be ensured that the processors know the basic principles of construction law and are fully able to handle insulation materials.

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Declaration of agreement

According to the proof of applicability, a declaration of conformity must be completed for each piece of insulation installed. This certificate confirms that the installed system corresponds to the conditions of the approval and that the installation engineer has complied with all the specifications. The confirmation should then be handed over to the client for presentation to the construction authorities.

2.4 Insulation systems, construction types

Solid walls and ceilings made of masonry and concrete as well as lightweight partition walls, built using dry construction methods, require appropriately suitable insulation measures.The installations which can pass through can be made up of cables and cable support systems, combustible and non-combustible pipes or a combination of both. There are requirements, for example, for a dust- and fibre-free installation, destruction-free retroinstallation and certain gas pressure tightnesses.

Typical insulation systems consist of: mortar, mineral fibre plates with coating, bags, local foam, single-component compounds, foams and fittings, boxes, silicones and modular insulation. All the systems possess special fire protection components, which fulfil a safe function in case of fire in accordance with the testing standard.

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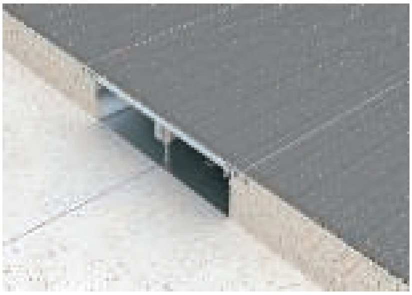
2.5 Applications and special applications



Survey for special applications

The testing standard for insulation systems defines standard applications in walls and ceilings. In most cases, the possible electrical and sanitary installations are covered by the specifications of the standard. However, no two buildings are alike, meaning that applications may occur which are not defined by the standard. Not only such deviations from the standard, but also special cases, can only be interpreted through surveys. Often, a report from the manufacturer is sufficient here, as they are able to evaluate whether an insulation material can also function with the appropriate deviation. However, in some situations it can happen that, due to the construction environment, a survey from an independent materials' testing institute is required. For positive measures, these provide a surveyor's report for the appropriate construction project. This ensures that both the erection engineer and the operator of the building are then on the safe side.

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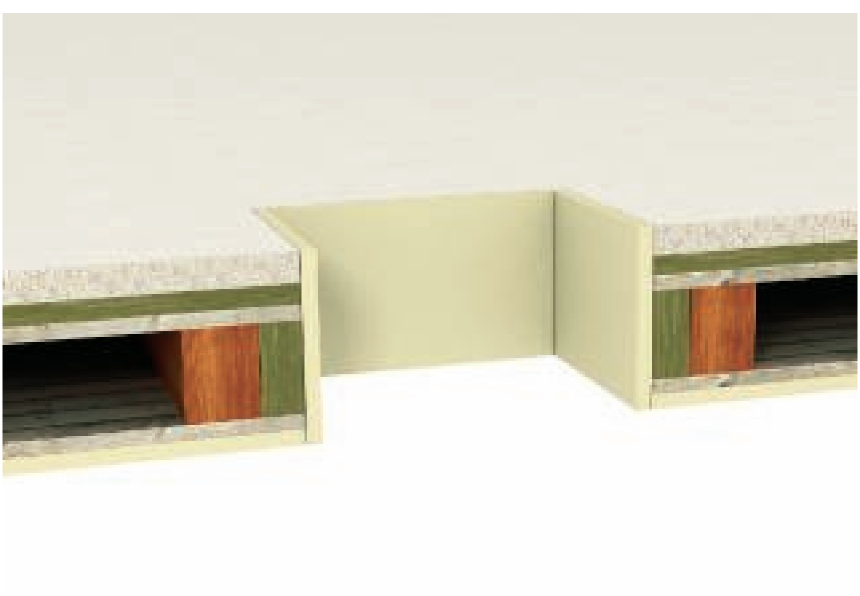
2.6 Building in old buildings

The following applies to all old building ceilings and wall constructions made of special components (sandwich elements): Mounting of insulation systems is approved when this kind of application is included in the approval. In conjunction with the construction authorities, systems can be used which, according to the approval, are approved for a similar application, e.g. within a layer of non-combustible materials. It is important before mounting to always obtain the approval from the relevant authorities, e.g. construction supervision or fire brigade.

Important: obtain approval!



Wood beam ceiling soffit, made of non-combustible materials

Chapter 3
Protection of escape routes – Second protection aim

Approximately 95% of all deaths during fires are caused by smoke poisoning! In case of fire, emergency and escape routes are the central lifeline of the building and must remain usable under all circumstances.

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3.1 What is an emergency and escape route?

According to the construction regulations, there must be routes in buildings, which not only permit access to the building in a horizontal and vertical direction in normal situations, but which also offer the option of rescue in case of fire. It is therefore obligatory to equip buildings with at least one constructive emergency and escape route. Additional emergency and escape routes may also be necessary, depending on the type of building. These include:

- Necessary staircases (vertical access)
- Connecting rooms between the necessary stairwells and exits to the outside
- Necessary corridors (horizontal access)

There must be a guarantee that, if there is a fire, these routes can be used to leave the building without any risk. In addition to evacuation, the emergency and escape routes also aid the local fire brigades as a point of attack.

3.2 Problem: Fire loads

In the area of emergency and escape routes, an installation may not pose an additional fire load. This requirement can be fulfilled using an appropriate type of installation:

- Concealed installation
- Installation in fire protection duct systems
- Installation above suspended fire protection ceilings
- Use of non-combustible materials
- Routing of cables with improved behaviour in case of fire

Protection aim: prevention of fire spread in the direction of escape!

Fire loads through installations in emergency and escape routes are not permitted!

However, there are exceptions here: the cables required for the operation of an emergency and escape route may be routed in the open. The reason for this is that, for example, in a corridor made of combustible plastic, the risk of a fire through a small joint cable to supply a lamp is hardly increased. However, a massive volume of cables, routed openly in a corridor to supply other areas of the building, is not accepted. Systems tested and approved for fires must be installed here.

Behaviour of cables in case of fire: PVC-insulated, low-smoke, halogen-free (from left)

3.3 Safe routing options

The option of open routing is not a problem with, for example, non-combustible sanitary pipes. It only becomes a problem when the sanitary pipes are jacketed with combustible insulation.In most corridors, the installations of all the different networks meet: electrics, sanitation, ventilation and air-conditioning.The electrical installation is a special case as electricity can ignite flammable materials, e.g. cable insulation and insulation layers of pipes.

Electrical installation as a potential source of ignition

Under normal circumstances a correctly executed electrical installation with a correctly selected wire cross-section, correct fuses and cables, which were not damaged during drawing in, would not be dangerous The risk of a fire starting only occurs when the cables become too hot or the insulation is damaged due to incorrect routing and dimensioning.

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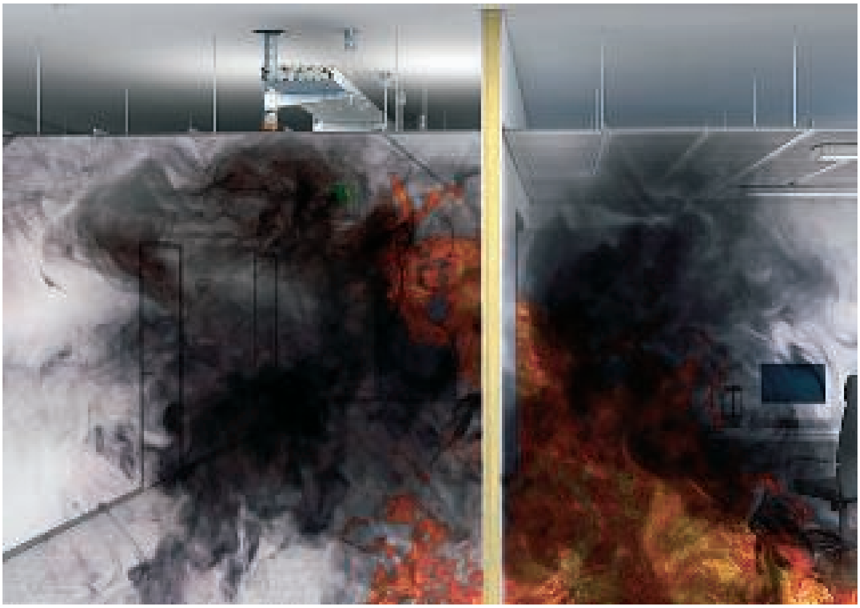
3.3.1 Installation in false ceilings

If corridors are used for the routing of the whole building technology, suspended fire protection ceilings are often used. If there is a fire, the systems, tested at the top and bottom for fire loads, safely shield the false ceiling areas created by the suspension.

No mechanical load in case of fire

Even if there is a fire of the cables installed there, the emergency and escape route still remains safe. However, there must be a guarantee that the suspended fire protection ceiling is not subjected to additional mechanical loads through, for example, falling cables or parts of the support system.In addition, the fire protection ceiling protects the combustible installations against a fire from below, preventing the fire from spreading along the corridor.



Fire load from below

The German MLAR directive permits only the following systems for electrical installations above suspended fire protection ceilings in the area of emergency and escape routes:

- Routing systems for function maintenance tested according to DIN 4102 Part 12 [8]
- Special routing systems, tested for fire protection for this application.

The strictly controlled system limits mean that function maintenance systems can only be used with restrictions for this type of electrical installation. In order to offer practical installation options for intermediate ceiling mounting, proofs for special routing systems with high load capacities and their deformation behaviour in case of fire are available.

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3.3.2 Shielding with plate material

An additional option for fireproof encapsulation of fire loads is to shield installations with special plate material. For example, the entire cable support system is surrounded by fire protection plates. This type of mounting is commonly used in old buildings. However, there may be no mechanical load on the plates requiring the installations to be securely fastened against fire. This shielding is created at great effort by drywall engineers and insulation engineers on the construction site. In addition, these constructions must possess proof of applicability. Often, this is a general construction test certificate of a materials testing institute.

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3.3.3 Cable routing in fire protection ducts

If there is a cable fire, fire protection ducts prevent thick, black smoke from entering emergency and escape routes. In addition, they are easy to install and are available in various different versions: as a metal duct with shielding made of calcium silicate or mineral wool plates, as a prefabricated lightweight concrete duct or as a self-assembly duct made of non-supporting, coated mineral fibre plates. The dimensioning of the fire protection ducts is dependent on the version used and the fire resistance class to be achieved.

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3.3.4 Bandaging of cable support systems

The last option for protecting an escape route is the covering of the existing cable support systems with cable bandages of coated mesh. This limits a cable fire to the local area, preventing its spread. This measure is taken when the mounting of a false ceiling classified for fire protection, shielding with plates or the installation of a fire protection duct are not possible due to local conditions or insufficient space. However, cable bandages have a combustible, although flame-resistant, material. Due to their combustibility, they may not be formally used in the escape route. The keyword is: fire load 0 kWh/m²! Nevertheless, on account of their function and the proof of the fire behaviour, cable bandages are often the last economic option for securing escape routes. However, before mounting, always obtain the approval from the client, e.g. construction supervision or fire brigade. You can find more on the subject of fire protection cable bandages in Chapter 5.

3.4 Proofs of applicability

Fire protection plate constructions and intermediate ceiling systems with fire protection properties often possess general construction test certificates and classification reports according to the relevant testing and classification standards. There are various manufacturers and providers for these. Fire protection ducts also possess this type of proof. However, the situation is rather different in the case of support systems above fire protection ceilings. The requirements and tests are explained below.

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3.4.1 Tests

Fire protection ducts are tested by an independent materials' testing institute in accordance with DIN 4102 Part 11 [10]. The electrical cables are flamed within the duct.During the entire classified time, neither fire nor smoke may escape from the duct system. This provides effective and secure protection of an emergency and escape route against a cable fire. The fire load in the duct is effectively encapsulated.

A European testing standard for fire protection ducts is currently being worked on. The standard makes a distinction between locally created ducts made of plate material and prefabricated ducts. It is not yet certain in which series of test standards the appropriate ducts will be included.

Requirements for false ceiling systems

To evaluate practical solutions in the sense of the directives for electrical installations above suspended fire protection ceilings, fire tests are carried out according to DIN 4102 Part 12 and Part 4 [10]. For example, the following solutions are tested:

- Cable support systems for wall and ceiling mounting
- Collecting clamps for wall and ceiling mounting
- Metal pressure clips for ceiling mounting

Fire tests test the following requirements:

- High mechanical load
- Stability of the routing system
- Deformation of the laying system

Measuring units from the testing furnace

Steel chains as replacement weights

The tests are carried out using the standard temperature-time curve (ETK), by simulating a full fire in an intermediate ceiling area. In most cases, testing is carried out for a fire resistance length of 30 minutes, but in special cases a 90-minute test is carried out. The test results can be used to make statements on practical execution, e.g. on compliance of spacing distances to the intermediate ceiling.

Fire protection bandages are subjected to a cable bundle test on a vertically arranged test body. This test is stored in the testing standard IEC 60332-3-22, Cat. A:2000 [11] and the identical EN 50266-2-2:2001 [12]. A defined, approved burning height may not be exceeded during a period of 40 minutes.

Flaming of the fire protection bandage

3.4.2 Classifications and certificates

Fire protection ducts for use in emergency and escape routes are classified as I ducts according to DIN 4102 Part 11. There are I30 (fire-retardant) to I120 (fire-resistant) versions. According to the European Classification Standard EN 13501, ducts can have the properties EI90 (veho i↔o) (see Chapter 2.3.2). Here, "veho i↔o" stands for the installation options: vertical and horizontal; tested and approved with a fire load from the interior to the exterior and vice versa.Applicability is documented in a test report from a material testing institute.

There is no testing standard for installations above fire protection ceilings and thus no classification is possible. The test reports provide information on the results. The tests are not subject to accreditation and can, in principle, be carried out and documented by the manufacturers themselves. The documentation should contain all the relevant parameters, such as the maximum mechanical loads, support spacing distances, securing measures and deformation behaviour. Such a system then fulfils construction law requirements, e.g. those of the cable system directive.

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Besides a material classification, cable bandages also have an application approval. Additional proofs can be, for example, reports on the basis of an IEC test. These documents describe the proven function.

Fire protection bandages were developed, in order to prevent fires from spreading within fire sections.Comparison with an I duct for use in emergency and escape routes is not possible.

Important! Cable bandages never fulfil the requirements for I ducts.

Logos of the testing institutes and approval offices: DIBt, iBMB, BET, IEC, GL, DIN

Chapter 4
Function maintenance for electrical systems – Third protection aim

If there is a fire, emergency and escape routes must remain usable and important technical equipment, such as emergency lighting, fire alarm systems and smoke extraction systems, continue to function.Therefore it is essential that the power supply for these systems is specially protected. In addition, certain technical systems must support the fire brigades in fighting fires for a sufficiently long period of time.

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4.1 What is electrical function maintenance?

Special cables and routing systems make it possible to maintain the support of an electrical current in the case of fire, thus guaranteeing function maintenance. However, there are many misunderstandings here, which can be caused by different abbreviations. The following incorrect terms are often connected with function maintenance:

- FE180
- Non-combustible cables
- Fireproof
- Fireproof installation
- Insulation maintenance
- No smoke creation

In particular, the abbreviation "FE180" continually causes confusion.Although you might think otherwise, it does not stand for "Function maintenance for 180 minutes" but for "Flame impact time". The "flame impact time" is a testing criterion according to DIN VDE 0472-814 [13] and IEC 60331-11, -12 and -13 [14]. In this test, cable samples are subjected to direct flaming at a constant temperature of 750 °C for a period of 90 minutes (IEC) or 180 minutes (VDE). During this time, none of the fuses monitoring the individual wires may drop. This test of "insulation maintenance" may not, under any circumstances, be confused with the test of the electrical function maintenance of cable systems.

Where is function maintenance required?

Technical equipment with function maintenance is required for the following buildings and systems:

- Hospitals
- Hotels and restaurants
- Tower blocks
- Meeting points
- Commercial buildings
- Closed large garages
- Underground railway systems
- Chemicals industry
- Power stations
- Tunnels

This could be because these constructions are regularly frequented by many people. This creates an increased safety risk for gatherings of people. However, with certain systems, property and the environment must also be protected.

Function maintenance in construction regulations

Safety equipment required by construction law

The requirement for electrical installations with function maintenance is a component part of the construction regulations. Function maintenance only relates to those areas which provide the power supply to safety-relevant systems, such as emergency lighting, alarm systems, fire alarm systems and smoke extraction systems. Here, the regulations require that the power supply must be insured for a specific period of time, even if there is a fire.

4.2 Tasks of function maintenance

30 minutes: Function maintenance for a safe evacuation and rescue
The first 30 minutes after the start of a fire play an important role. For the affected building to be cleared quickly, the function maintenance must be guaranteed for the following equipment during this time:

- Safety lighting systems
- Lifts with fire control
- Fire alarm systems
- Alarm systems and systems to issue instructions
- Fire extraction systems

90 minutes: Function maintenance for effective fire-fighting
To support fire-fighting operations, it is imperative that certain technical equipment is supplied with sufficient power even up to 90 minutes after a fire breaks out in a building. This equipment includes:

- Water pressure increase systems for fire water supply
- Mechanical smoke extraction systems and smoke protection pressure systems
- Fire brigade lifts
- Bed lifts in hospitals and similar equipment

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4.3 Proofs of applicability

4.3.1 Tests

Fire test

The proof of the function maintenance of electrical installation material must be obtained by a fire test, carried out by an independent materials' testing agency. There is currently no European standard on function maintenance, but there are some national test regulations. The most widely spread and accepted is testing according to DIN 4102 Part 12.

The test body, i.e. the cable system, must have a testing length of at least 3,000 mm and is installed in a special oven. The cables are routed on the support systems. According to the standard, two testing cables of the same type are used. In order to cover a cross-sectional range in a test, the smallest and largest desired wire cross-section are tested. In most cases, 50 mm² of copper is chosen for the largest cross-section, which, subject to agreement between all the testing institutes, covers all the cross-sections above it with sufficient safety.

The test voltages are 400 V for the power cable types (e.g. NHXH) and 110 V for data and telecommunications cables (e.g. of types JE-H(St)H). The test criteria is: no failure of the cables through short-circuits or conductor breaks through the required testing time.

Function maintenance test structure

Testing furnace of a materials' testing institute (MPA)

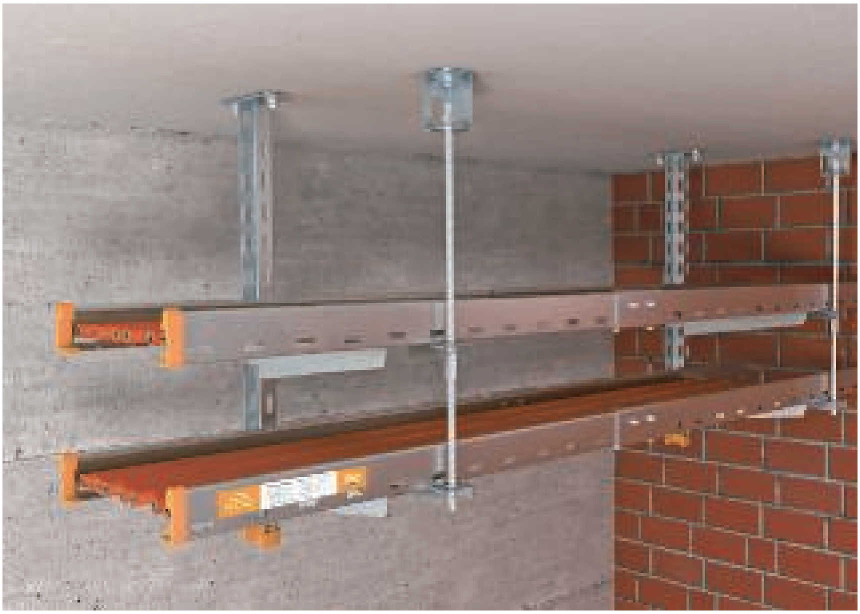
4.3.2 Definition of a cable system

A cable system with integrated function maintenance is, according to DIN 4102 Part 12, the combination of the laying system (cable ladder, cable tray, etc.) and cables with integrated function maintenance.

System labelling by the erection engineer

Each cable system must be permanently labelled with a sign. This labelling must contain the following information:

- Name of the erection engineer of the cable system (installation engineer)
- Function maintenance class "E" or "P"
- Number of the test certificate
- Owner of the test certificate
- Year of manufacture



Labelling of a cable system

4.3.3 Cables

Extreme loads for cables

If there is a fire, the cables and conductors are subjected to extreme loads from flames and heat.Cables used for a function maintenance installation must be able to withstand temperatures of up to 1,000 °C and higher for a specific period of time, without there being a short-circuit of the copper conductors. As the copper conductor may begin to anneal at these extreme temperatures, thus impairing its own mechanical stability, the support system serving as a "support corset" has a special significance.

Cables with integrated function maintenance

Therefore, in the case of cables with integrated function maintenance, the insulation has a special role to play. A distinction is made between two different construction types: on the one hand, special coils around the copper conductor made of fibre glass or mica type, on the other, special ceramising plastic insulations.

If there is a fire, then, with cables with special coils of fibre glass or mica tape, the cable insulation burns completely, creating a layer of ash. This is kept together by the windings and ensures that the copper conductors are kept apart and that no short-circuit of the support system can take place.

More modern cable types use special ceramising plastic insulation instead of the coils. The main component of the insulation is aluminium hydroxide, which forms a soft ceramic sleeve when it burns. This creates the desired insulation of the wires carrying current, both between each other and also to the support system.

Function maintenance cable with insulating ash layer

The copper conductors remain separate from one another – no short-circuit is created.

Halogen-free plastic

Halogen-free plastic is always used for the manufacture of cables with integrated function maintenance. This plastic does not contain any chlorine, bromine or fluorine and does not create any corrosive fire gases during combustion. This is proven through the combustion of the insulation material and measurement of the pH value and the conductivity according to EN 50267-2, -3 [15] and IEC 60754-2 [16].

Low-smoke and reduced fire spreading

Cables can also help with fire protection!

In addition, cables with integrated function maintenance have additional positive characteristics in case of fire. These include:

- Low-smoke combustion
- Reduced fire spreading

These additional properties are also checked using fire tests on cable samples. The smoke density is measured according to IEC 61034-1, -2 [17] and EN 61034-1, -2 [18]. The light intensity is measured using photoelectrics, whereby the minimum value may not fall below 60 per cent of the nominal output of the light source due to the smoke.

The spread of fires is tested in a vertical arrangement according to EN 50266-2-4 [19] and IEC 60332-3-24 Cat. C [20]. Cable bundles are flamed on a vertical section. After the prescribed length of 20 minutes, the flames must go out by themselves and there may be no damage up to 2.5 m above the burner.

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4.3.4 Classifications and certificates

The result of the fire test is documented in a construction test certificate. For cable systems with cable-specific support constructions, this test certificate is considered the proof of function maintenance. In addition to the test certificate, for standard support structures, a surveyor's comments are required as proof of function maintenance.

Together, the cables and the routing system form a single unit.

Depending on the length of time achieved, the cable systems are assigned to the classes E30 to E90 according to DIN. According to the European classification standard EN 13501, a cable system is given the abbreviation "P" with the appropriate time in minutes after a successfully completed test.

Function maintenance classes according to DIN 4102 Part 12

Testing length	Short code	Division into function maintenance classes
30 minutes	E30	Function maintenance at least 30 minutes
60 minutes	E60	Function maintenance at least 60 minutes
90 minutes	E90	Function maintenance at least 90 minutes

4.4 Installation types

There are various routing options for routing cables with integrated function maintenance. Besides the type and number of cables to be routed, economic aspects are naturally also of importance. There are many variations, from the tried and trusted standard support structures with which planning is possible, irrespective of the cable type, right through to economical cable-specific solutions.

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4.4.1 Standard support constructions

The standard specifies that not just the cables themselves belong to the function maintenance of an electrical cabling system but also the routing systems. With standard support structures, it is possible to select the cables required for the installation freely. This is possible, as all the cable manufacturers have proved the function maintenance of their cables and conductors for the standard support systems.

Specified routing types

DIN 4102 Part 12 defines three standard routing systems:
- Routing on cable ladders
- Routing on cable trays
- Individual cable routing under the ceiling

Individual cable routing under the ceiling comprises the following routing types:
- Individual clips
- Profile rails
- Clamp clips with and without long troughs.

The parameters of the horizontal routing types were transferred to vertical installations, making vertical sections possible.

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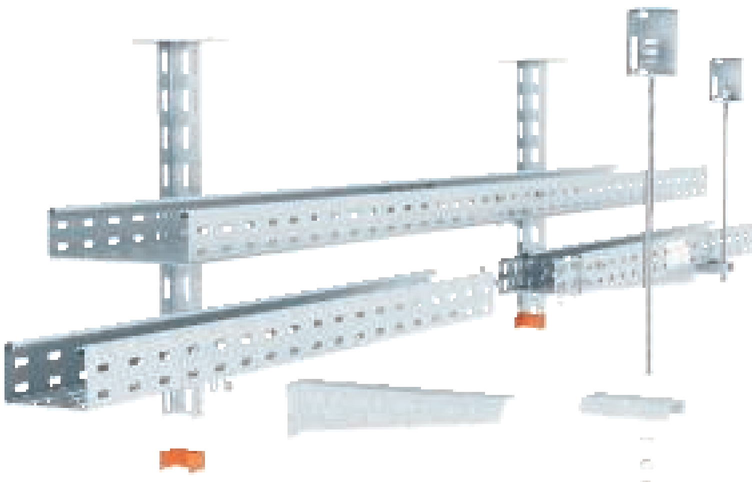

Table 3: Parameters of the standard support structures: cable trays and ladders

	Cable trays	Cable ladders	Rising sections
Fastening spacings [m]	1,2	1,2	1,2
Maximum width [mm]	300	400	600
Maximum cable load [kg/m]	10	20	20
Maximum number of layers	6	3	1
Threaded rod locking	Yes	Yes	-

The benefits

- Free cable selection, as the combinations of cables and standard support structures possess proof of applicability.
- No binding to specific cable types.
- The structures are ideal for smaller projects.
- Testing means that the countless installation variants are approved for many years.

Summary: Here, the installation engineer can "play it safe".

Table 4: Parameters of the standard support structures: individual routing with clips

	Individual clips	Clamp clips without long troughs	Clamp clips with long troughs
Horizontal fastening spacings [cm]	30	30	60
Vertical fastening spacings [cm]	30	30	-
Maximum cable diameter [mm]	Unlimited	Unlimited	Unlimited
Maximum bundle diameter [mm]	3 x 25	3 x 25	3 x 25

4.4.2 Cable-specific support systems

Make routing more economical

Cable-specific support systems require specific cables. Any proof is only valid for the actually tested combination of laying variant and cable. There are many tested combinations. With these systems, economical routing is paramount. Thus, they differ considerably from standard support constructions. Cable-specific systems differ from the standard, e.g. in the fastening spacing distances of the clips. Fastening spacing distances of 80 cm are no rarity with specific cable types.

When cables are routed on cable trays, the support spacing distances and load capacities are increased.In addition, with some systems there is no need for the attachment of a threaded rod lock near the bracket tip. The great advantage of this is that cables need not be threaded through on retroinstallation.

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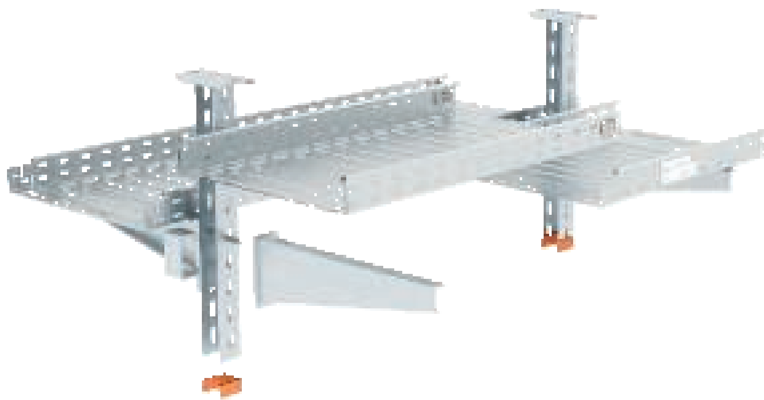

The benefits

- Low material and mounting costs.
- Planned systems: Support systems are clearly assigned to defined cable types.
- Large selection of approved cable types.
- Ideal for larger buildings (project business).

Summary: Here, the possibilities of the combination of cables and support systems can be fully exploited – the systems are optimised for the appropriate application.

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The following cable-specific support systems can be considered for an economical electrical installation with function maintenance.

- Cable trays with and without threaded rod locking
- Mesh cable trays
- Cable ladders
- Individual clips
- Collecting clamps
- Pressure clips
- Electrical installation pipes in proven variants

Note:
When choosing products approved for function maintenance, the specifications of the planner and the details of the test certificates must be observed. The test certificates contain all the parameters on mounting and the applicable components. It must be guaranteed that the cables used with the support system are tested and approved.
Data for cable cross-sections, distances and maximum loads may vary depending on the cable type and cable manufacturer. The maximum approved cable load may not be exceeded during installation. Even in the case of retroinstallation in cable-specific routing types, the approved cable types must be observed.

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Cable trays RKSM

Grip M collecting clamps

Observe local factors!

4.4.3 Installation situations

Local factors on the construction site sometimes require specific adaptations, in order to prevent or compensate the cable system from being negatively influenced by surrounding components.

Space with plenty of girders

If there are height jumps, the installed cables must be supported. This may be required when cables with large cross-sections are no longer on the support system. For this, additional profile rails or brackets could be mounted, in order to accept the cable load.

Combination with other systems

Ventilation systems, pipes, etc. may not be installed above the electrical installation with function maintenance, as parts may fall down if there is a fire, damaging function maintenance cables. For this, function maintenance cables must be placed directly under the ceiling or on the wall.

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Limited space

Two solutions are suitable when space is limited. For example, cables can be mounted directly under the ceiling with clips or pressure clips. Alternatively, it is possible to install several narrow tracks, one above the other, instead of one wide track.

Problematic substrate

The supporting force of old ceiling constructions cannot be determined reliably. Therefore, wall mounting is recommended (e.g. for restoration projects).

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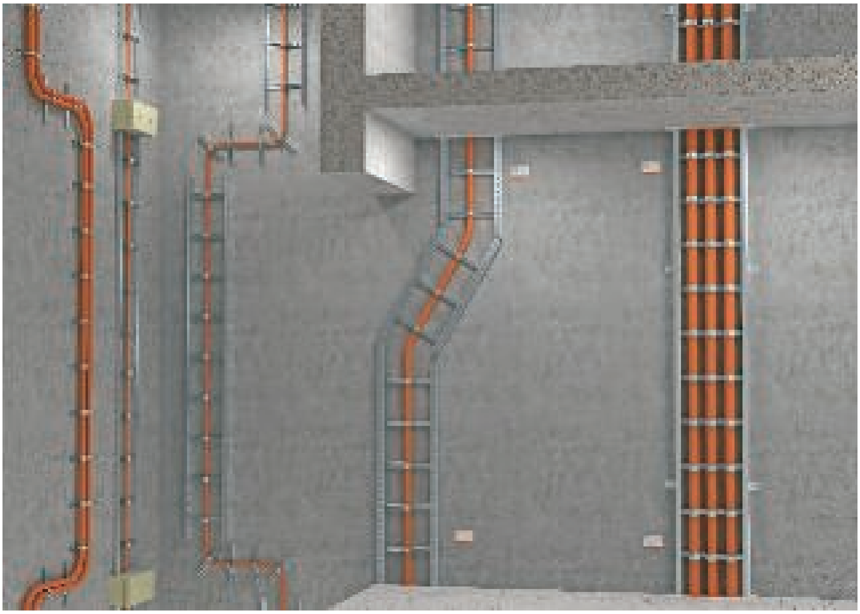
4.5 Special features of vertical routing

Cables on rising sections must be effectively supported in the transfer area between vertical and horizontal routing, to prevent bending or sliding. Continuous cable systems only receive the appropriate function maintenance classification when there is effective support at a spacing of max. 3.5 m.



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Strain relief through loops

To ensure that cables do not break through their own weight during a fire, DIN 4102 Part 12 requires that they be routed in loops. The maximum permitted distance between the individual loops is 3.5 m. The minimum length of the horizontally routed cables is 0.3 m. The horizontal fastening clips must, as with vertical mounting, also be mounted every 0.3 m.In addition, during the installation the permissible bending radii of the cables mist be observed. However, in practice, this variant may often not be used due to the large amount of space required at the side.

If there is a fire, the cables form an insulating ash layer and deposit themselves on the sides of the clip elements. This prevents the cables from breaking on account of the copper weight.

Strain relief through cable insulation

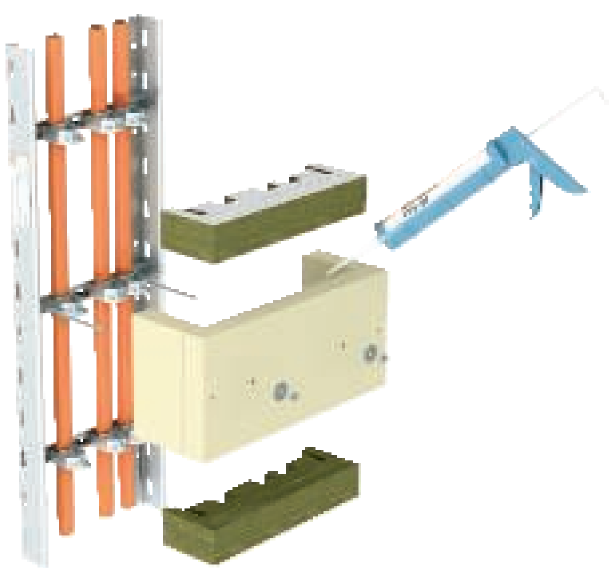
An additional strain relief option is the installation of approved cable insulations in the ceiling openings. In so doing, the fire resistance length of the insulation system must correspond to the function maintenance class of the installed cable system. In such cases, the storey height may not exceed 3.5 m. If there is a fire, the copper weight is caught by the series of clips located directly above the insulation, as this remains sufficiently cool due to the insulation function. The cables are clamped according to the regulations and, at a storey height of maximum 3.5 m, "only" support a permitted weight of 3.5 m of copper.

Effective support through proven clip design

The boxes, made of a non-combustible material with integrated mineral fibre insulation and which are mounted directly over a series of clips, have proven their worth as a practical solution. This allows avoidance of the difficult loops according to DIN 4102 Part 12.

The action principle is similar to that of the cable insulation in the storey ceiling: if there is a fire, the series of clips in the box remains relatively cold and the cables remain clamped, preventing breaking. This solution is approved for all types of vertical ladder and also for individual clips, which carry vertical cables. As ladder rungs can be penetrated, mounting is also possible in existing, continuous rising sections.

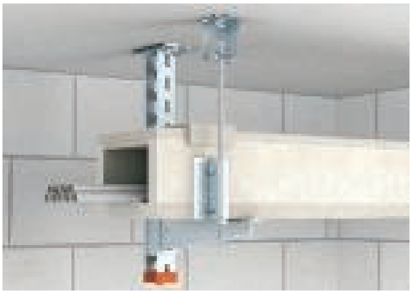
Due to the independence of specific cable types or manufacturers, DIN-conformant and effective support of the vertically installed function maintenance cables can be achieved in a way which is extremely economic and space-saving.



4.6 Function maintenance with fire protection ducts

Electrical function maintenance can not only be achieved through cable systems according DIN 4102 Part 12, but also through cable ducts. The different construction types of the ducts ensure that the cables routed in the interior continue to function in a fire on the outside. This is ensured using different insulation materials.

The advantage of fire protection ducts is that, instead of special function maintenance cables, standard PVC-insulated cables can be routed. As cables with integrated function maintenance are usually created with a nominal voltage of 0.6/1 kV, there are no options in the field of cable systems for routing medium-voltage cables with function maintenance, for example.However, these cable types can be routed in fire protection ducts without risking the protection aim of the safe supply of a safety-relevant system.



4.7 Limits of function maintenance

Not only neighbouring installations can have a negative impact on electrical function maintenance.Insufficient knowledge of local factors or even incorrect planning can quickly limit implementation of function maintenance in accordance with the approval. It is rare to find a technical building manager coordinating fire protection measures on construction sites. As such, networks are often managed by different planners and installation engineers and only poorly matched.

If architects and construction engineers do not employ technical building managers, then they must assume the coordination of fire protection measures themselves. But planners of technical building equipment will, in future, have to expand their knowledge of construction and system fire protection.

4.7.1 Unsuitable components

Only supportive components permit function maintenance.

In many cases, the building structure often does not permit function maintenance routing which is conformant with the approval. Components closing rooms, such as walls and ceilings, but which do not have a supporting function in the case of fire, are unsuitable for fastening cable systems with integrated function maintenance according to DIN 4102 Part 12. Dry-construction walls with metal stand constructions with a fire protection-classified version are the best example of this. The structure of these walls means that a spread load, such as a cable tray, cannot be mounted. If there is a fire, then the structure of the normally plasterboard plates becomes brittle and breaks away from the subconstruction. So-called sandwich elements behave in a similar way. These are sheet steel walls with a polyurethane foam insulation. They have no fire resistance and are thus unsuitable for a fastening substrate for function maintenance.

However, the greatest problems are caused by buildings or halls with a steel support construction, panelling with sandwich elements (as described above) and a roof of trapezoidal plates. Unprotected steel has no fire resistance length. At a temperature of 500 °C, which can be reached very quickly during a full fire, it only retains half its strength. As such, fastening of function maintenance routing to steel is not possible.
In order to protect the building structure against premature failure in case of fire, steel fire protection is usually created in the form of plate panelling or coatings. If something is to be fastened to these protected steel girders, then the panelling or coatings must ultimately be destroyed. The appropriate corrective work is often very difficult.

Even worse than steel girders are roofs made of trapezoidal plates. If there is a fire, hot fire gases rise, create a "ceiling jet", which distributes the fire smoke throughout the whole building at great speed.At the same time, the thermals of the fire gases draw a lot of oxygen from the environment into the fire, fanning the fire further through the draught.These operations cause the temperatures under the ceiling to rise very quickly. This quickly causes a loss of strength in the thin trapezoid plates.Installations attached to the ceiling would then fall down at an early stage of the fire.

Temperaturerhöhung durch Rauchausbreitung

4.7.2 Solution options

The simplest solution for mounting function maintenance in accordance with the approval, is to arrange the systems above other components. If there is a fire, no surrounding components may fall onto safety-relevant equipment fastened to the raw ceiling or the highest point on the wall. This protects function maintenance against negative impacts.

If other fire protection problems of a building are known, then system safety for people and the environment can be achieved using compensation measures.Firstly, the protection aims to be achieved must be defined.The higher the aims, the more comprehensive the necessary fire protection measures will be.
A simple option for implementing function maintenance is, for example, routing cables through non-endangered areas. If no function maintenance cable tray can be fastened to a steel girder, then this area must be bypassed and a different route to the installation must be found. This can be done, for example, through routing in the earth outside the building.

Despite matching with all the offices involved in construction, fastening on steel girders can be the only option for mounting function maintenance. This deviation from the approved mounting substrate can be compensated through technical measures. These include smoke/heat extractors (RWA), sprinkler systems or full monitoring through a fire alarm system.

Deviating solutions must be documented.

If these technical measures are implemented, then it is necessary to document them in the fire protection concept of the construction system. In the case of larger buildings, the fire protection concept is a component part of the construction approval and thus obligatory. It is important that the protection aims for the building are achieved, even if there are deviations from construction and system requirements.

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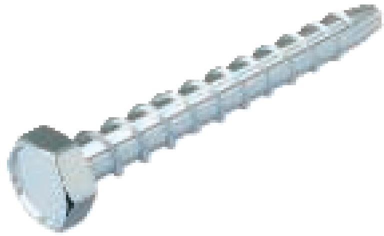
4.8 Fastenings

Metal spreading anchor



Bolt tie

Of equal importance to the selection of the support system is the decision for the most suitable fastening system. Here, too, the individual factors on the construction site must be taken into account. Depending on the substrate, many different anchoring systems are available with fire protection suitability.

For system fastening, the approvals of the cable systems with integrated function maintenance according to DIN 4102 Part 12 require metal anchors with a general construction approval. In contrast to normal "cold" fastening, these anchors must be set at least twice as deeply for a fire protection application. Alternatively, anchors are used which have proven their load capacity and fire resistance length in a fire test. When these solutions are used, the necessary setting depths according to the load are documented in the approval documents or in the appropriate fire protection reports. It must be noted, for which substrates and resistance classes the ties and anchors are approved.

The following standard fastening systems are available:

- Metal spreading anchor
- Injection tie
- Bolt tie

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Wood beam ceiling in existing building

The main differences between the fastenings are in the suitable fastening substrates and load classes. While most anchors are suitable and approved for use in concrete, there are also special solutions for various masonry types, even for hollow brick or porous concrete.With metal spreading anchors, certain spacing distances must be guaranteed, e.g. to the edge of a component. As metal spreading anchors develop lateral forces when subjected to loads, break-outs may occur when the prescribed spacing distances are not complied with. By contrast, bolt ties can be placed very close to the edge, as they do not create any lateral forces.

Dry construction is not supportive.

Dry construction walls are, as already described, particularly problematic. Due to their structure, it is not physically possible to fasten installations to them securely for fire protection. Walls and ceilings in old existing buildings are an additional obstacle. Due to their construction, these can often not be allocated to fire resistance classes. In such cases, so-called extraction experiments are often required, in order to determine the resistance and load capacity of the construction.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

Chapter 5
Additional protection aims

A building or a construction system must not only fulfil the construction requirements for resistance and traffic safety.There will also be additional requirements from other areas.System operators naturally have a great interest in guaranteeing the safety and availability of their system. This overlaps with the interests of the insurance companies: the more measures are implemented with regard to safe use, the lower the costs of the risk coverage conditions will normally be.

5.1 Protection of property and the environment

The protection of property includes not only the protection of the building or the system, but also the protection of cultural goods and irreplaceable data. With regard to environmental protection, the German MBO prescribes a special protection aim: "Public safety and order as well as life, health and the natural basics of life (may) not be endangered." In other words, environmental protection must also be observed when implementing fire protection measures. A system must be designed in such a way that, in case of fire, neither people nor nature are endangered unnecessarily.

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5.2 Industrial fire protection

Of course, in industrial systems, construction fire protection requirements must also be implemented. Also, in most cases, such systems require a fire protection concept, without which the system cannot be approved. Besides the aspect of safety for those people working in the machine, the operator must also focus on the protection of the machines, product and warehouse facilities. These points are also of importance for power generation. Protection of the usually very high investments in plant values is the main argument.

5.2.1 Fire alarm systems

Technician systems for early fire detection

The risk evaluation and risk analysis of a system can lead to the construction authorities to require the erection of an all-covering fire protection system before an approval is issued. The fire alarm system must match the operative risks: the triggering elements should be selected according to the risk to be expected. If smoke development is to be expected, then the characteristic value for the fire alarm is "smoke". Additional trigger characteristics such as flames or aerosols are also available.

Networked fire alarm systems, which must function for 30 minutes according to construction law, can be achieved using different technologies. However, they all share the fact that additional technical systems are controlled via the alarm systems and can be run in a state which does not pose a risk to people. These include fire controllers for lifts, voice alarm systems and the triggering of extinguishing systems.

5.2.2 Extinguishing systems

Not only the fire alarm system, as a detector and trigger unit, but also the technical extinguishing systems are an important component of preventive fire protection. The risk analysis means that various systems are used according to the combustible substances. These determine the type of the extinguishing agent and thus the design of the extinguishing system. Thus, a distinction is made between water extinguishing systems such as sprinkler and spray mist systems, foam extinguishing systems and gas extinguishing systems. Gas extinguishing systems are often used for electrical systems, as electrical current, together with the conductivity of the extinguishing water, would pose a considerable danger to those involved and the rescue services.
However, one has to point out that using "smaller solutions" can also achieve considerable effects. Even wall hydrants and hand fire extinguishers (which are part of the statutory requirements for construction systems) can be used for fires for the self-help of employees and the fire brigade.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

5.2.3 Prevention of fire spread

In the field of construction, a lot of emphasis is placed on the use of non-combustible substances and components. In addition, systems are arranged in such a way that fire sections of manageable size can be formed according to the risks. Spatial separation through construction measures is a very effective measure in the prevention of the spread of fires to other areas of buildings and systems.

If structural separation is not possible, other measures can be used. For example, installations can be safely shielded with plate material or routed in fire protection ducts. Coatings can be applied to supports and can form an insulation layer in case of fire. Thus, it is possible to increase the fire resistance capacity of these components.

Protected bridging of the fire wall using a fire protection bandage

Coatings and cable bandages

Cable systems can also be equipped to provide fire protection. Instead of applying coatings to the cables, cable bandages can help to provide a shield. These protect the environment against a cable fire, as the coating foams up when there is a short-circuit, suffocating the fire.
When flamed from outside, the cable systems protected in this way are then excluded from the fire, as the combustible insulation of the cable is shielded from the environment. This function to prevent the spread of fires is tested in a fire test according to IEC 60332-3-22 Cat. A [21] using a vertical arrangement of bandaged cable bundles. Various bandage types are available, e.g. for dry use in interior areas or external use in aggressive atmospheres.
Thus, in photovoltaics, fire walls can be bridged with combustible cables.Cable bandages are also used in wind power plants, even in offshore areas, as they reduce the feared chimney effect in a fire and thus limit the damage. Fire brigades are scarcely able to fight fires in the gondola of a wind power plant with an average height of 90 to 100 metres.

Chapter 6
Fire protection from OBO Bettermann

OBO Bettermann is the right contact for all fire protection measures required by construction law. The fire protection product range from OBO comprises practical and tried-and-trusted systems which can fulfil all the requirements of fireproof electrical installations. This allows the three protection aims to be reliably achieved: the prevention of the spread of fire, the securing of escape routes and the maintenance of functions.

In addition, OBO can offer complete solutions for the entire electrical infrastructure from a single source – from housing through to industrial complexes. All the systems of cable management and building technology can be obtained from OBO Bettermann: connection and fastening technology, cable support and cable routing systems, underfloor systems as well as transient and lightning protection.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

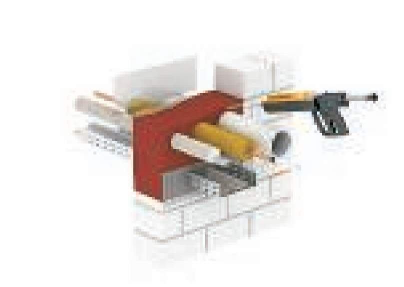
6.1 Insulation systems

Tested and approved

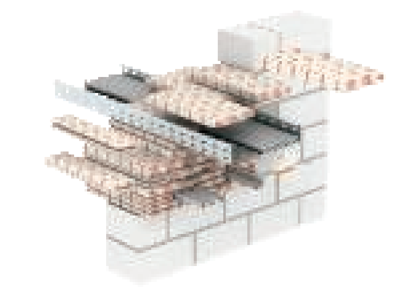
Various cable, pipe and combination insulation is available to close openings in ceilings and walls with fire protection classification. These fulfil the necessary standards and possess the appropriate approvals. In addition, the number of systems tested according to the European standard EN 1366-3 is growing. Thus, OBO can offer an almost complete product range for the insulation of electrical installations. Taken individually, the OBO insulation systems are:

PYROMIX®
DIN-tested combination insulation system made of special fire protection mortar, fire resistance class S90

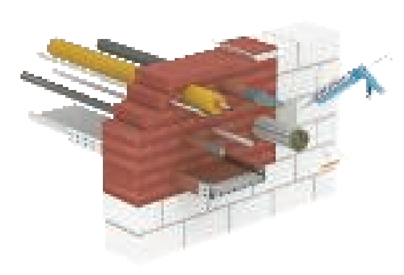
PYROPLATE® Fibre
DIN-tested combination insulation system with coated mineral fibre plates, fire resistance class S90



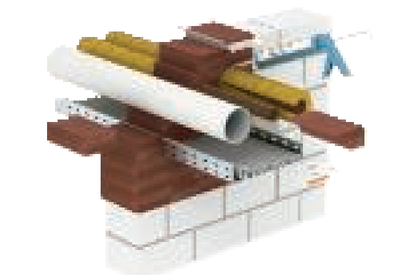
PYROSIT® NG
EN-tested combination insulation system made of 2-component fire protection foam from cartridges, fire resistance classes to EI120



PYROBAG®
DIN-tested cable insulation made of fire protection bags with special, fibre-free filling, fire resistance class S90



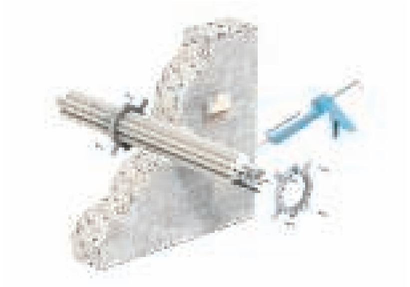
PYROPLUG® Block 220
EN-tested cable insulation made of foam blocks, fire resistance classes to EI120



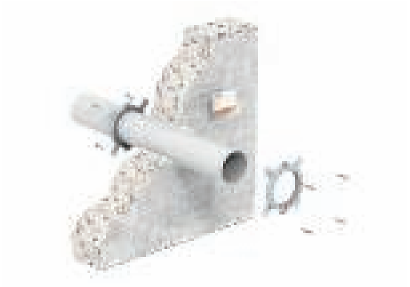
PYROPLUG® Block 200
DIN-tested combination insulation made of foam blocks, fire resistance class S90

PYROPLUG® Peg
DIN-tested cable insulation made of foam plugs, fire resistance classes S30 to S90

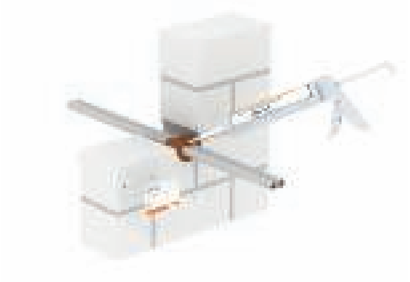
PYROPLUG® Shell
DIN-tested systems for the insulation of cables with pipe shells, fire resistance classes S30 to S90



PYROCOMB® Tubes
DIN-tested cable insulation with pipe seals PYROCOMB® to insulate electrical installation pipes, fire resistance class S90



PYROCOMB®
DIN-tested pipe seals for insulation of combustible pipes in the PYROMIX®, PYROPLATE® Fibre systems and as a standalone solution, fire resistance class S90



PYROPLUG® Mini
DIN-tested system for insulation of cables with one-component filler, fire resistance class S90

PYROMIX® Screed
DIN-tested system for the insulation of cables with one-component filler and mineral wool, fire resistance class S90

Insulation can be implemented as special solutions:

- In plastic and metal line routing ducts
- In underfloor systems, screed-covered or open
- In cast plastic pipe shells

OBO Bettermann possesses various surveyor's reports and approvals from official materials testing institutes on these subjects. In addition, the requirements of the cable system directive are fulfilled in penetration of individual cables with insulating materials from OBO.

For support, OBO offers calculation software to determine the material for insulation systems. With just a few questions, the user is guided towards the solution of their fire protection problem and the suitable system. The Excel-based program can be downloaded free of charge on the website www.obo.de.

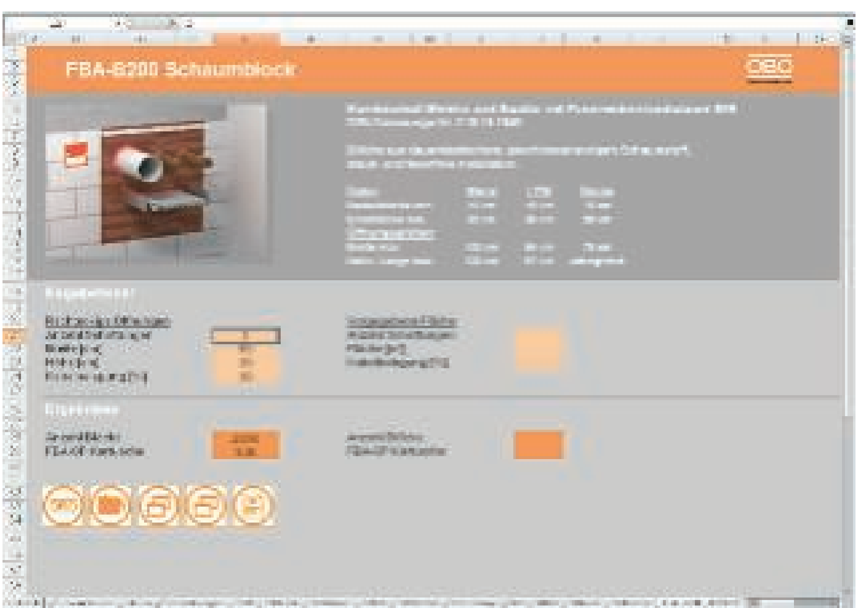


Figure: Screenshot BSSpro

6.2 Escape route installation systems

There are two systems within the area of escape route installations: The suspended ceiling systems tested by OBO for use above the suspended fire-protection ceiling and the proven and tested fire-protection ducts made from glass fibre-reinforced lightweight concrete.
The situation regarding the cable coating is somewhat different, as the function to prevent the expansion of fire is without doubt proven, however the formal certification for use in emergency exit routes cannot be issued. Coordination with the construction supervisory board is always required (see paragraph 6.4).

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6.2.1 False ceiling mounting

OBO Bettermann has tested the following routing types according to DIN 4102 Part 12 for mechanical resistance above fire protection ceilings by recording the deformation behaviour:

- Cable trays RKSM, SKS, MKS with maximum cable loads of 90 kg/m at a support spacing of 1.5 m for a fire load of 30 minutes
- Mesh cable trays GRM with maximum cable loads of up to 40 kg/m at a support spacing of 1.5 m for a fire load of 30 minutes
- Mesh cable trays G-GRM with maximum cable loads of up to 15 kg/m at a support spacing of 1.2 m for a fire load of 30 minutes
- Pressure clips 2033M and 2034M for a fire load of 30 minutes
- Collecting clamps 2031 M15, 2031 M30 and 2031 M70 for fire loads of 30 and 90 minutes

Fire test reports of the Braunschweig Materials' Testing Institute and BET reports from OBO Bettermann document the resistance and deformation behaviour of the routing variants, clearly proving the applicability of the above systems.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

6.2.2 Fire protection ducts

OBO fire protection ducts are available in two versions: firstly, ducts of type BSK for direct and ceiling mounting and, secondly, ducts of type BSKH for mounting on support systems. Both versions have been tested and approved in accordance with DIN 4102 Part 11 and 12. Thus, they are not only suitable for use as emergency and escape route ducts to encapsulate the fire load, but also for electrical function maintenance. The ducts are available with five different interior dimensions. On the BSK types, fittings can be created from straight duct pieces, and there are prefabricated 90° bends and T-branches for the BSKH variants. Appropriately adjusted accessories round off the product spectrum.

One duct – two classes

The following classification combinations are available:

- BSK 09... - Fire resistance classes I90 and E30 to DIN
- BSK 12... - Fire resistance classes I120 and E90 to DIN
- BSKH 09... - Fire resistance classes I90 and E30 to DIN

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6.3 Function maintenance systems

With its tested routing types according to DIN 4102 Part 12, OBO Bettermann is a pioneer in the field of function maintenance. OBO recognised at an early stage that there was a necessity for viewing the topic of "Supply of safety-relevant systems with electrical current, even in the case of fire" as a single subject. The development of an appropriate testing standard was also worked on with the same level of action. Even today, OBO employees are represented in the standardisation committees, both in the DIN committee and in the European Standardisation Commission, and are highly regarded as interlocutors on account of their great experience. The function maintenance systems were tested at German testing institutes in cooperation with renowned manufacturers of safety cables, such as Dätwyler Cables, Kabelwerk Eupen, Leoni Studer, Nexans and Prysmian. In addition, certain routing types were tested and approved appropriately at local testing offices along with manufacturers from other countries according to DIN 4102 Part 12.

Systems for all requirements

OBO Bettermann offers the following systems as standard support structures with the function maintenance classes E30 to E90 according to DIN:

- Cable trays SKS
- Cable ladders LG
- Rising sections in light-duty and heavy-duty versions
- Single and clamp clips, types 732/733 and 2056(U)M
- Strain relief ZSE90 as effective support for vertical routing

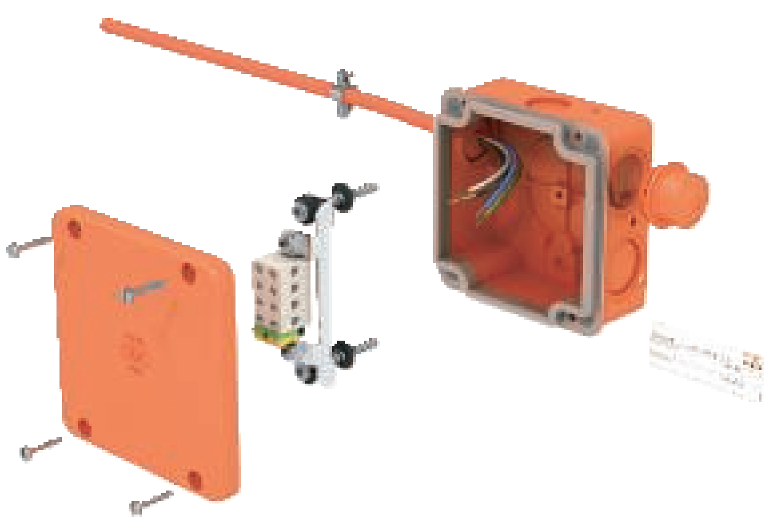
The following cable-specific support structures and routing types are available:

- Cable trays RKSM
- Mesh cable trays GRM and G-GRM
- Line routing ducts LKM
- Cable ladders SL
- Grip M collecting clamps
- Pressure clips 2033M/2034M
- Steel armoured pipes
- Tunnel systems made of VA

Many combinations with cable spacing clips and clamp clips with larger fastening spacing distances were tested and proven through various cable manufacturers. Even the routing of function maintenance cables in pipes was covered. To aid clarity, OBO makes a so-called cable list with the tested and approval routing system cable combinations available at regular intervals.

Connection technology with function maintenance

Junction boxes of the type FireBox are available for connecting and branching safety cables. These are equipped with a high temperature-resistant connection unit with ceramic terminals and offer terminal areas of 0.5 mm² to 16 mm² of copper cross-section.



This large area is rounded off by the fire-tested and approved anchoring systems. OBO offers the following fastening solutions to anchor small to very large loads in most supportive substrates:

- Metal spreading anchors for use in concrete (heavy-duty anchors, nail ties, interior thread anchors, cavity ceiling ties)
- Injection ties for use in concrete, hollow brick and porous concrete (anchor rods inserted in plastic or metal sieve sleeves with special mortar)
- Bolt ties for use in concrete and various types of masonry (self-tapping concrete screws with various head shapes)

6.4 Industrial fire protection systems

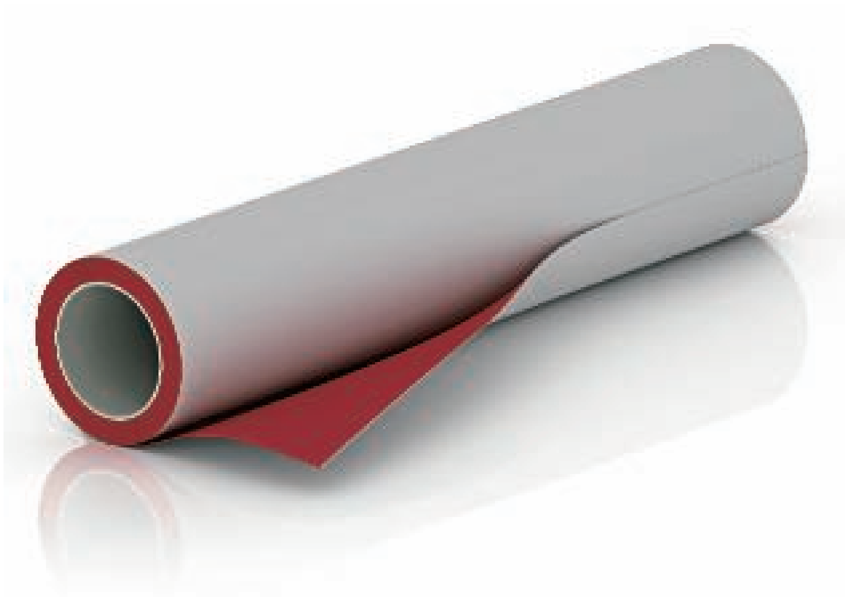
All the above fire protection systems from OBO Bettermann are also used, of course, in order to fulfil construction law protection aims in industrial buildings and systems. The requirements for components in buildings of another type do not differ from the component requirements in industrial systems.

Prevention of fire spread – interior and exterior

As a complement, OBO offers cable bandages tested according to EN and IEC to prevent the spread of fires. These bandages have proven their safe functioning using the vertical cable bundle tests and are available in two versions:

- Cable bandage FSB-BS, applicable in dry interior areas, colour: interior white, exterior grey
- Cable bandage FSB-WB, usable in external areas, resistant to chemicals such as benzine, heating oil, butanol, hydraulic fluid, colour: interior red, exterior grey

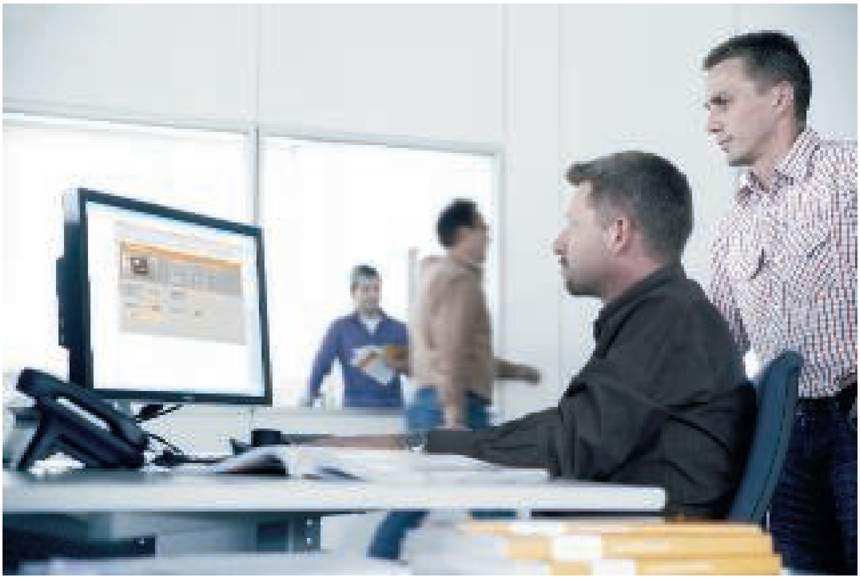
Industrial use of cable bandages



The cable bandages have the following advantages:

- Guaranteed dry layer thickness of the fire protection coating through machine production
- Dry routing
- Simple tightening strap principle for fastening and securing
- Simple retroinstallation through opening of the tightening straps (reusable)
- Easy to mount: outside always grey
- Washable surface through PU coating
- Material approval according to DIN
- Application approval according to IEC
- Prevention of fire spread proven for 120 minutes
- FSB-WB approved according to GL (Germanischer Lloyd) for offshore applications

6.5 Engineering and support



Support from OBO

The fire protection experts at OBO Bettermann help if there are problems and deviations in the conception of fire protection measures. Competent OBO field service employees are available for individual consultation and construction site support. These will support you in working out the problem and offer the first solution options. If the requirements are more complex, fire protection product management at the head office in Menden can offer additional support.

Great experience and direct contact to surveyors and the materials' testing institutes can often deal with deviations from approvals and test certifications through the use of compensation measures. OBO has already implemented many special solutions in this field, in particular in existing buildings and the renovation of buildings.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

By experts – for experts!

Through a comprehensive range of seminars and workshops on the subject of fire protection in electrical engineering, OBO Bettermann is supporting users from all branches of electrical installations, e.g. installation engineers, planners, workers in electrical wholesalers, architects and construction engineers. Current trends and developments are explained along with information on the most important standards and regulations.The basic principles are presented and practical implementation in everyday situations explained. Customer- or project-specific seminar content is also possible.

Imprint

7.1 About the author

Stefan Ring, born in 1968, first completed training as an electronics engineer for energy devices. Then, he studied electrical engineering at Fachhochschule Dortmund, with special emphases on electrical energy technology, and was awarded the title of Diplom-Ingenieur (FH) in October 1994. He has worked as a product manager for fire protection systems at OBO Bettermann GmbH & Co. KG in Menden, Sauerland, since 2005. There, he manages the product portfolio of construction fire protection for electrical installation technology, carries out market analyses and supports the marketing activities of the company with training courses, seminars and trade fair appearances in Germany and overseas.
During his activities, he successfully completed training as a specialist planner for construction fire protection at the European Institute for Postgraduate Education EIPOS e.V. in Dresden.
Besides his work activities, Stefan Ring has been active with the voluntary fire brigade in his home town of Bergkamen for over 25 years, with the Weddinghofen fire engine. As the Chief Fire Officer, he is also employed as the Safety Officer. He is also a guest lecturer at the Fire Brigade Institute IdF in Münster in the area of preventive fire protection.

7.2 Creation, concept, layout

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Except: Chapter 2.1 – photo of fire damage from the Brandschutz-Atlas, with the kind permission of Feuertrutz-Verlag, Cologne.

05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

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05 BSS_Brandschutzinformation_Europa | OBO | / en / 06/03/2012 (LLExport_01392)

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05 BSS_Fire protection information_Europe | O

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Back page

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