



Fire protection guide for electrical installations

Building Connections

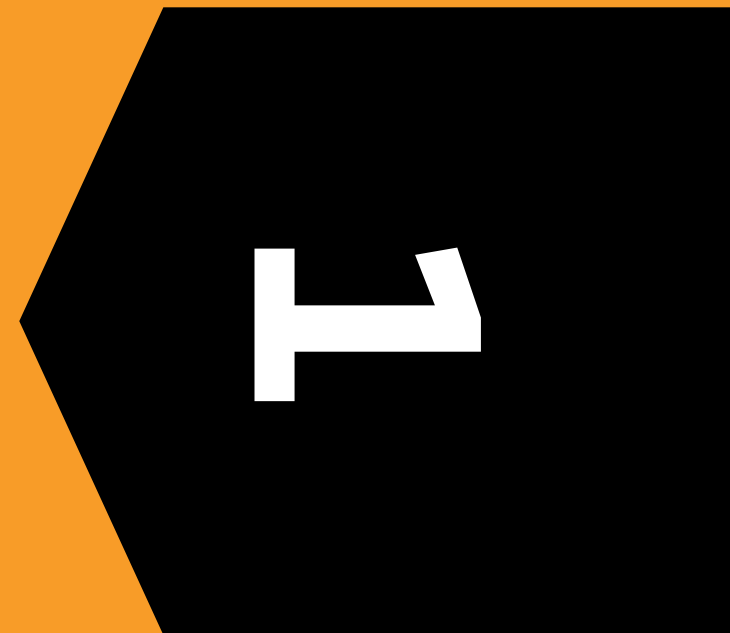
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In the second edition of this fire protection guide, we have again compiled lots of useful information. The interconnections of fire protection between different types of technical building equipment are now explained in even more detail. Perhaps you will find some new information in this edition which can help you in the planning and implementation of fire protection systems.

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Chapter 1: General introduction

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*"It is the people who don't
know how to play with (fire)
who get burned..."*

Oscar Wilde

1 General introduction

For years, the requirements for building safety have increased continuously. In this context, the sensitivity towards necessary fire protection in buildings is also growing.

However, professional fire protection is challenging and multi-faceted. Nowadays, fire protection presents many planners and installation engineers of building equipment with almost insurmountable obstacles. Installations run like networks through the complex building structures and 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.

When the fire protection design has been completed, the appropriate systems and components are installed. The installation engineer is required here. And it is here where there are requirements which cannot be implemented without further work.

After planning and correct implementation, the fire protection building alignment must finally be approved. All the installations must be executed accord-

ing to regulations and the appropriate fire protection proofs must be available. The requirements are thus appropriately high and require comprehensive knowledge of fire creation, fire behaviour and fire avoidance as well as the range of options to limit or prevent the spread of fire.

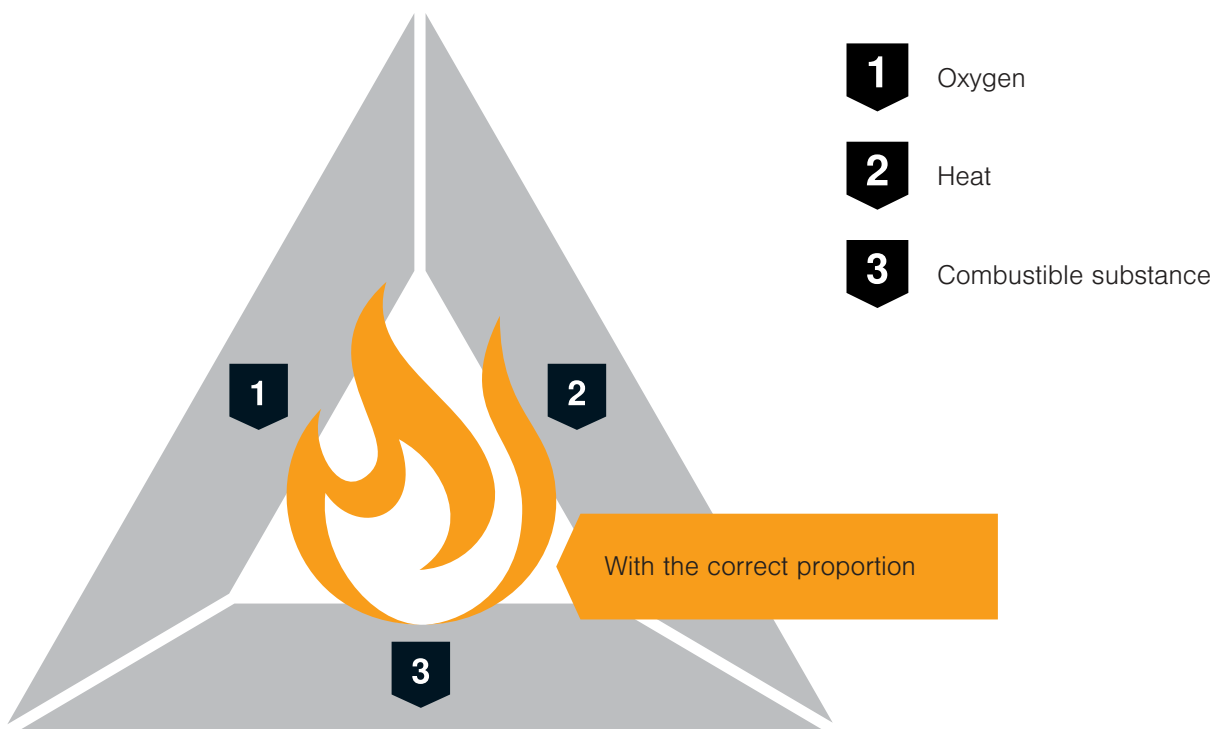
How does a fire occur?

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.

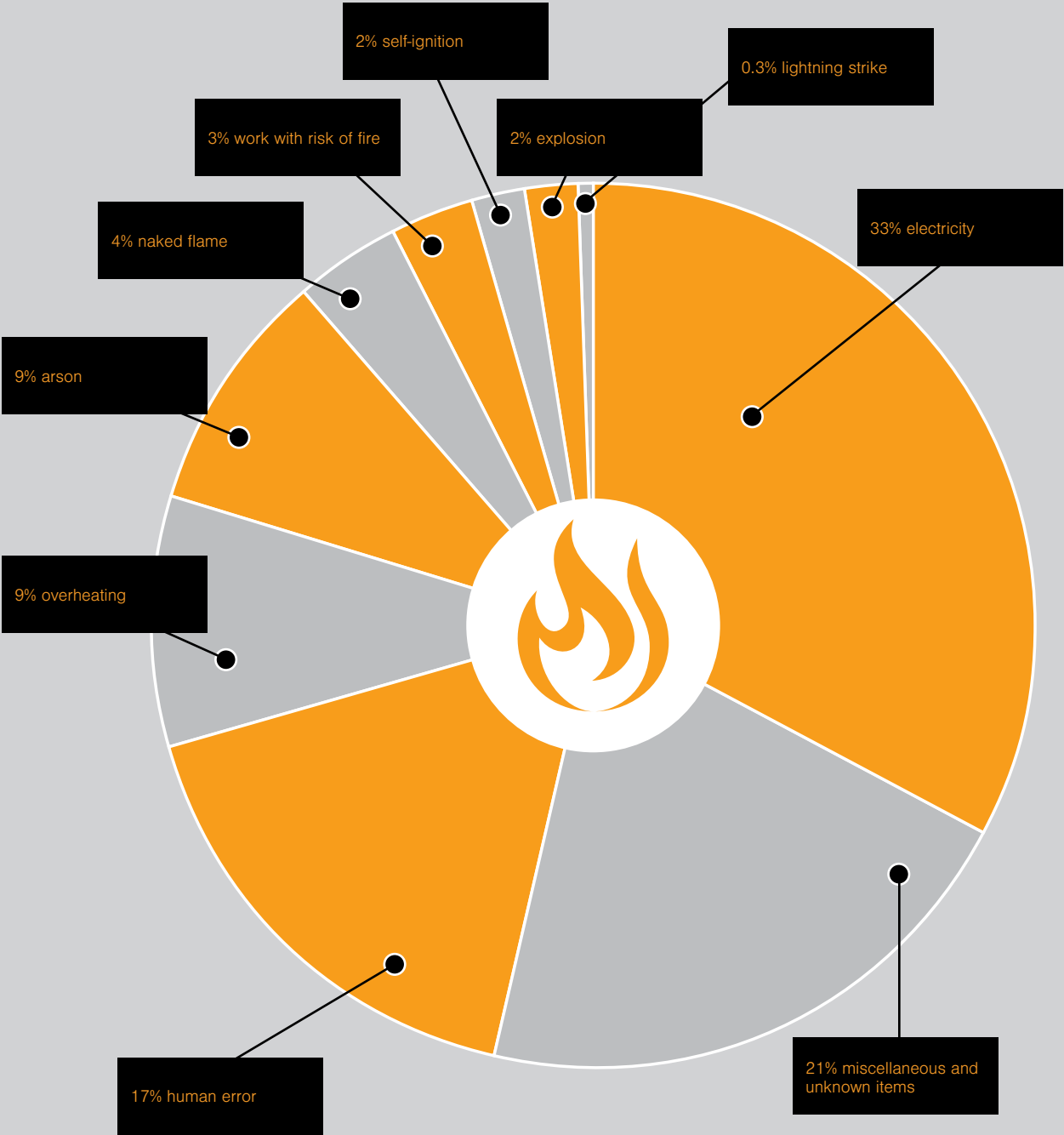
A fire requires three basic conditions:

- A combustible substance
- Oxygen
- An ignition source

A damaging fire can only develop with a particular mixing ratio and a (not always necessary) catalyst.



A fire requires three basic conditions



Causes of fire

Fire statistics

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 fire and 60,000 are injured, of whom 10% are seriously injured. The tables below show the number of fires and fire deaths each year in the countries evaluated by CTIF (International Association of Fire and Rescue Services) [1] in 2014.

At 33%, electricity is the no. 1 cause of fire. On the one hand, the electrical current is a potential source of ignition. On the other, the materials used to route and fasten electrical installations and cable insulation are usually combustible. For this reason, electrical installations require special consideration for fire protection.

The catastrophic impact of the highly toxic and aggressive fire gases are 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. Immense property damage is also incurred through the corrosive effects of the gases created during a fire. They may cause lasting damage to the structure of a building.

No.	Total number of fires per year	Number of countries	States
1	800,000 – 1,500,000	1	United States
2	100,000 - 600,000	13	UK, France, Germany, Russia, Poland, China, India, Brazil, Italy, Mexico, Australia, Argentina, Pakistan
3	20,000 – 100,000	21	Japan, Indonesia, Turkey, Canada, South Africa, Malaysia, Netherlands, Ukraine, Spain, Iran and others
4	10,000 – 20,000	20	Thailand, Algeria, Uzbekistan, Romania, Kazakhstan, Cuba, Czech Republic, Belgium, Serbia, Denmark, Finland and others
5	5,000 – 10,000	15	Iraq, Sri Lanka, Tunisia, Slovakia, Georgia, Singapore, Croatia, Philippines and others
6	< 5,000	150	These countries usually have less than 5,000 fires per year
	Total	220	

Table 1: Number of fires per year in 2010 - 2014

No.	Total number of fires per year	Number of countries	States
1	10,000 – 25,000	3	India, Russia, Pakistan
2	1,000 – 10,000	5	USA, China, South Africa, Ukraine, Japan
3	200 – 1,000	20	UK, Germany, Indonesia, Belarus, Brazil, Mexico, Turkey, Iran, South Korea, Spain, Poland, Canada, Uzbekistan, Romania, Kazakhstan, Lithuania, Latvia and others
4	100 – 200	11	Australia, Sri Lanka, Czech Republic, Hungary, Sweden, Bulgaria, Moldova and others
5	< 100	180	These countries usually have less than 100 fire deaths per year
	Total	220	

Table 2: Number of fire deaths per year in 2010 – 2014

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

Impacts of fire

Rapid spread of the fire

If a fire starts, then it may get out of control very quickly. In a moment, the flames consume all combustible materials, temperatures rise and the fire spreads in an explosive manner. Therefore, for fire brigades, besides actually fighting the existing flames, the main task is to prevent further spreading of the fire to neighbouring buildings or building sections, in order to limit the damage.

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

Heavy smoke development

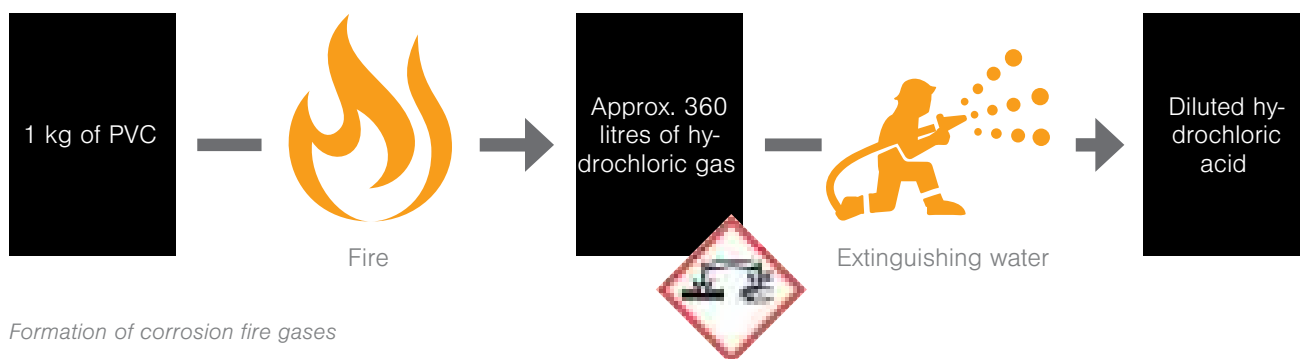
The development of smoke and soot are an often underestimated source of danger. Depending on which materials catch fire, the combustion process will cause, amongst other things, the forming of the toxic gases:

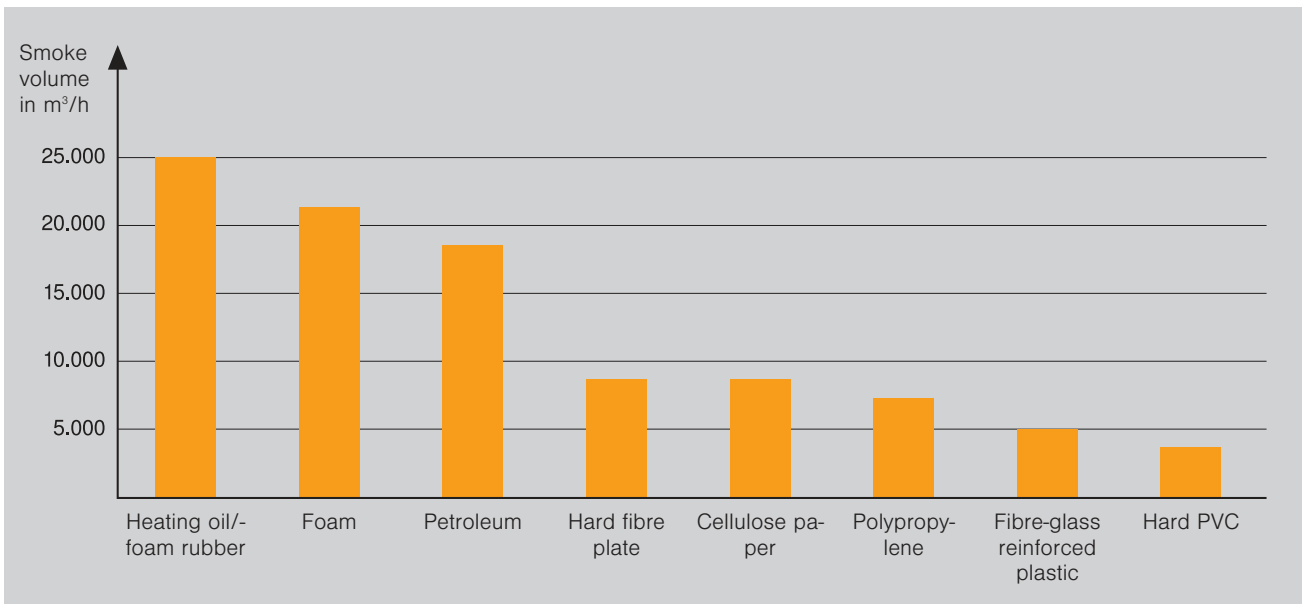
- Carbon monoxide
- Carbon dioxide
- Sulphur dioxide
- Water vapour and soot

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

Electrical installations contain cables with different insulating materials, which burn with smoke development of different strengths.

In Germany, 95% of all cable insulation in building installations is made from PVC. Alternatives, such as halogen-free insulation materials, have not been required by construction law in Germany. By contrast, in Luxembourg, for example, halogen-free cables are required for public buildings.





Smoke and fire gases when using 10 kg of material

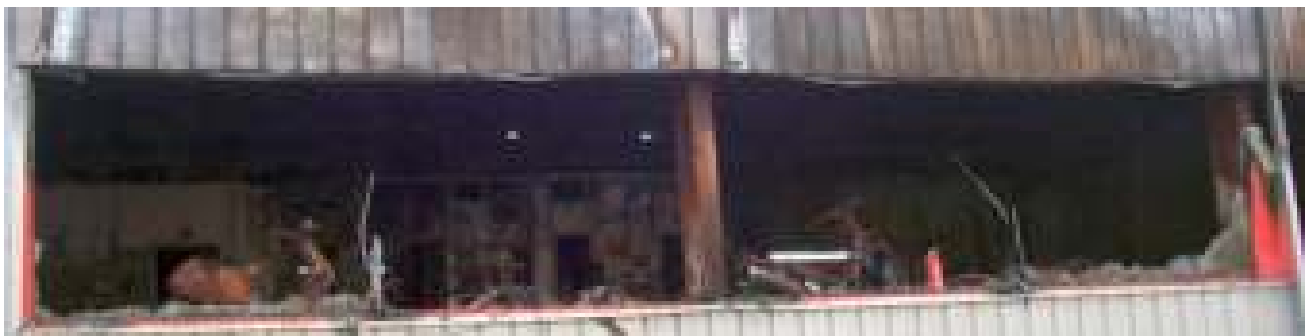
Corrosive fire gases

The subsequent damage from fires, and particularly from cable fires, can be very serious. For example, if the 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.
1 kg of PVC corresponds to 13 m of a PVC-insulated cable of type NYM 3 x 1.5 mm².*



Fire damage through corrosive gases



Historic city fire: London 1666

1.1 Construction law

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 the 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 MBO [2] serve as a basis for the erection of structures and the use of construction products. The state construction regulations in the individual German federal states were created according to the model building regulations, as construction law is the responsibility of the states.

Construction law – state law – European law?

The version of the construction laws and the appropriate ordinances vary between the federal states of Germany. This means that there may be differences from state to state. The master cable installation guidelines are also affected: The states have the right to include changes or to apply the suggestion exactly. Therefore, during planning, observe both the location of the construction project and the valid regulations.

Currently, there is no construction law for the whole of Europe. National regulations must be observed. In recent years, the harmonisation of construction products according to the European Construction Products Ordinance has increasingly led to free trading of approved construction products in the European Union.

General requirements

Construction regulations place basic requirements on a construction system. 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".[2] This means people, animals and property and their surroundings. Depending on the area concerned, the responsibilities lay with the planner, craftsman and operator.

Fire protection in the construction regulations

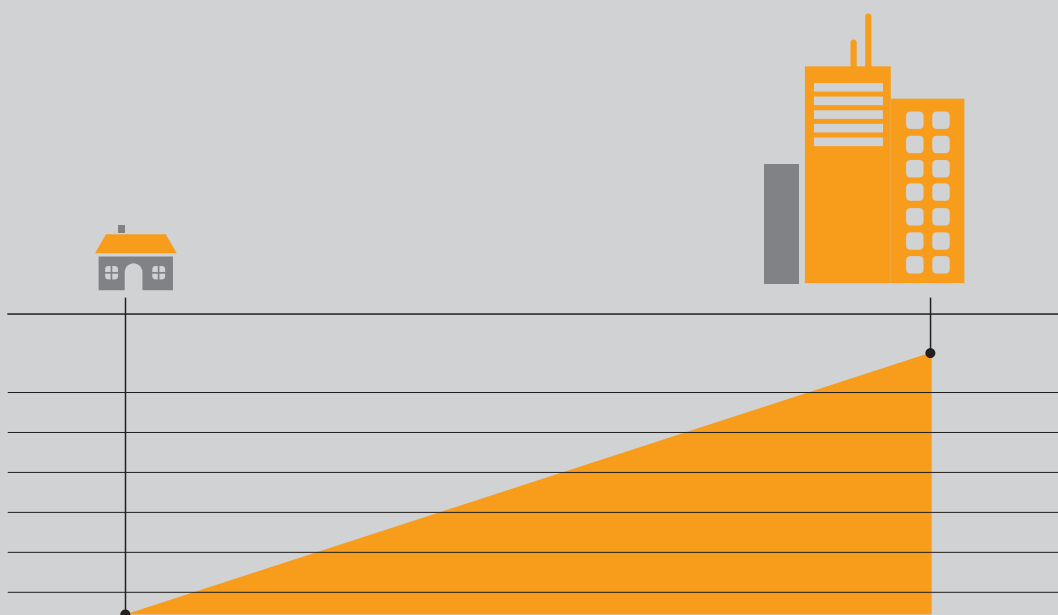
The first fire protection requirements are, for example, defined in §14 of the German MBO. The building must have been erected as already described in the general requirements, in order to "prevent the creation of fires and the spread of fire and smoke, and allow the rescue of people and animals as well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

Guidelines for electrical installations

Besides the basic national requirements from construction law, there are also the electrical requirements. These are specified by, for example, VDE, ÖVE, KEMA-KEUR and others. 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 requirements for installations in a building. 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 separating walls and ceilings as well as to systems with electrical integrity in the event of a 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. In Austria, the cable systems' directive dealing solely with the electrical installation is called ÖVE ÖNORM E 8002 [4].



Schematic drawing of the increasing requirements for fire protection measures, depending on the building type and size

1.1.1 Construction law protection aims

Measures are taken in buildings with a lot of people, so that, in the event of a fire, no-one is injured by fire and smoke. The opportunity for a safe, quick exit must exist. 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. Therefore, three steps are essential for the effective fire protection in a building:

First protection aim

Limit the spread of the fire

Second protection aim

Protect escape and rescue routes

Third protection aim

Maintain the electrical function – important electrical systems must continue to operate

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 this special protection aim: It states that "Public safety and order as well as life, health and the natural basics of life (may) not be endangered".

When implementing fire protection measures, environmental protection must also be observed. A system must be designed in such a way that, even in the event of a fire, neither people nor nature are endangered unnecessarily. In the industrial sector, it is also of course mandatory to implement the construction fire protection requirements. 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 plant, the operator must also focus on the protection of their machines, products and warehouse facilities. These points are also of importance in terms of power generation. Protection of the usually very high investments in plant equipment is the main argument for a fire protection concept.

1.1.2 Building classes (using the example of Germany)

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. In buildings regulated according to classes 1 to 5, a single structure rescue route is sufficient, e.g. a stairwell. In these buildings, rooms in upper storeys can be reached by the local fire brigade using portable ladders.

For higher buildings above 22 m (upper edge of the floor of the top room), aerial rescue vehicles, e.g. rotary ladders, are required. Not every municipality possesses an appropriately equipped fire brigade, as these special vehicles are very expensive to buy. This is why these municipalities very infrequently have tower blocks.





Buildings which exceed the tower block limit or are special structures must possess at least two structurally independent rescue routes.



Different objectives: Protecting people or property

Special structures

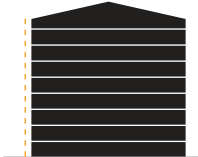
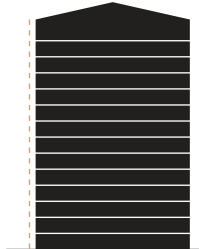
The requirements increase with larger construction projects. The requirements for special structures such as industrial buildings, tower blocks or meeting places are regulated by special specifications. It is possible that a building complex may be divided into various sections, the fire protection of 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 state building regulations apply.

To be able to classify a special construction, at least one of the following "facts" must be fulfilled according to the Model Building Regulations:

- Exceeding a certain floor area
- Exceeding specified building heights
- High number of people usually located in the building
- Special use
- Processing and storage of hazardous substances

Examples could be the following special structures: Tower blocks, shopping centres, schools, stadia, hospitals. Some of these special structures have special technical construction regulations and ordinances, e.g. meeting place ordinance, tower block directive, hospital construction ordinance and so on. These building types are termed "regulated" special structures. Alongside these are so-called "unregulated" special structures, for which there are no special regulations. However, here the general rules of technology apply, along with the minimum requirements of the state's laws.

Classification of the building classes according to the Model Building Regulations (Germany)

a BC1 b		BC2	BC3	BC4	BC5
					
Free-standing buildings UFE < 7 m use units $\sum$ UU < 400 m²		Non-free-standing build- ings UFE < 7 m use units $\sum$ UU < 400 m²	Other buildings with an UFE < 7 m	UFE < 13 m use unit with < 400 m²	Other buildings, with the exception of special buildings, UFE < 22 m
Fire brigade deployment with scaling ladder possible				Fire brigade deployment with rotary ladder possible	

UFE: Upper floor edge of the highest storey
UU: Use units, BC: Building classes

1.2 The four pillars of fire protection

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

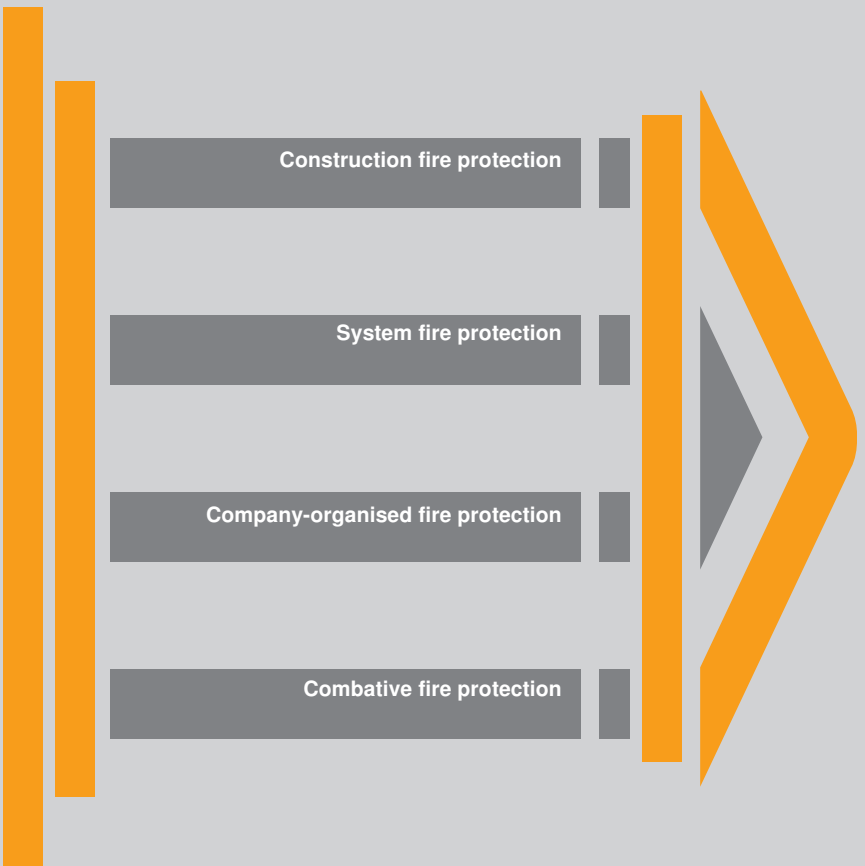
1.2.1 Construction fire protection

There are different requirements, depending on the way a building is used. On the construction side, fire sections are formed, fire-resistant components defined or the position and length of escape routes specified. The basis for this is the construction regula-

tions and special construction ordinances of the German states. These specify the minimum requirements for the building according to its use. Besides the construction law requirements for the stability and traffic safety of a building or construction site, there are also additional requirements. Thus, it is surely in the interest of systems operators that the safety and availability of the building are at the forefront. This is also in 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 often are.

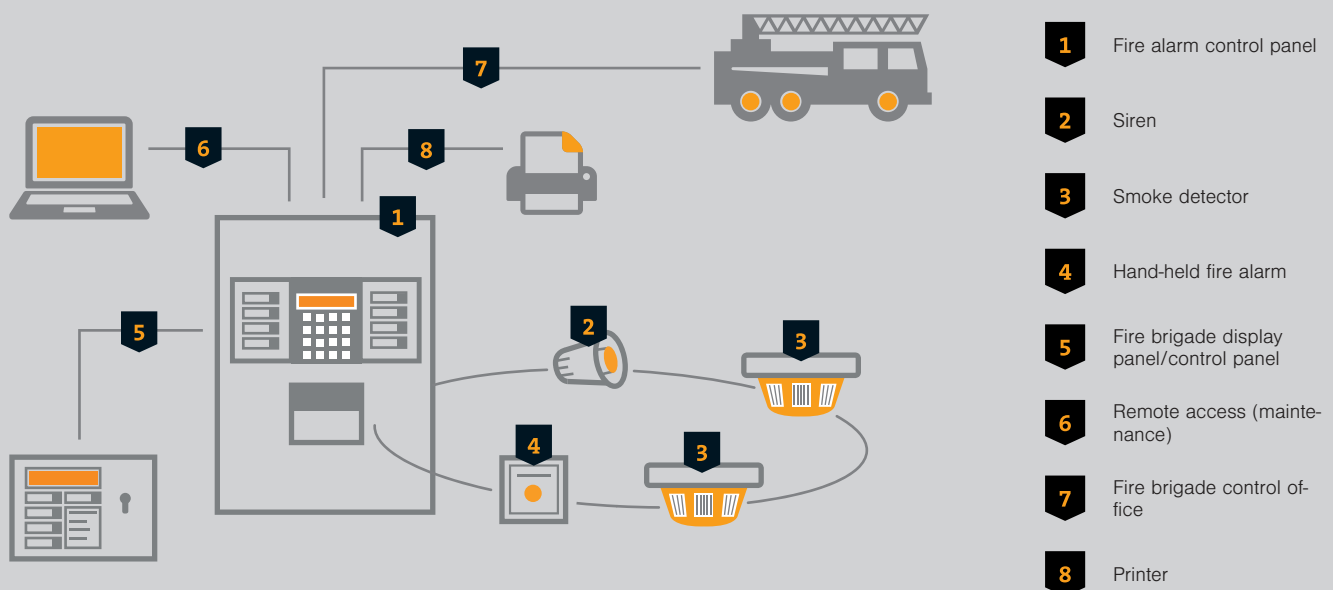


The formation of fire sections through firewalls or components with fire resistance



Four pillars of fire protection





Schematic diagram of a modern fire alarm system

1.2.2 System fire protection

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

Fire alarm systems

Networked fire alarm systems, which must function for 30 minutes according to construction law, can be achieved using different technologies, e.g. as a ring-bus system. 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.

Fire alarm systems normally consist of the following components:

- Fire alarm control panel as a higher-level computer
- Sensors such as manual fire alarms, smoke detectors, temperature monitors
- Alarm encoders, flashing lights and siren
- Fire brigade equipment such as fire brigade display panel and control panel

Fire alarm systems required by construction law must be connected to the command centres of the local fire brigades. The systems may only be erected by certified installation companies.

Safety lighting systems

These systems should ensure that, if there is a fire, people can leave a room and the building safely via escape and rescue routes. Rescue symbol luminaires with green and white pictograms also help here, which show stylised people and an arrow in the escape direction.

The rescue routes must have sufficient light conditions, so that possible obstacles in the escape route can be detected in good time and do not represent a danger to evacuation.



Extinguishing systems

Not only the fire alarm system, as a detector and trigger unit, but also the technical extinguishing systems represent a very large part of preventive fire protection. The risk analysis means that various systems are used according to the combustible substances. The combustible substances in the appropriate building 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 the danger posed by - electrical current, together with the conductivity of the extinguishing water, is considerable to those involved and also to the rescue services.

However, not only extinguishing systems have an effect as a "major" solution. Even wall hydrants and hand fire extinguishers, which are mandatory in construction systems, can be used by employees and fire brigades for (timely) fighting of fires in the early stages.

Fire protection walls

In the field of construction, a lot of emphasis is placed on the use of non-combustible substances and components. In addition, when arranging systems, fire sections with reasonable dimensions must be ensured, depending on the appropriate risk. Spatial separation through construction measures represents a very effective step toward the prevention of the spread of fires to other areas of buildings and systems.

In production companies and in logistics, for example, roller conveyors for goods that run through fire protection walls are also given a closure which closes automatically in the event of a fire. This ensures that the fire resistance class of the penetrated component remains intact.

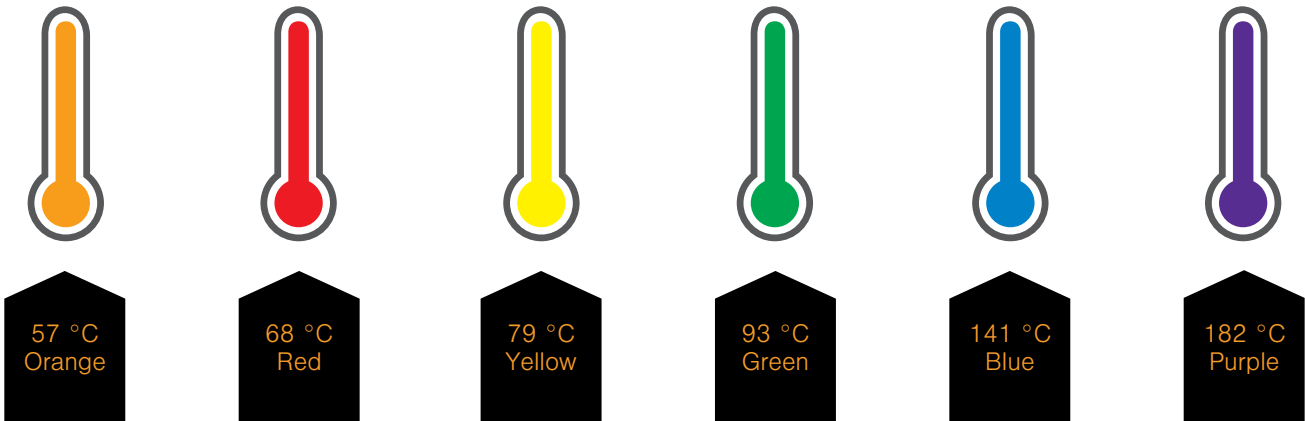
If structural separation is no longer possible, other measures can be used. For example, installations can be safely shielded with plate material or routed in fire protection ducts. Coatings can be applied to supports and can form an insulation layer in the event of a fire. Thus, it is possible to increase the fire resistance capacity of these components.

Roller shutters with fire resistance class as fire protection closure





Triggering of a sprinkler head when a nominal temperature of 68 °C is exceeded on the glass vial



Different trigger temperatures of glass vials on the sprinkler head

1.2.3 A company's organisational 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 a fire occur, in order to minimise the risk to personnel and visitors, who 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.

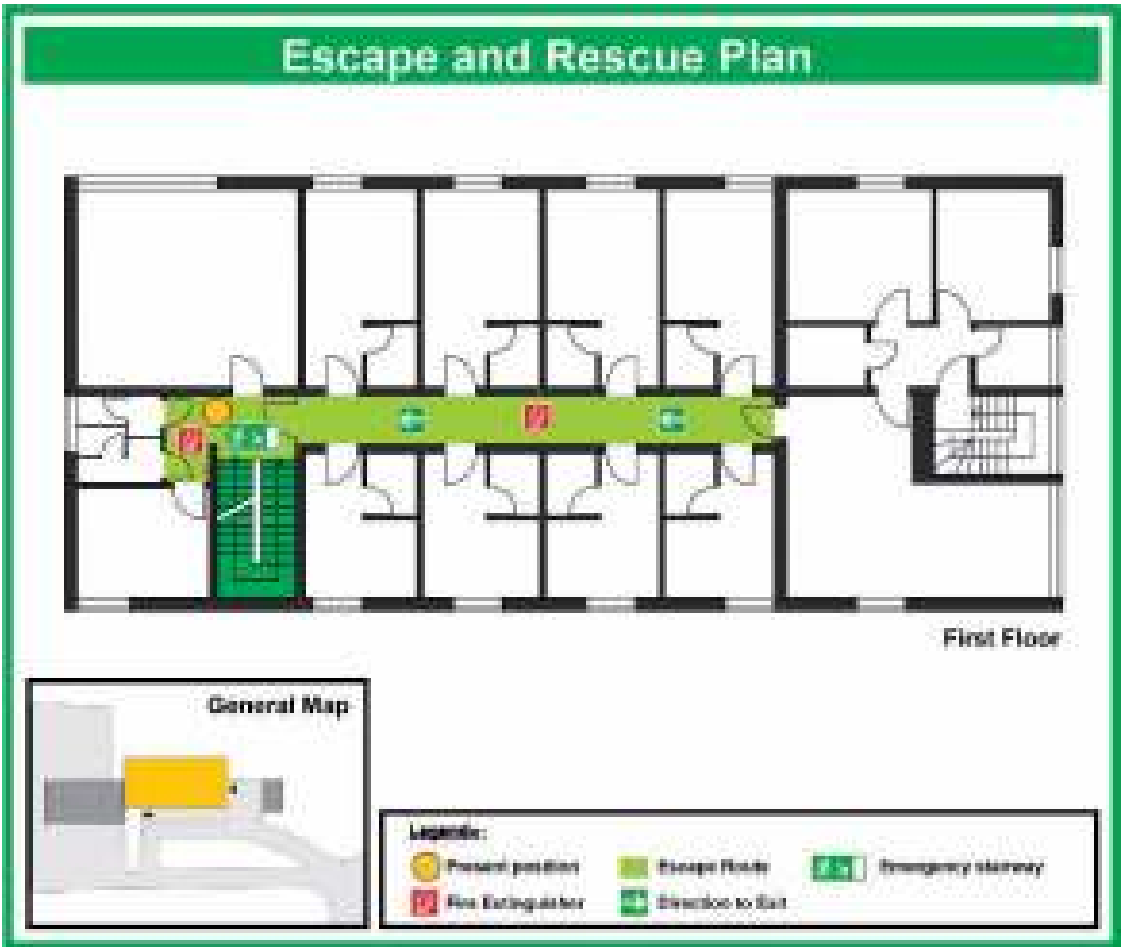
The installation of fire guards can be necessary if maintenance work is carried out on fire protection equipment. A further reason for these could be work posing a fire risk, e.g. welding steel in areas with an increased fire load. This measure, too, belongs to the field of organisational fire protection.

1.2.4 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 are primarily firefighting and technical assistance. The fire brigades can be public or private. Each municipality is obliged to maintain a fire brigade. Companies may have company or plant fire brigades. These usually carry out preventive fire protection within companies.

All four pillars of fire protection 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.



Escape route plan



1.3 Construction products

Construction products consist of substances which must be suitable for long-term use in buildings. Construction types are also created from construction products. Construction types assume an activity for erection. The phrase "construction kits" is used increasingly in Europe. These construction kits, which must consist of at least two construction products, are also permanently installed in buildings and, like construction types, must be continuously suitable.



As already specified in the basic conditions of the German Model Building Regulations, the following points are named under Point 2 - fire protection:

"The structure must be drafted and executed in such a way that, in a fire

- a) The load capacity of the structure remains intact for a specific period of time;
- b) The creation and spread of fire and smoke are limited within the structure;
- c) The spread of fire to neighbouring structures is limited;
- d) The inhabitants of the structure can leave the structure without injury or can be rescued through other measures;
- e) The safety of the rescue teams has been taken into account.

The resulting protection aims are comparable to those stated in German law.



1.3.1 European Construction Parts Regulation

The Construction Parts Regulation (CPR) [5] took effect in the whole of Europe on 1 July 2013 as a directly valid law. It replaced the Construction Parts Directive (CPD). The ordinance specified the trading and putting into circulation of construction products in the European Union and specified the rights and obligations of the affected actors.

Basic requirements for construction products

The regulations specify key characteristics for construction products, which relate to the basic requirements for structures. The key characteristics are:

1. Mechanical resistance and stability
2. Fire protection
3. Hygiene, health and environment
4. Safety and accessibility during use
5. Noise protection
6. Energy savings and heat protection
7. Sustainable use of natural resources

CE labelling and declaration of performance

According to the construction parts regulations, products installed in structures must perform according to the key characteristics. For example, fire protection products must have fire resistance classes and have a specific behaviour in the event of a fire. If the products fulfil these requirements, then they will receive the CE mark. The CE mark is essentially the "passport" for the construction product throughout the whole of Europe. It may be traded and installed in every member country of the European Union. Besides marking, the manufacturers are obliged to provide a DOP (declaration of performance) for the product. The declaration of performance helps the technical planner in their selection of the suitable approved products for their applications and fire protection requirements.



1.3.2 Tests, approvals and standards

However, before a construction product can be given the CE mark, it must provide proof of the required performance. This is tested in the known fire tests according to the relevant standards EN 1363 [6] and EN 1366 [7] and classified according to EN 13501 [8].

Note:

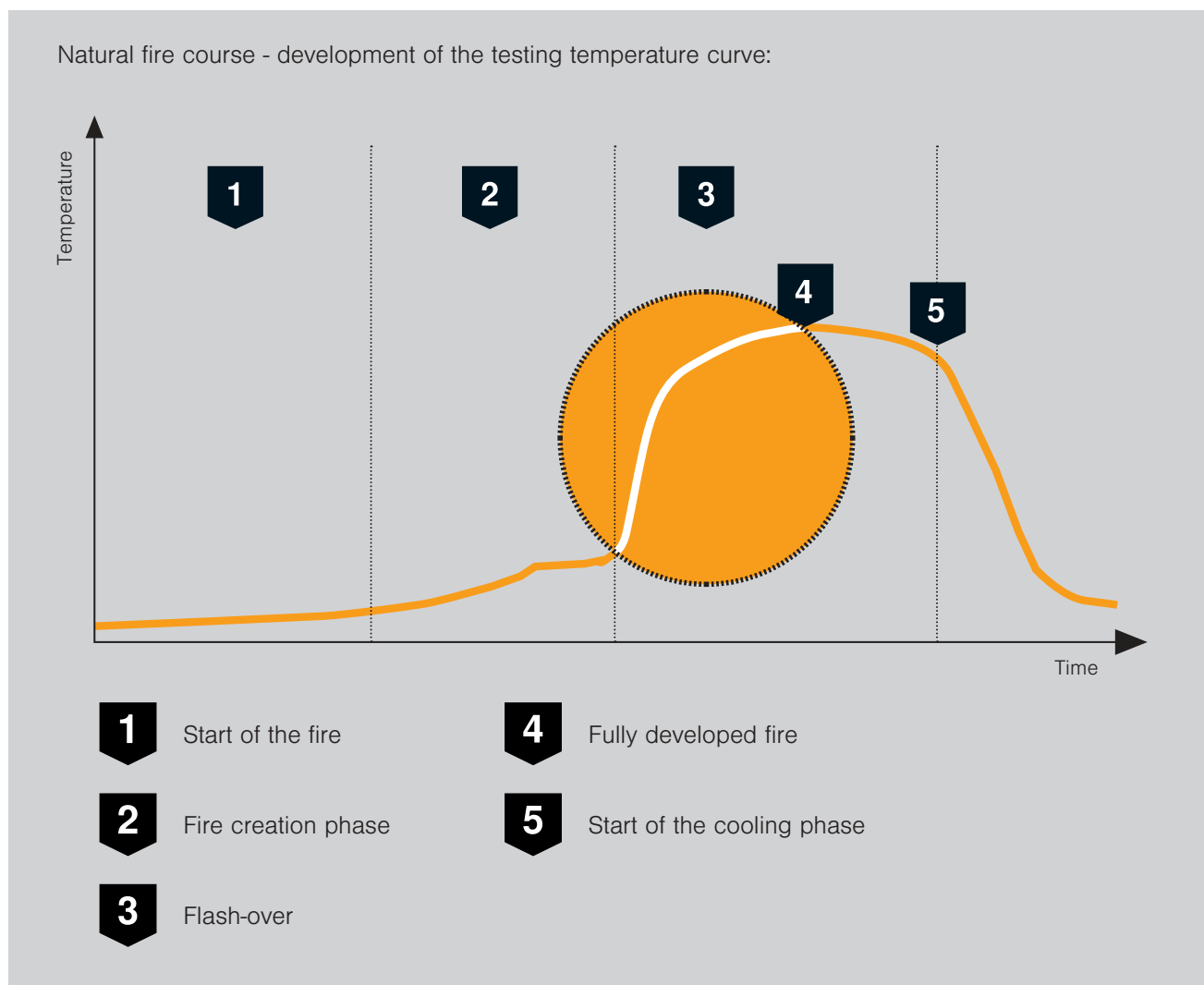
Construction products tested according to national standards, e.g. DIN, NEN, BS, do not receive a CE symbol!

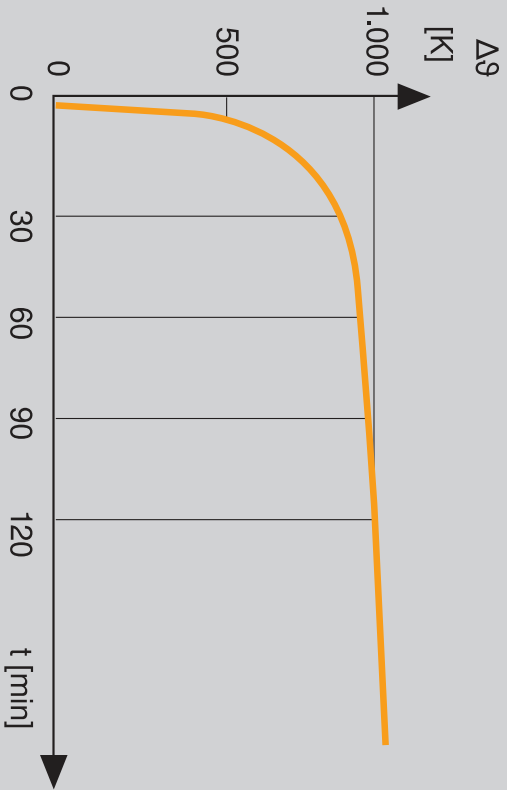
Comparison of fire curves

Fire tests are carried out at the materials testing institutes to compare the performance of the fire protection products and systems. To achieve comparable results, a temperature-time curve is used, which is internationally standardised according to ISO 834-1 [9] and used around the world for fire tests. It is also termed the standard temperature-time curve (ETK).

The systems are tested in special testing furnaces, in which the sample installation on test is heated up according to the standard temperature-time curve. It forms the so-called "flash-over", which is the most critical phase of a fire. After the smouldering fire phase, all the combustible gases located in the fire chamber ignite suddenly, meaning that the temperature rises very quickly. A solid matter fire is simulated. The installed installations must withstand this full fire. Depending on the required classification, the test lasts between 15 and 120 minutes, usually in 15-minute steps.

Besides the standard temperature-time curve, there are various other fire course curves, e.g. for the simulation of tunnel or liquid fires. Construction products and their construction types are tested according to the STC, as solid matter fires can usually be assumed in normal buildings.

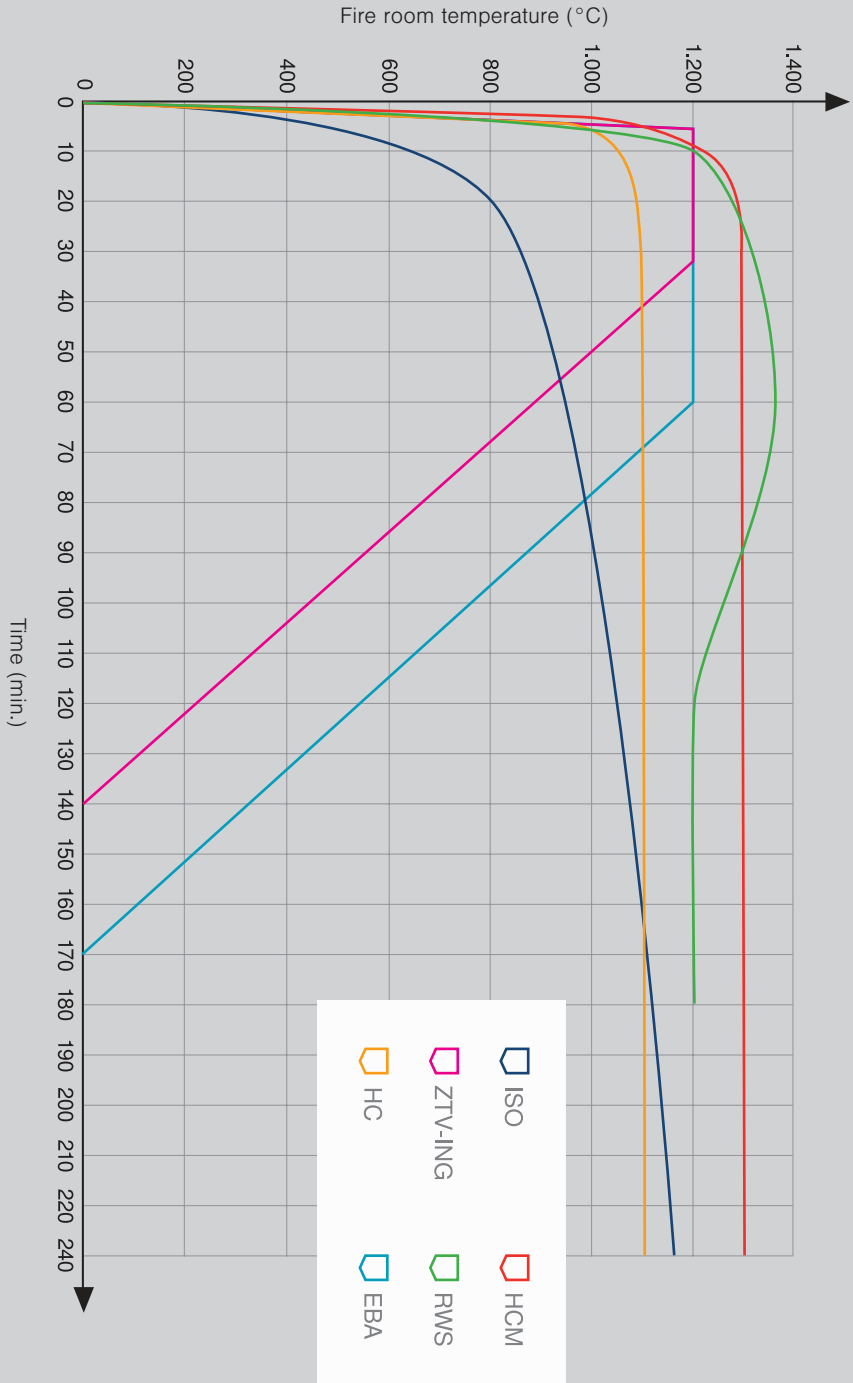




t	$\Delta\theta$
5	556
10	658
20	761
30	822
60	925
90	986
120	1.029

t: Time in minutes
 $\Delta\theta$: Temperature increase in Kelvin

Standard temperature-time curve (ETK) according to ISO 834-1 and DIN 4102 Part 2 [10]



Different fire course curves for testing purposes [11]

Comparison of classifications

After successfully passed tests, they are documented by the testing institutes and the systems classified according to the results of EN 13501. In most European countries, the European classification reports can be used as a proof of suitability in conjunction with the manufacturer's mounting instructions.

However, some countries demand further approval documents. 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). Materials are classified according to Table 3 in accordance with their fire behaviour.

The abbreviations s (= Smoke) and d (= Droplets) stand for the smoke development and the drip behaviour of the substance. For example, s1 = low smoke development and d0 = No burning drips of the material during defined testing time periods.

The properties and thus the performance of the construction product in the event of a fire is classified according to EN 13501-2 [12]. These values are reflected in the labelling of the construction products and must be named in the manufacturer's performance declaration.

Construction requirements	Additional requirement No smoke	Additional requirement No falling or dripping of burning material	European classes according to DIN EN 13501-1	Class according to DIN 4102-1
Non-combustible	X	X	A1	A1 A2
- Minimum	X	X	A2 - s1 d0	A1 A2
Hardly flammable	X	X	B, C - s1 d0	B1
Hardly flammable		X	A2 - s2 d0 A2, B, C - s3 d0	B1
Hardly flammable	X		A2 - s1 d1 A2, B, C - s1 d2	B1
- Minimum			A2, B, C - s3 d2	B1
Normally flammable		X	D - s1 d0 - s2 d0 - s3 d0 E	B2
- Minimum			E - d2	B2
Easily flammable			F	B3

Table 3: Construction material classes according to EN 13501-1 [13]

Proofs of application

Construction products to be installed in structures must possess a technical proof according to the construction products regulations, which confirms their suitability for the appropriate purpose. Here, the European regulation requires a European Technical Assessment (ETA for short). Systems tested according to national standards cannot receive an ETA.

The abbreviations after EN do not name the component but the properties!

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	Maintenance of electrical function (power)	Cable systems
15, 20...120	Fire resistance period in minutes	
Indices		
V _e h _o	Vertical/horizontal installation possible	Ventilation flaps, installation ducts
- S	Limitation of the smoke leakage rate	Doors, ventilation flaps
i → o i ← o i ↔ o	Impact direction of the fire resistance duration (inside/outside)	Ventilation flaps, installation ducts
U/U U/C C/U	Closing of pipe ends (uncapped/capped)	Pipe insulation

Table 4: Fire protection classifications and abbreviations according to EN 13501-2

Installation	Classification to EN 13501	Classification to DIN 4102
Cable/combination insulation	EI 90	S 90
Pipe insulation	EI 90 U/U	R 90
Installation ducts	EI 90 (v _e h _o i ↔ o)	I 90
Maintenance of electrical function	P 90	E 90

Table 5: Comparison of the labels according to EN and DIN (Examples)

1.4 Fire protection concepts

When planning a building project, it is important to establish 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.

In Germany, a fire protection concept is required for the issuing of a construction approval for special structures.

Economic aspects

It is wise to combine the maximum of risk reduction with the minimum of financial cost. For example, 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.

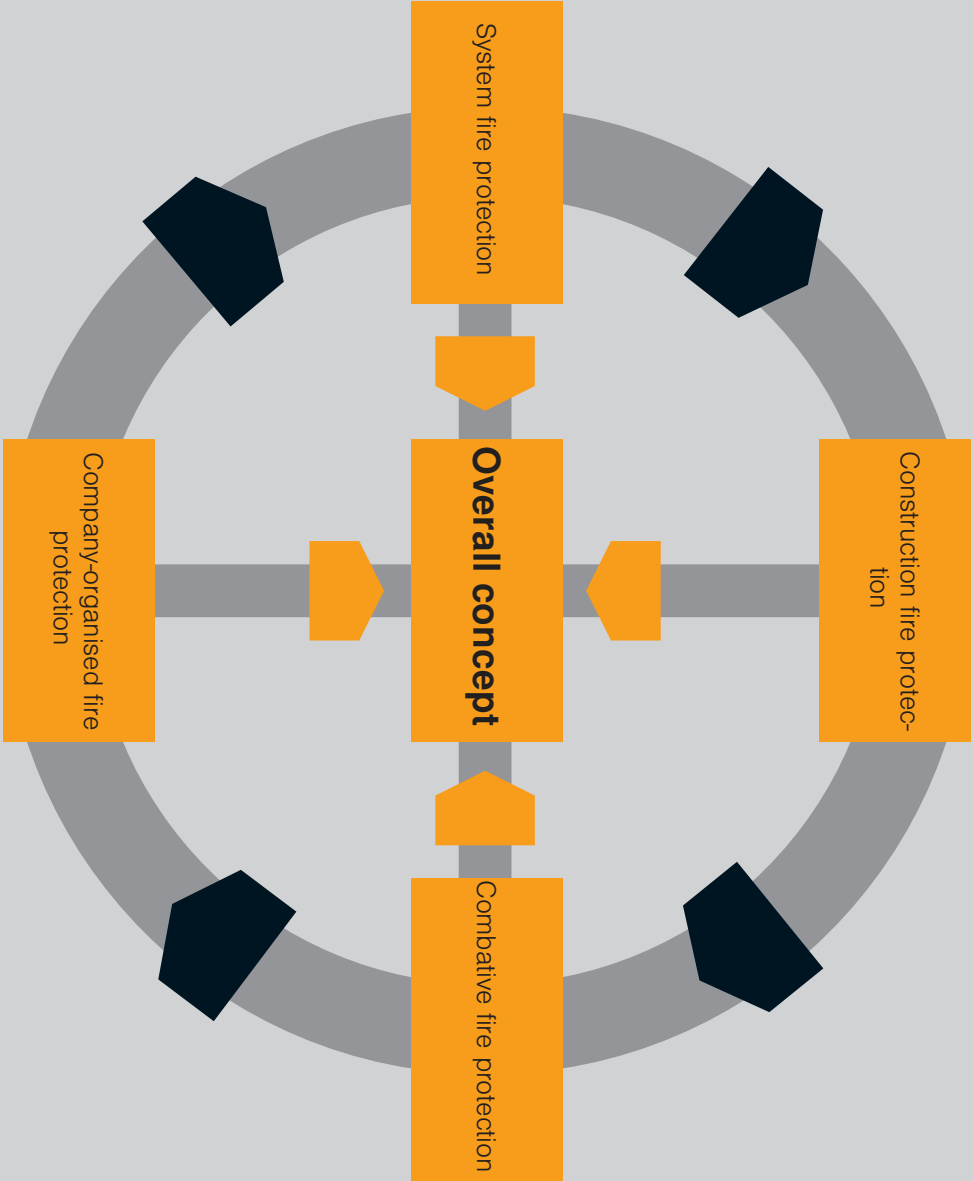
1.4.1 Planning and contents

Fire protection concepts are used to view a building in its entirety and to record all the risks and dangers. The protection aims for the building are derived from these definitions. The consequence: Definition of 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.

1.4.2 Handling deviations and compensations

The proofs of suitability, in conjunction with the declarations of performance, help clients and planners in selecting the approved construction products and systems for new buildings. The construction law regulations are tailor-made for this. If planned correctly, the construction product with the required capability should be installed. Should, during mounting, the erection engineer keep to the mounting instructions and the manufacturer's specifications, the described performance is reached without deviations. Building work can take place according to the approval.

The situation is different in existing buildings: Due to the structural situation, it is often not possible to install available fire protection systems according to the approval. Here, the planner must define which protection aim they wish to achieve with the measure. Deviations from valid construction regulations or proofs of suitability are then documented in the fire protection concept. Measures defined to compensate for deviations and to achieve the protection aim are also a component part of the fire protection concept and also of the construction approval.



Interaction of all fire protection measures in a fire protection concept



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Firewalls prevent the spread of fire

2 Maintenance of the fire sections – protection aim 1

The construction limitation of the fire to specific sections, so-called fire sections, means that the remaining building sections are protected from fire for a specific period of time. The fire brigades can secure further building sections through extinguishing measures. This helps to protect people and property.

In particular, insulation helps to maintain the fire sections, thus limiting the spread of fire and smoke.

2.1 Separating components - firewalls

Function of firewalls

Fire sections are created with firewalls. They are made of non-combustible substances and should ensure that a fire cannot pass to neighbouring buildings or building sections. The construction design of these firewalls - materials, fire resistance classes, stress values - is regulated by the appropriate building regulations and standards.

2.2 Requirements for cable penetrations - insulation

Electrical cables and pipes may only be run through walls and ceilings at the ends of rooms, although there must be no opportunity for fire and smoke to spread. This requirement is fulfilled by insulation systems. These permit the reliable sealing of the ceiling and wall penetrations required for installations against fire and smoke.

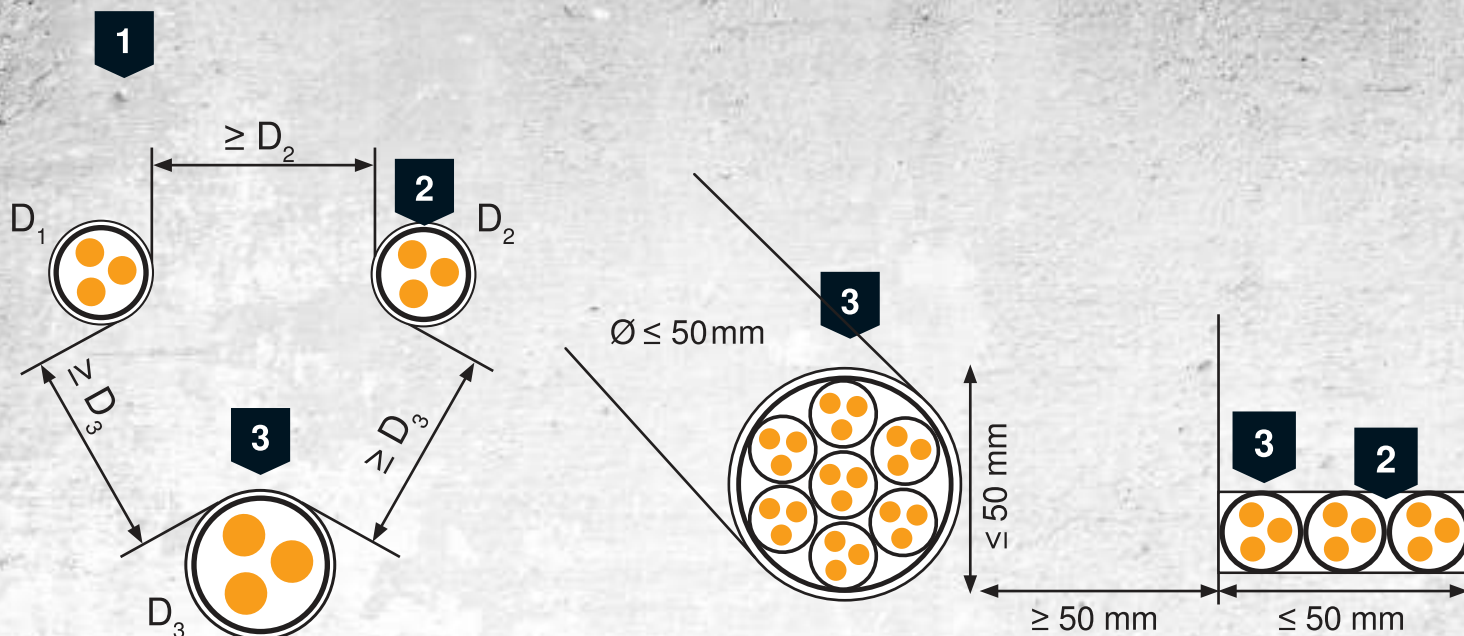
Special requirements

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 must not heat up strongly to an impermissible level.



Ceiling and wall penetrations can be sealed reliably against fire and smoke



1 Construction part (e.g. concrete, masonry)

2 Fire protection compound or mineral substance

3 Cable of various diameters

2.2.1 Spacing regulations

If only individual cables or small cable bundles are run through fire-resistant components, they can be routed through individual holes with an appropriate spacing. The individual holes must be closed off with mineral substances or substances which foam up in a fire. In so doing, the greatest diameter defines the distance to the smaller cables. The risk of fire spreading does not increase. Individual cables without a diameter limit are permitted without insulation - a ring gap closure around the cable is sufficient.

2.2.2 Exceptions regarding fire-resistant walls

In fire-resistant walls (30 minutes of fire resistance), it is possible to close off openings, through which cables are passed, with mineral wool (melting point $> 1,000 \text{ }^{\circ}\text{C}$). Filling with mineral substances or substances forming an insulation layer ensures smoke protection.



2.3 Proofs of usability

The effect or application of insulation systems required by law must be proven through tests. These fire tests are carried out by official materials testing institutes or accredited testing institutes all over the world on the basis of testing standards. The fire tests are the basis of the approval as a construction product that can be used as an insulation system. Besides the testing norm EN 1366 "Fire resistance tests for installations, Part 3 – Insulation", introduced in Europe in 2009, there are additional, internationally recognised standards, according to which such systems are tested and approved. The insulation tested according to ANSI/UL1479 [14] is accepted in many parts of the world, particularly in the USA and Canada.

Currently, various documents are valid proofs of usability: like national proof documents such as the German "General construction approval" according to DIN 4102 Part 9 [15] or approval documents of the Association of Cantonal Fire Insurers VKF in Switzerland. In addition, in the coming years, the European Technical Approvals (ETA), based on EN tests, will increasingly replace national approvals. Systems tested according to the European standard EN 1366-3 can be used in all member states, whose standardisation organisations are a part of the European Committee for Standardisation, CEN. The insulation systems can also be used in other countries accepting this standard.

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. EI 90 or F/T rating)
- General installation conditions (e.g. installation in concrete walls, etc.)
- Maximum insulation dimensions
- Minimum cable insulation thickness
- Minimum ceiling/wall thickness
- Materials to be used to create the insulation
- Approved installations (e.g. cables or cable support systems, pipes)
- Sequence and type of installation
- Execution of a retrofit installation
- Data on the manufacturer's duty to train people who create the insulation





Fire test on mortar insulation



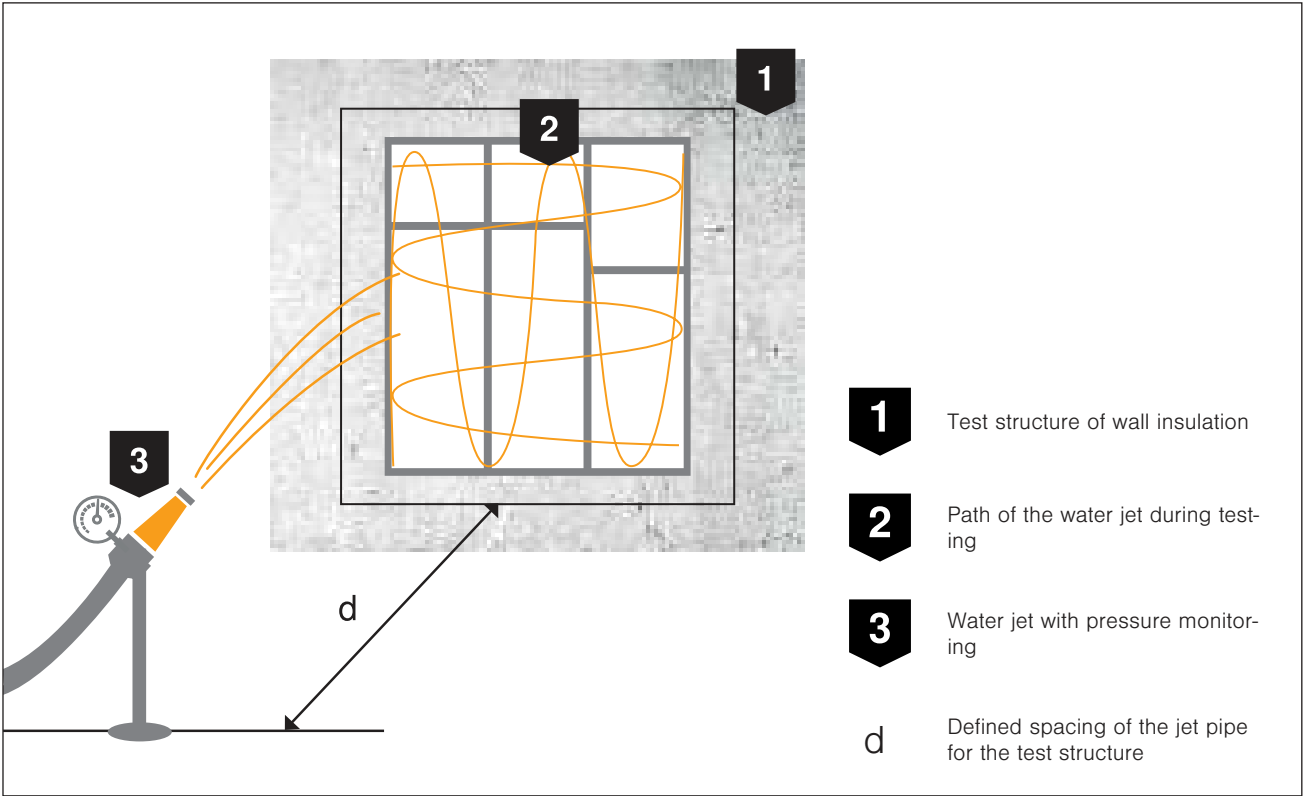
2.3.1 Tests

The testing of the insulation takes place in special test furnaces, in which the sample installations to be tested are heated up according to a standard temperature-time curve. This curve is internationally standardised according to ISO 834-1 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 fire phase, all the combustible gases located in the fire chamber ignite suddenly, meaning that the temperature rises very quickly.

The installed installations must withstand this full fire. Depending on the required classification, the test will last between 15 and 120 minutes, usually divided into 15-minute steps. In particular, the following are tested:

- Whether the escape of fire and smoke is prevented from the fire area,
- and whether the surface temperature on the side of the insulation away from the fire does not rise by more than 180° Kelvin above the starting temperature.

This test always takes place under the worst possible installation conditions (e.g. lowest insulation thickness, largest insulation height or width). In addition to the temperature, the pressure conditions in the furnace are specified according to the standard.



Hose stream test

Systems tested according to ANSI (American National Standards Institute)/UL1479 (Underwriters Laboratories) possess a special feature: During testing, a water jet test (the "Hose Stream Test") is carried out, during which a high-pressure water jet is pointed at the insulation. This situation is comparable to an extinguishing attack by the fire brigade. The insulation must not be destroyed by the water jet and must not lose its room-closing function.

2.3.2 Classifications and certificates

After successfully passed tests, the results are documented by the testing institutes and the systems are

classified, e.g. according to the results of EN 13501. In most European countries, this classification report can be used as a proof of suitability 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). Classifications according to UL (Underwriters Laboratories) deviate from this. The following table provides an overview of the possible classifications of insulation systems.

Classification to (examples):

Fire resistance in minutes	DIN 4102-9	EN 13501-2 End of room	EN 13501-2 Insulation	EN 13501-2 Combination	UL Temperature	UL End of room
≥ 30	S 30	E 30	I 30	EI 30	T ½ hr	F ½ hr
≥ 60	S 60	E 60	I 60	EI 60	T 1 hr	F 1 hr
≥ 90	S 90	E 90	I 90	EI 90	T 1½ hr	F 1½ hr
≥ 120	S 120	E 120	I 120	EI 120	T 2 hr	F 2 hr

Table 6: Fire resistance classes and their abbreviations

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 builder 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

The labelling is necessary, on the one hand, to prove that an approved valid insulation system was used. On the other hand, it is used to identify the system for any later installations. The systems were constructed and tested using different materials and can prove the function of these special material combinations. If combined with other components which do not belong to the system, then this can have a negative impact on behaviour if there is a fire. This must be avoided. The requirement of the approval offices for user training courses is derived from this. The users should know the basic principles of construction law and be fully able to handle the insulation materials.



Identification plate for insulation

2.3.4 Documentation

According to the proof of usability, 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. In future, digital applications will almost certainly replace documentation in paper form.

2.4 Construction types of cable and combination insulation

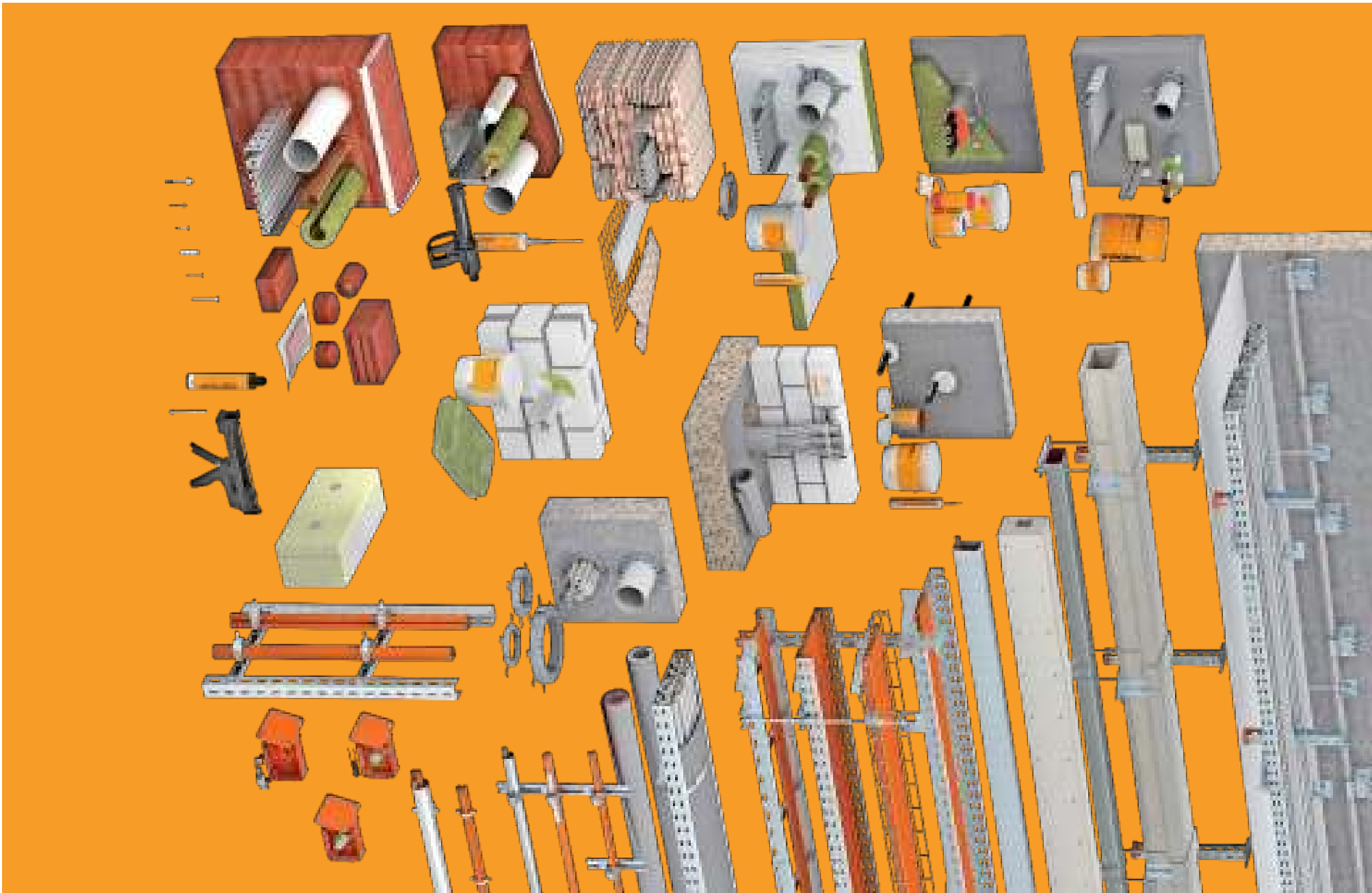
Various components require appropriately suitable insulation measures. The selection of the matching insulation system is dependent on various parameters. The application options range from solid walls and ceilings made of masonry and concrete through to dry-construction partitions. The installations 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 pressure resistances. 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 and UL (Underwriters Laboratories) is growing.

Typical insulation systems consist of:

Mortar, mineral fibre plates with coating, fire protection foam, single-component compounds, foams and fittings, boxes, silicones and special rubbery modules.

All the systems possess special fire protection components and additives, which fulfil a safe function in the event of a fire in accordance with the testing standard.





2.4.1 PYROMIX® mortar insulation system

The PYROMIX® system from OBO is used to create cable and combination insulation made of a mineral fibre-free special mortar. Depending on the amount of water added, the finished compound can be applied to openings by hand, with pumps or with presses. The

high level of substrate adhesion makes lining unnecessary for small insulation areas. The porous consistency of the mortar means that reinstallation is easy. If there is a fire, the fire protection mortar reliably prevents the spread of fire and smoke.



2.4.2 PYROPLATE® Fibre mineral fibre insulation system

The PYROPLATE® Fibre system from OBO is used to create cable and combination insulation. The core of the system is the mineral fibre plate coated with a moisture-resistant ablation coating. When there is a fire, the fire protection coating creates an insulating carbon foam and, in combination with the mineral fibre plate, prevents the spread of fire and smoke. Ac-

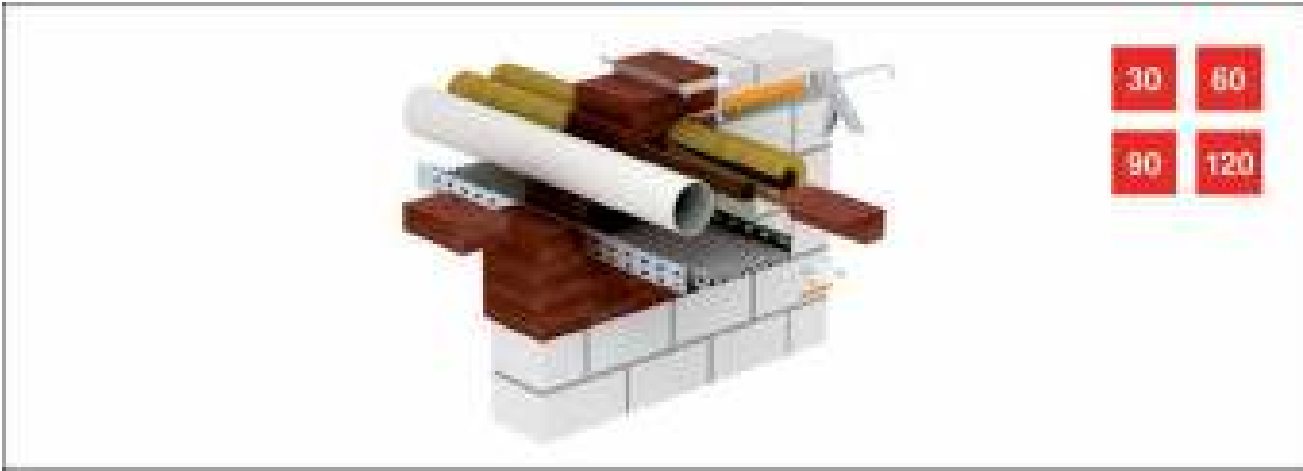
cording to the construction approval, in addition to the cables, pipes made of steel, copper or various plastics may also be run through the same insulation. For pipelines, additional fire protection measures, such as section insulation and pipe sleeves, are required. The mortar or soft insulation made of PYROPLATE® Fibre is a combination insulation which is appropriate for diverse structures.



2.4.3 PYROSIT® NG fire protection foam

The PYROPLATE® NG system from OBO is used to create cable and combination insulation made of fire protection foam. The special recipe of the 2-component foam allows simple, "pinpointed" processing. The good substrate adhesion prevents the foam from running out of the opening. Work can easily be interrupted to carry out checks. The system can be installed without dust and fibres. Surface coating is not neces-

sary. According to the construction approval, in addition to the cables, pipes made of steel, copper or various plastics may also be run through the same insulation. The PYROSIT® NG insulation is suitable as combination insulation for different units. Due to the soft consistency, the insulation made of PYROSIT® NG can be reassigned simply. The insulation system can be combined with the PYROPLUG® Block foam block.



2.4.4 PYROPLUG® foams
PYROPLUG® Block foam blocks

The PYROPLUG® Block system from OBO is used to create cable and combination insulation from fire protection foam blocks. If there is a fire, the foam blocks expand without any significant pressure build-up, creating an insulating plastic foam. This prevents reliably the penetration of fire and smoke through the insulation. According to the construction approval, in addition to the cables, combustible pipes without a pipe sleeve and pipes made of steel and copper, with and without section insulation, may be run through the

same insulation. If the component opening is only accessible from one side, e.g. in a shaft, then all the measures to close off the opening can take place from one side. The PYROPLUG® Block insulation is completely dust- and fibre-free. Necessary retroinstallations can be created simply and without a great deal of dust formation, which is important, for example, in IT and laboratory rooms. According to ETA, the insulation system can be combined with the PYROSIT® NG fire protection foam.



PYROPLUG® Peg foam plugs

The PYROPLUG® Peg system from OBO is used to create cable insulation with fire protection foam plugs. The foam plugs are ideal for closing core drill holes in solid walls and concrete ceilings. The foam plugs are made of permanently elastic, closed-pore foam, which expands in the event of a fire without any significant pressure build-up, thus creating an insulating plastic foam. This reliably prevents the penetration of fire and

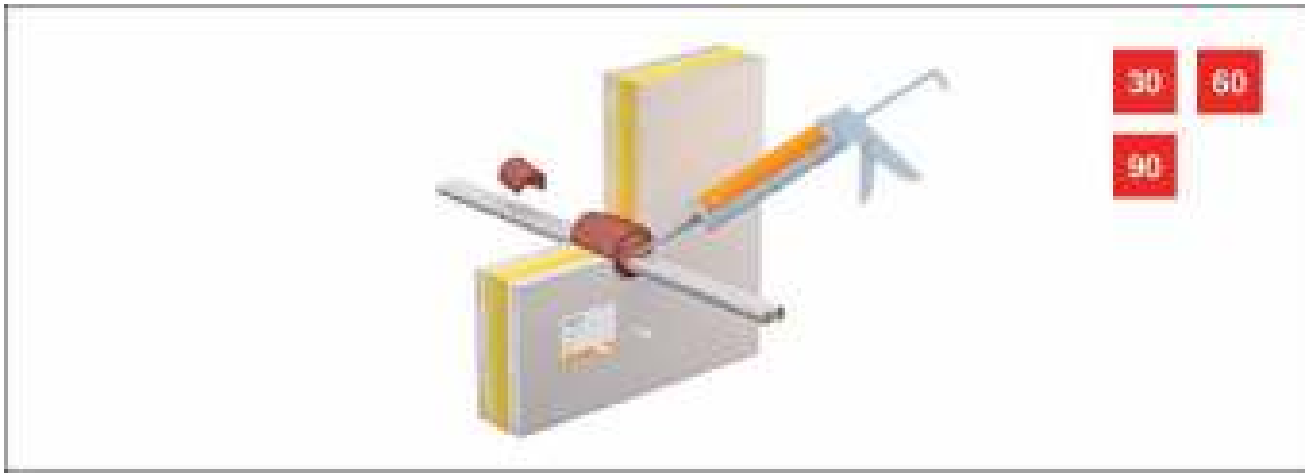
smoke through the cable insulation. The PYROPLUG® Peg insulation system can be used without difficulty in areas of data processing and in laboratories, as mounting is completely clean and is free of dust and fibres. This also applies to any necessary cable installations at a later date. Special tools are not required for processing, a knife is sufficient.



Boxes made of PYROPLUG® Box foam

The PYROPLUG® Box system from OBO is used to create cable insulation with boxes made of foam. The system is particularly suitable for simple mounting of cable insulation in lightweight partitions. No layering is required. Installation in solid walls and solid ceilings is also possible and approved. The insulation system consists of a two-part frame and two matching internal pieces. The permanently elastic, closed-pore foam

material expands in the event of fire without any significant pressure build-up, thus creating an insulating plastic foam. This reliably prevents the penetration of fire and smoke through the cable insulation. The usable area of the boxes corresponds to the maximum approval cable assignment area of 60%. It is thus impossible to over assign it with cables.



Mini pipe shell for PYROPLUG® Shell box drill holes

The OBO PYROPLUG® Shell system is specially designed for cable insulation in box drill holes in light-duty partitions. The insulation system consists of a pipe shell and two matching plugs. The material is made of permanently elastic, closed-pore foam, which expands in case of fire without any significant pres-

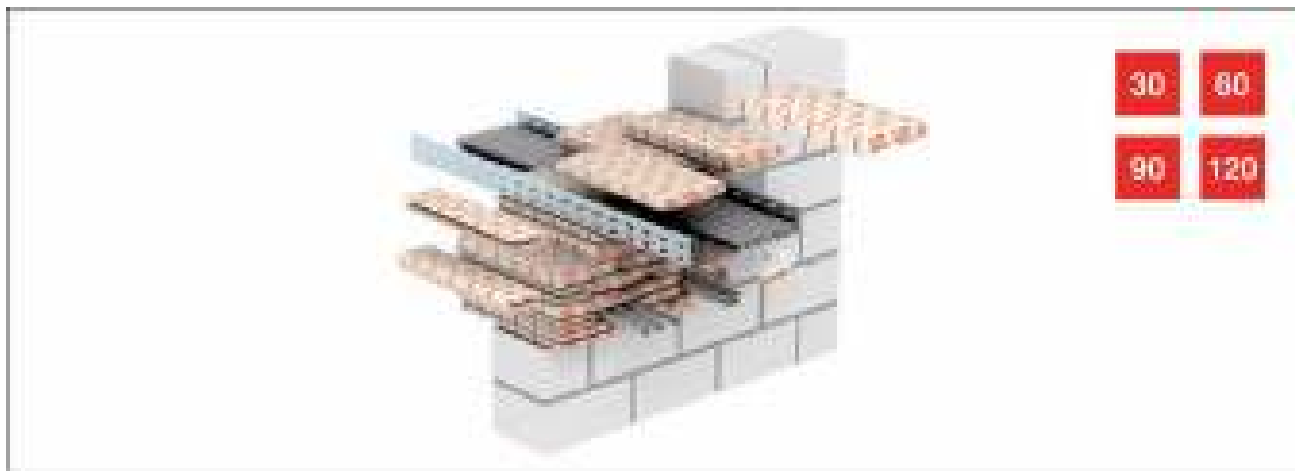
sure build-up, thus creating an insulating plastic foam. This reliably prevents the penetration of fire and smoke through the cable insulation. The ratio of the external diameter to the internal diameter of the pipe shell ensures that over assignment with cables is not possible, even at full assignment.



PYROPLUG® Mini filler

The OBO PYROPLUG® Mini system is ideal for small, round cable insulations up to a diameter of 8 cm. It only consists of the one-component filler PYROPLUG® Screed. In light-duty partitions, the empty mini pipe

shell of the PYROPLUG® Shell system is used as layering. The interior of these pipe shells may be completely assigned. Only the residual joints must be filled with the filler.



2.4.5 PYROBAG® cushion insulation

The PYROBAG® system from OBO is used to create cable insulation from fire protection cushions. The fire protection cushions, which can be shaped in any way, are stacked simply and quickly on top of each other, allowing absolutely tidy and dust-free mounting. The cushions can be used for permanent or temporary insulation in walls and ceilings, e.g. during renovations. The fire protection cushions are an ideal solution for

frequent retroinstallations. Additional cables can be installed quickly, neatly and economically at a later date because the cushions can be used several times over. The cushions consist of a close-knit, dense and mechanically solid glass fabric with a special filling. The shell and the filling are free of mineral fibres and are also weatherproof and waterproof. Neither painting nor the use of filler are required.



2.4.6 PYROCOMB® Tubes pipe sleeve

The PYROCOMB® Tubes system is used to create cable insulation with pipe sleeves. The system comprises multiple sizes of the pipe sleeve, type TCX. This allows simple insulation of bundles of plastic electrical installation pipes, rigid or flexible, up to a size of M63. It is irrelevant whether the pipes are filled with cables

or are empty. In a fire, the fire protection material inserted within the seal foams up after a few minutes under high pressure, closing the softened bundles at a high pressure. This safely prevents the spread of fire and smoke, should a fire occur.



2.4.7 PYROCOMB® pipe sleeve

The PYROCOMB® system can be used as independent pipe sealing for combustible pipes (e.g. sanitary wastewater pipes). It is primarily made up of the pipe sleeves, type TCX. In a fire, the fire protection material inserted within the seal foams up after a few minutes under high pressure, closing the soft plastic pipes. This prevents the spread of fire and smoke safely,

should a fire occur. With wall mounting, the pipe sleeves are mounted on both sides of the wall with metal anchors. Ceiling penetrations only have a tube seal from the underside. In light-duty partitions, the pipe sleeves are fastened on passed-through threaded rods and connected together.



2.4.8 PYROCOMB® Intube pipe shell

The PYROCOMB® Intube system is used to create cable insulation with pipe shells or half shells. The pipe shell is particularly suitable for core drill holes and can very easily be installed in solid ceilings or walls and also light-duty partitions. For this, two half pipe sleeves are clicked together and bedded in mortar in the core hole. Then the pipe sleeves are closed with seals and the surface is sealed with ASX ablation coating. The cables do not require any coating. The

half shell can be used particularly well in the under-floor area. It is sealed on one side with fire protection plugs and sealed with ASX ablation coating. In a fire, the inner coating of the pipe shells or the half shell expands and, in so doing, closes the opening cross-section completely. The transfer of fire and smoke is thus safely prevented. With the PYROCOMB® Intube system, 100% assignment of the interior is possible.



2.4.9 Conlit® fire protection bandage

The Conlit® system, consisting of the fire protection bandage, type CL-KS, is used within buildings as cable insulation for individual cables, cable and electrical installation pipe bundles (EIP). The flexible bandage is simply laid around the installations and fixed with a wire. Cable bundles and rigid EIPs must be wound with at least 2 layers of the bandage and flexi-

ble EIPs with at least 3 layers. In a fire, the material foams up and closes the opening cross-section. The fire protection bandage is suitable for cable and electrical installation pipe bundles up to 100 mm diameter. For many insulated pipes, no separation distance between cables is required. The system insulates fire sections for a period of max. 90 minutes.



2.4.10 Small insulation PYROMIX Screed®

Small insulation for cables is created using the PYROMIX® Screed system. It consists of OBO's insulation forming material, type DSX, and the MIW mineral wool. As the insulation basis, the opening is first filled using the non-combustible mineral wool (melting point $\geq 1,000$ °C). Then, both sides of the opening

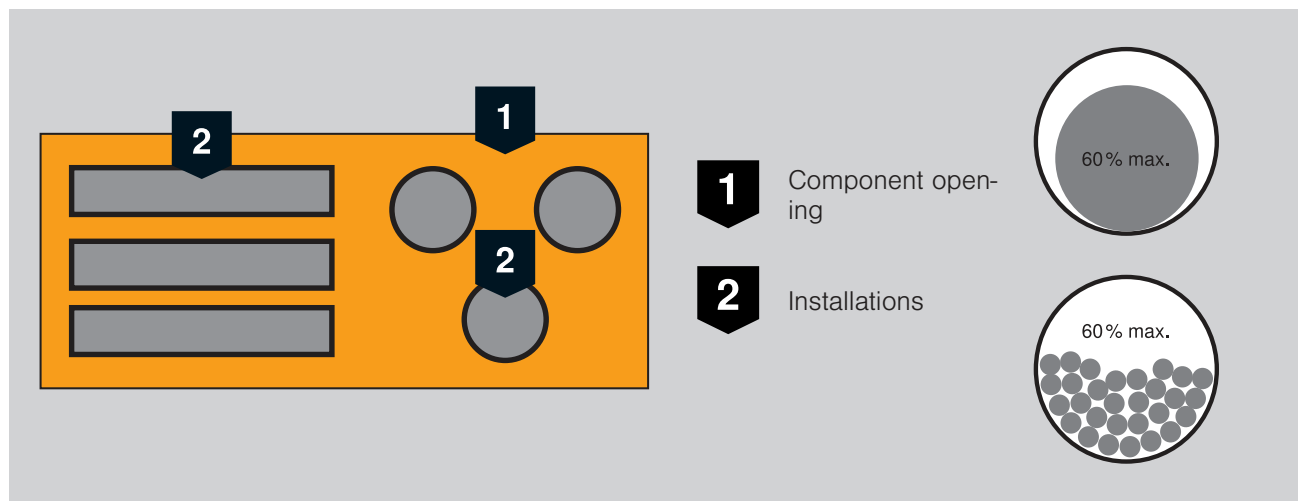
are sealed with the DSX insulation creator. If there is a fire, the filler foams up, preventing penetration by fire and smoke. When the material foams up, heat is also drawn from the cables, thus considerably reducing the transfer of heat via the copper cores.



2.4.11 DSX insulation forming material

The type DSX insulation forming material from OBO can be used to fill ring gaps around individual cables or multiple cables of a small cross-section routed alongside one another. The ring gap around the cable must be filled with fire protection filler along the entire

wall thickness. If there is a fire, the filler foams up, preventing penetration by fire and smoke. When the material foams up, heat is also drawn from the cables, thus considerably reducing the transfer of heat via the copper cores.



A maximum of 60% of the area may be assigned with cables, support systems, pipes, etc.

2.5 Types of application and special applications

The testing standards for insulation systems define the standard application in walls and ceilings. In most cases, the possible installations, electrical and sanitary, are covered by the specifications of the standard. However, today, no two buildings are alike, meaning that applications may occur which are not defined by the standard. Such deviations from the standard 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.

2.5.1 Assignment rule

Classic insulation is created according to the so-called 60% assignment rule. This means, from the component opening through which the installations run, a maximum of 60% of the area may be assigned with cables, support systems, pipes, etc. The remaining area, the remaining 40%, must be filled with fire protection material which is "active" in case of fire or be closed off. In this case, "active" does not mean that the material must react chemically. It must only ensure that the heat transmission via the media and the transmission of fire and smoke are prevented. This can take place through chemical reactions, but also through good acceptance of the heat energy and the resulting cooling effect.



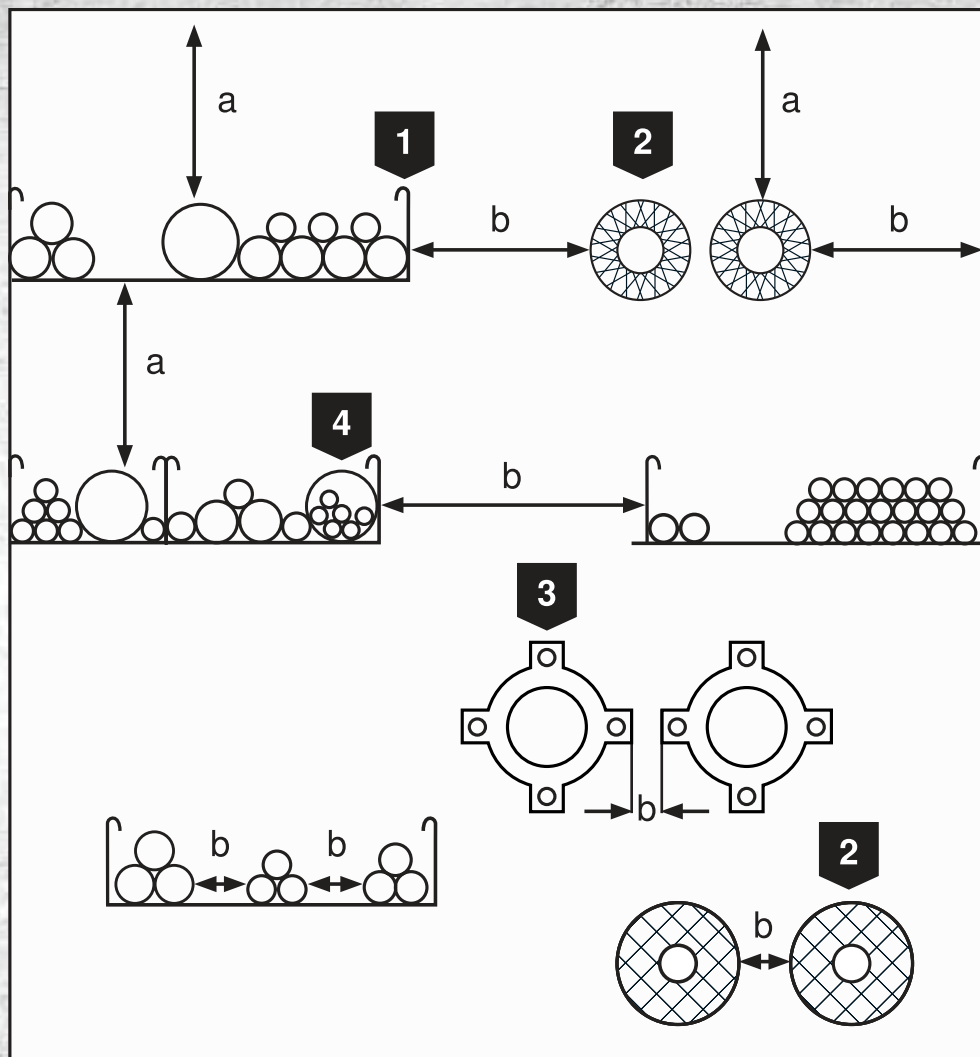
Some systems can be "fully" assigned. However, they must be tested and approved for this application.

Cable		Ducts made of plastic or metal	
Cable bundle		Metal pipes with insulation	
Fibre-optic cables		Plastic pipes for wastewater	
Hollow shaft conductor		Drink hoses	
Plastic electrical pipes		Speedpipes for fibre-optic cables	
Bundle of plastic electrical pipes		Air-conditioning unit connection cables	
Steel electrical pipes		Solarthermal cables	
Cable support systems		Hydraulic hoses	

2.5.2 Installations

All the insulation systems are tested with various specified installations, in order to cover different application areas. There are pure cable insulations which can be mounted by any electrical installation engineer, but there are also so-called combination insulations. Plastic and metal sanitary pipes can be run through these together with electrical cables.

In addition, some insulation has been tested for special cables, e.g. hollow shaft cables or bundled pipes (speedpipes). The approved installations differ from system to system.

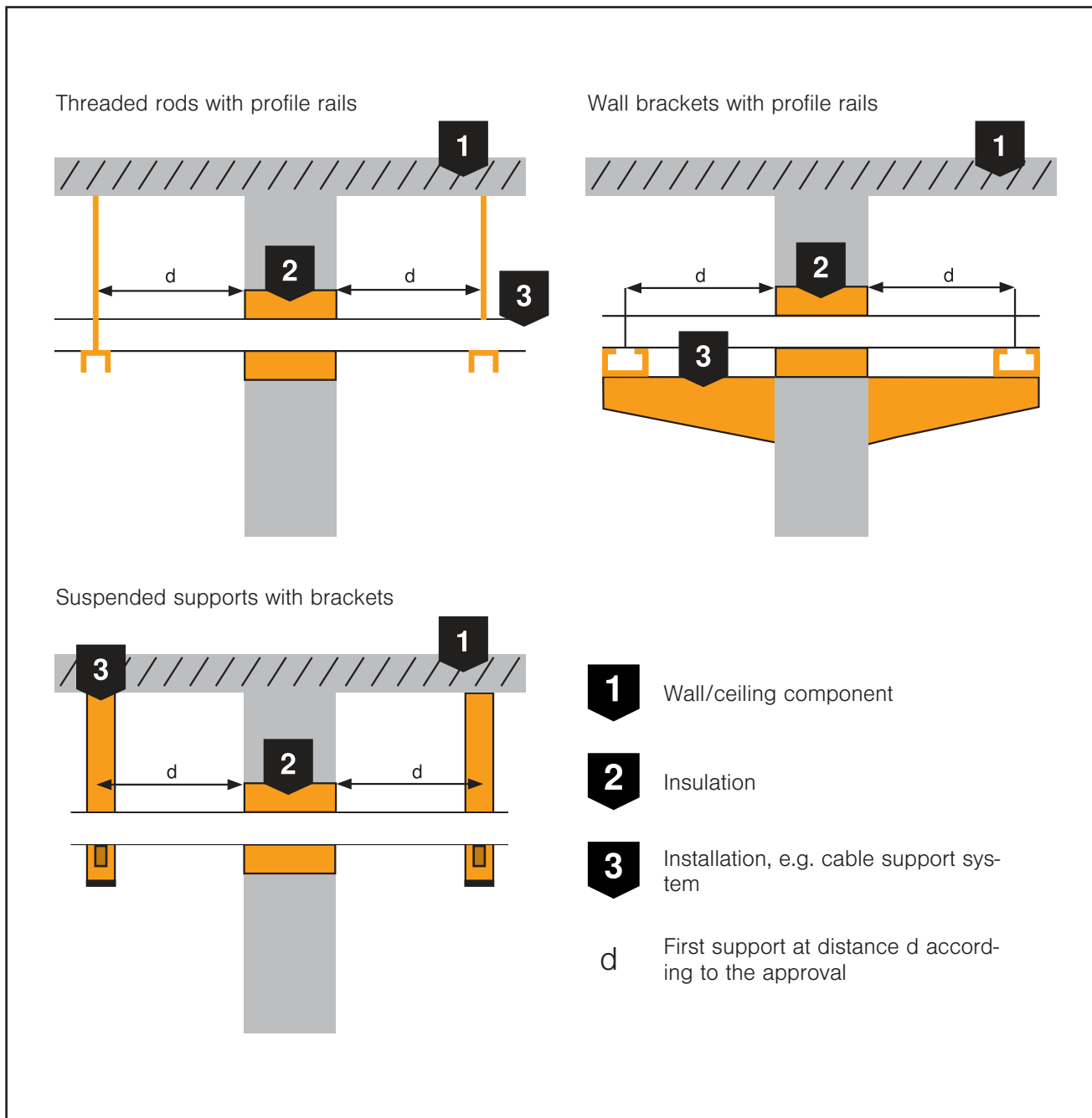


Spacings between the installations and to the component

2.5.3 Distances and support measures

Besides the possible installations, the proofs of suitability of the insulation systems also describe the requirements for how the installations should be arranged. Working spaces must be maintained which are the result of the arrangement of cable support systems to pipes and further installations during testing. This ensures that the passed-through cables and pipes do not impact on each other.

- 1** Cable support system
- 2** Metallic pipes with insulation
- 3** Sanitary pipe made of plastic with pipe sleeve
- 4** Electrical installation



Examples of support structures

If there is a fire, large forces impact on the installations. For this reason, fastenings of support systems may fail and the insulation may be subjected to mechanical loads. To prevent this, additional supports for the passed-through installations must be mounted at a defined spacing (d) in front of the surfaces of the insulation. The material used must be load-bearing and non-combustible. As support, mounting components of steel cable support system are a good choice:

- Suspended supports with brackets
- Profile rails with threaded rods
- Mounting rails
- Fire-tested anchors

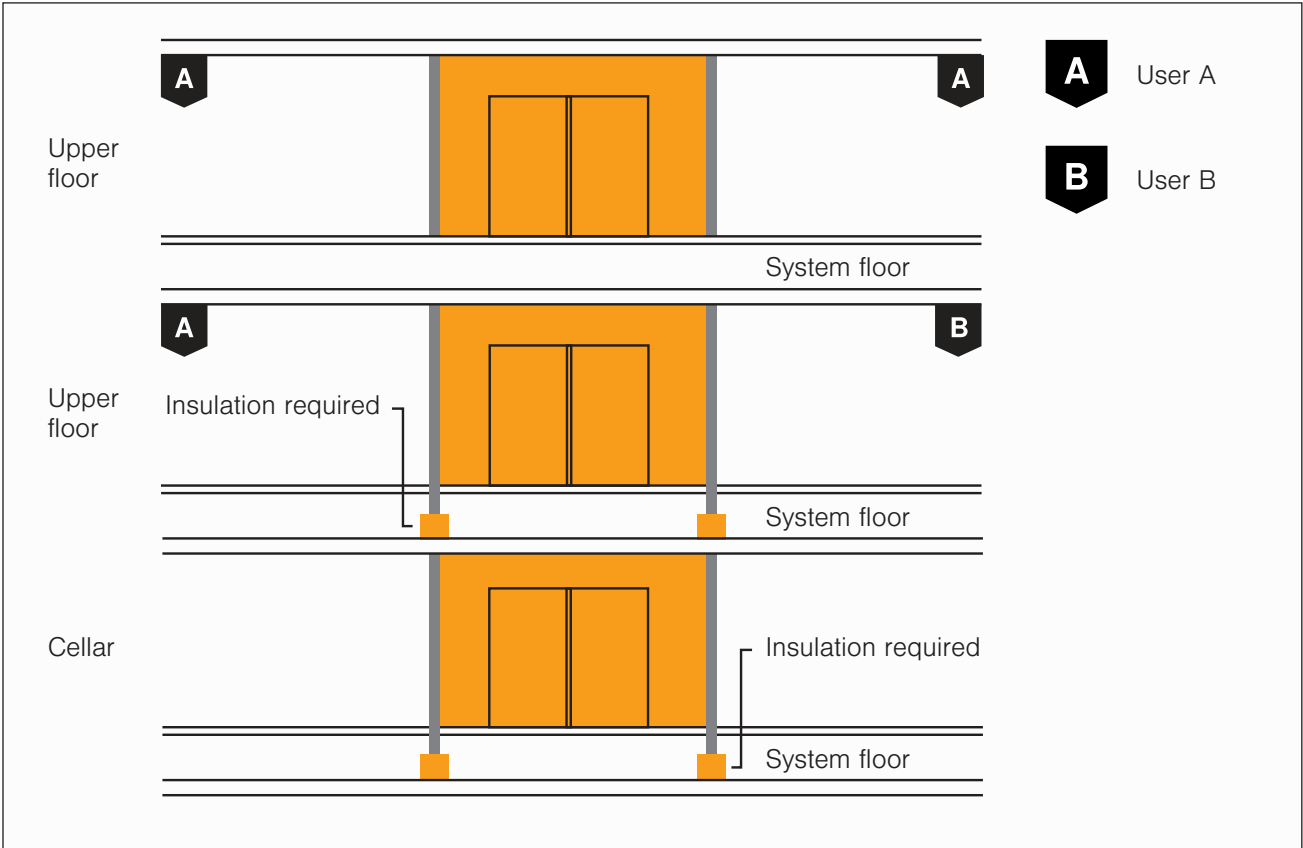
The constructions are not defined exactly in the approvals. The load capacity of the above-named components was proven in the fire tests for the maintenance of electrical functionality, meaning that they have also proven themselves in practice for the support of insulation.



2.5.4 PYROBAG® cushion insulation

The PYROBAG® system for cable insulation, made up of fire protection cushions, is the ideal solution for insulation in PVC and metal cable routing ducts. The fire protection cushions, which can be shaped in any way, are stacked simply and quickly on top of each other, allowing absolutely tidy and dust-free mounting. As the cushions are only used within the ducts, the cable insulation cannot be seen from the outside –

this is an advantage for cable ducts, which are usually subjected to particular optical requirements. The cushions can be used for permanent or temporary insulations in walls and ceilings. Additional cables can be installed quickly, neatly and economically at a later date because the cushions can be used several times over. Neither painting nor the use of filler are required.



Insulation in system floors: When is insulation required?

2.5.5 Insulation in system floors and underfloor ducts and trunking

Insulation must also be installed in so-called system floors - cavity floors and raised floors. If underfloor ducts and trunking run beneath walls with a fire resistance period, insulation measures must be taken. Screed-covered underfloor ducts are insulated starting from the closest connection sockets, as the wall opening can no longer be reached directly due to the poured screed. The distances between the connection sockets are irrelevant. Of importance is the smoke gas-tight and fireproof closure, in order to prevent the spread of fire. In the case of open trunking with freely accessible wall openings, insulation can be placed directly in the opening area.





PYROSIT® NG fire protection foam

The fire protection foam of the PYROSIT® NG system can be used to create cable insulation quickly and easily in underfloor ducts. If, during an electrical installation, underfloor ducts pass below walls classified for fire protection, then the ducts must be closed against smoke gas penetration and fire. With an open trunking system, the trunking cover is removed on both sides of the wall and the fire protection foam is inserted. With a screed-covered underfloor duct, the fire protection foam can be inserted through the underfloor boxes on both sides of the wall. Empty plastic

pipes can also be foamed in for later retroinstallations. The good substrate adhesion prevents the foam from running out of the opening. Work can easily be interrupted to carry out checks. The system can be installed without dust and fibres. Surface coating is not necessary. Due to the soft consistency, the insulation made of PYROSIT® NG can be reassigned simply. The possibilities for using the PYROSIT® NG system for cable insulation in underfloor ducts and trunking are covered by surveyor's reports.



PYROPLUG® Block foam blocks

The fire protection blocks of the PYROPLUG® Block system are the ideal solution for cable insulation in underfloor ducts. If, during an electrical installation, underfloor ducts pass below walls classified for fire protection, then the ducts must be closed against smoke gas penetration and fire in the area of the wall penetration. With an open trunking system, the trunking cover is removed on both sides of the wall and

the fire protection blocks inserted. With a screed-covered underfloor duct, the fire protection blocks can only be inserted through the underfloor boxes on both sides of the wall. If retroinstallations are necessary, individual blocks can be removed simply or empty plastic pipes inserted. The system can be installed without dust and fibres.



PYROCOMB® Intube half shell

The half shell of the PYROCOMB® Intube system is very suitable for cable insulation in underfloor areas. The insulation can be installed directly with mortar or cast in concrete and screed. If raised floors abut onto, for example, escape routes with poured screed, then there must be at least partial insulation beneath the smoke protection door or fire protection door. In most cases, the insulation can only be worked from one side. In these cases, the PYROCOMB® Intube system, cable insulation with a half shell can be used. The half

shell is laid around the cables and positioned in the insulation area using adhesive tape on the floor. Then the half shell is closed on one side with a foam plug and the surface is sealed with ASX ablation coating. The cables do not require any coating. In case of a fire, the inner coating of the half shell expands and, in so doing, closes the opening cross-section completely. The transfer of fire and smoke is safely prevented. With the PYROCOMB® Intube system, 100% assignment of the interior is possible.



2.5.6 PYROLIQ® shipbuilding and offshore casting compound

The PYROLIQ® system is used to create cable insulation under the toughest environmental conditions, such as in industry, shipbuilding and in offshore applications. Here, casting cables is the most secure way. The PYROLIQ® system consists of a casting compound, which is gas-tight, water-tight and fire-resistant. The proven fire resistance class A60 accord-

ing to maritime testing criteria and the approval by DNV GL document its high level of safety. The insulation is water-tight up to 2.5 bar and gas-tight up to 30 mbar. In comparison with modular insulation, the use of PYROLIQ® does not require any major planning work and the casting compound is very easy and safe to use.

2.6 Selection aid and OBO Construct BSS

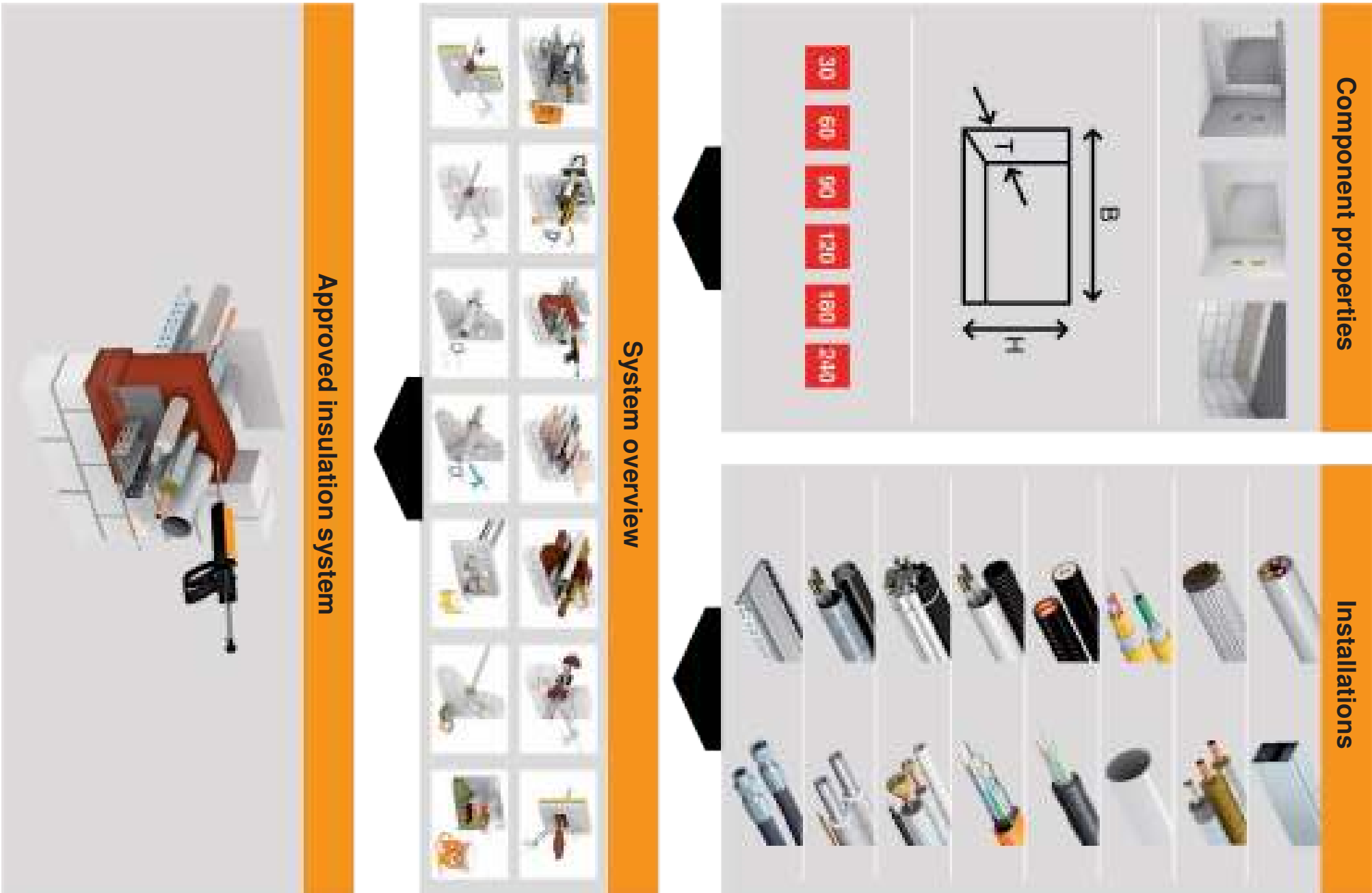
OBO provides a selection aid, in order to help you find a suitable, approved insulation system for any application. An overview presents different installations with the possible insulation systems, which fulfil the corresponding requirements.

The online tools Construct BSS and the BSS app for insulation systems can be used to determine the right materials. With just a few questions, the user is guided towards the solution to their fire protection problem and the suitable system.

Construct BSS works on any computer with Internet access and simplifies the material calculation and selection of the systems. After the basic data has been entered, the user obtains an overview of the approved insulation systems, as well as of necessary and optional system accessories. Shopping lists can be created, edited and exported. The approval documents can be reached via a link.

The Construct BSS app contains the same scope of function as the web application, simply in a mobile version. The calculated materials can be summarised on the shopping list and sent via e-mail.







2.7 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.

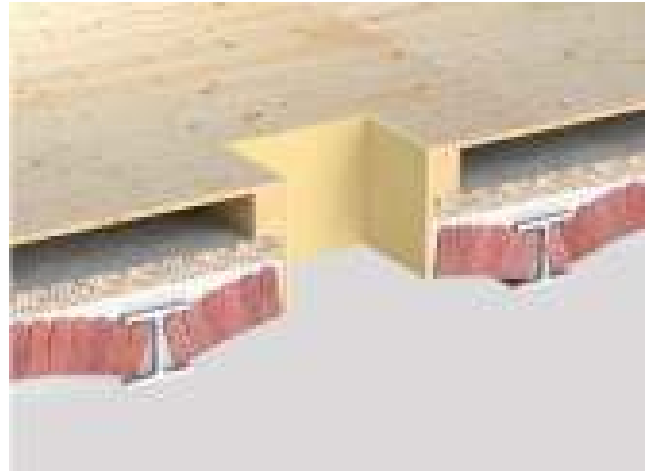
However, before mounting, always obtain the approval from the client, e.g. construction supervision or fire brigade.

2.7.1 Building stock

A large amount of the fire protection measures concern existing buildings. Besides the installations, which may no longer correspond to current rules, the building stock can cause a lot of problems during renovation. For example, the old structure of ceilings mean that they cannot be assigned to a fire resistance class. To be able to perform an evaluation, the stock must be inspected by statics engineers or construction experts. Only then can suitable fire protection measures be implemented as part of a concept.



Wooden beam ceiling without fire protection ceiling



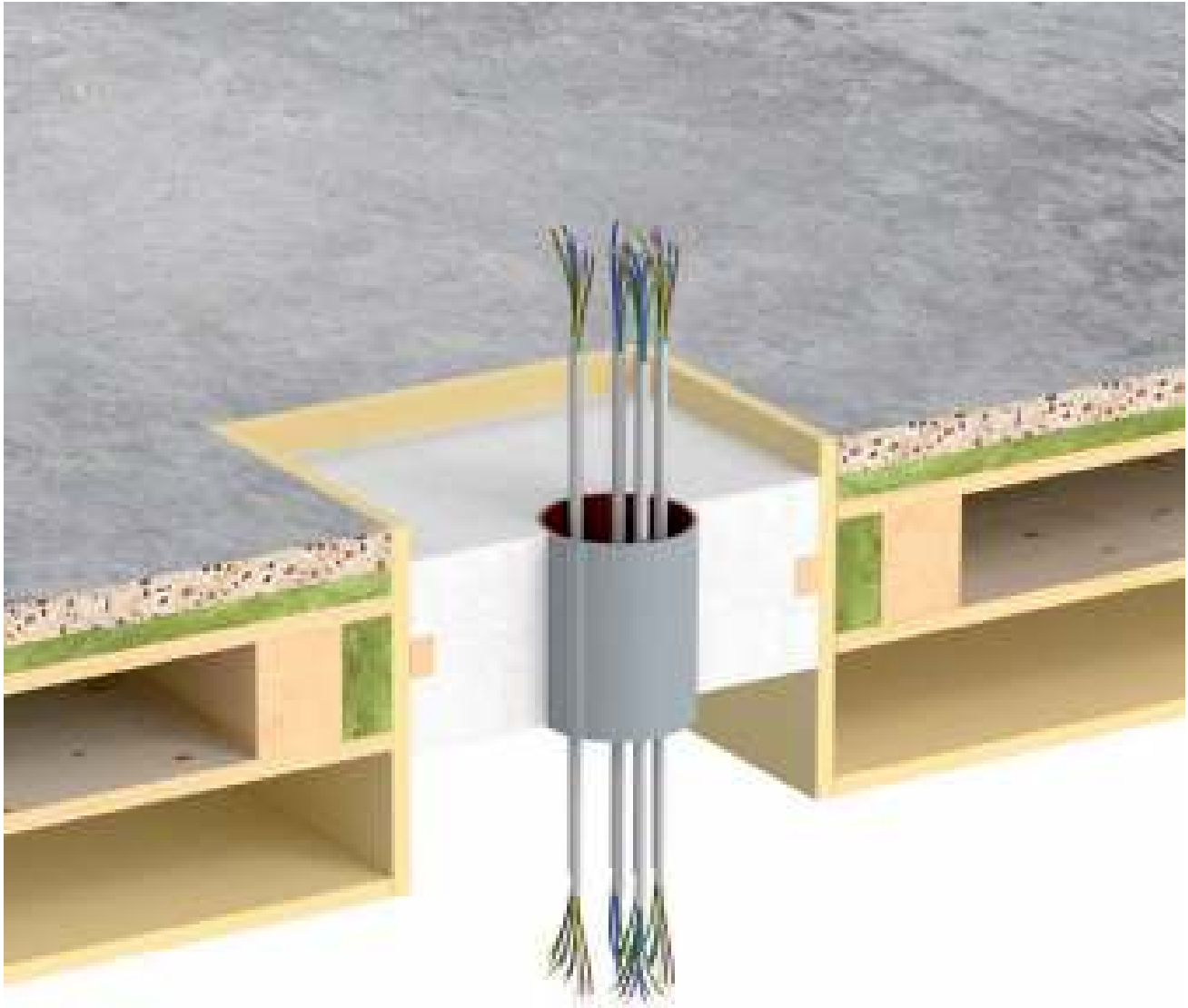
Cap cover



Cavity chamber ceiling

2.7.2 Ceiling types

In many existing buildings, we can find components in which insulation systems may exist but do not conform to the approval. The components are not described in the approvals, e.g. wooden ceilings. This is why the insulation in these components do not have a proof. Here, the appropriate insulation is selected according to the approvals which is then documented in the fire protection concept.



Insulation in existing ceiling as special solution

2.7.3 Special solutions

The following applies to ceilings in existing buildings and to wall constructions made of special components (e.g. sandwich elements): Insulation systems, tested and approved for this application, can be installed. As these special tests rarely exist, insulation is used in accordance with the approvals, whose function is proven in layers made of non-combustible materials, e.g. in lightweight partitions. Before mounting, clarify the application with a surveyor.



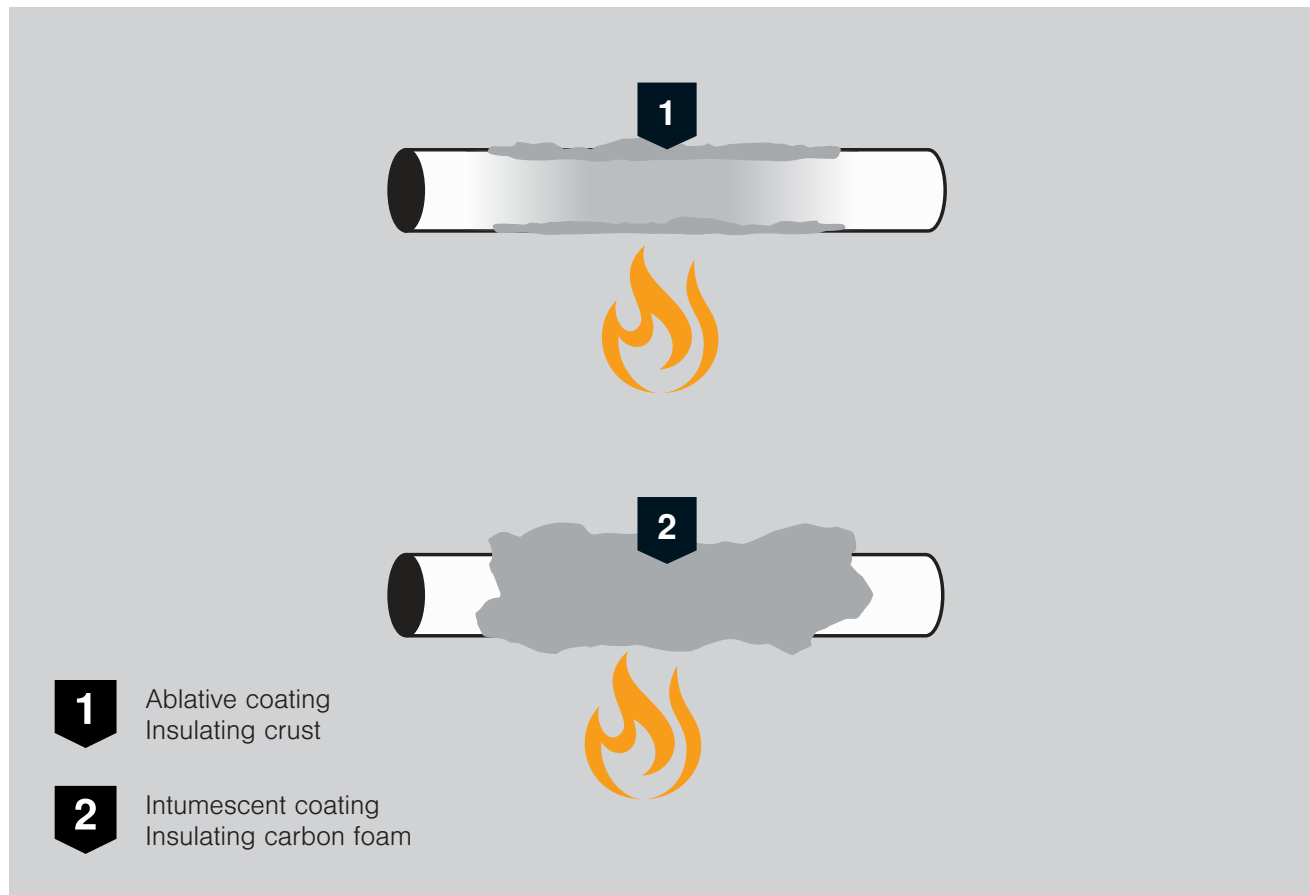
2.8 Cable bandages

To prevent the fire expansion within fire sections, existing cable support systems are bandaged with a coated mesh, which restricts a cable fire to a local area. In many cases, the total of the routed cables represents a "fuse wire", which runs through the building. Particularly critical are rising sections, as the flames spread most quickly in a vertical direction. Bandaged cable bundles or rising sections do not burn over a great period of time and thus limit the damage.

The cable bandages are also used in industrial buildings and systems, in order to fulfil construction law protection aims. The requirements for components in the industrial sector do not differ in this regard to those in other types of buildings.

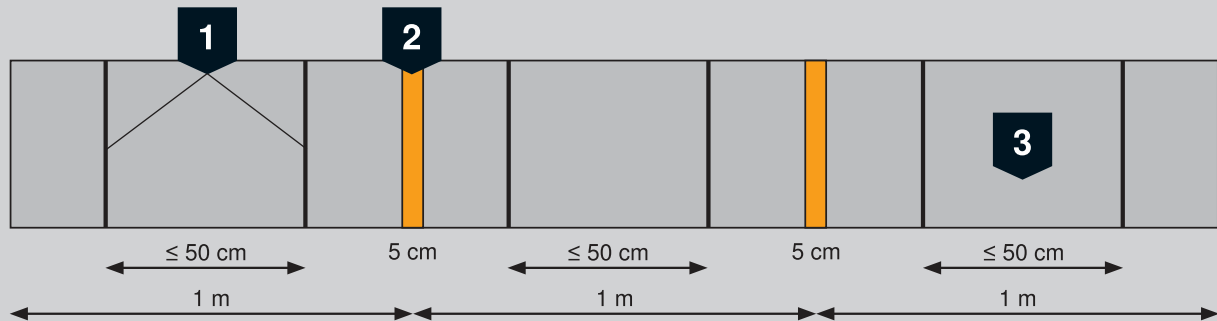
Besides a material classification, the cable bandages also have an application approval. Additional proof certificates are, for example, reports on the basis of an IEC test. These documents describe the proven function.



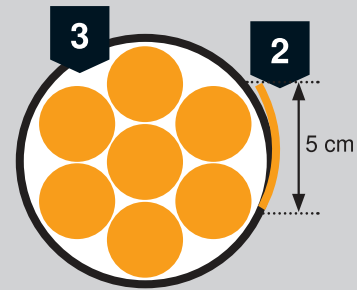


Reaction of coating compounds

Before cable bandages were developed, (intumescent) substances creating an insulation layer or ablation coatings were used to coat cables and prevent the spread of fire. If there is a fire, substances creating an insulation layer for cable coating foam up without any major pressure formation, forming an insulating protective layer. Ablation coatings cool the materials around them in the event of a fire. The ablation coating PYROCOAT® ASX for cable and combination insulation is approved for this application.



- 1** Fixing of the bandage with a max. spacing of 50 cm
- 2** Minimum bandage overlapping 5 cm
- 3** Cable bundle or cable support system



Use of cable bandages

2.8.1 Benefits compared to coatings

Frequently, cables are additionally given fire prevention coatings. The problem here is the major work of the wet application. In addition, it must be ensured that the dry layer thickness corresponds to the prescribed data. By contrast, bandages have the following advantages:

- Mechanically applied coating guarantees the necessary dry layer thickness
- Dry routing
- Simple fastening and lock with tightening strap
- Simple reinstallation through opening of the tightening straps (reusable)
- Easy to mount thanks to differently coloured surface
- Surface is PU-coated and washable

2.8.2 Basic principle

Unprotected cable bundles facilitate the rapid expansion of fire and make it particularly hard for fire brigades to fight the fire. At temperatures of 150 °C and upwards, the insulating material in the cable bandages that faces the cables foams up, thereby displacing the oxygen. The plastic insulation of the cables cannot ignite and the fast expansion of the fire is prevented. Moreover, the creation of thick black smoke will also be inhibited.

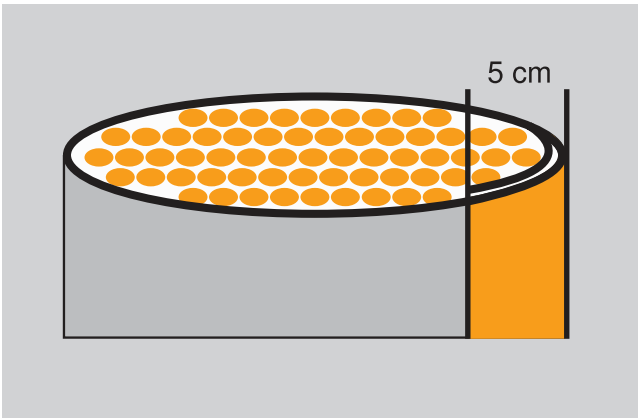




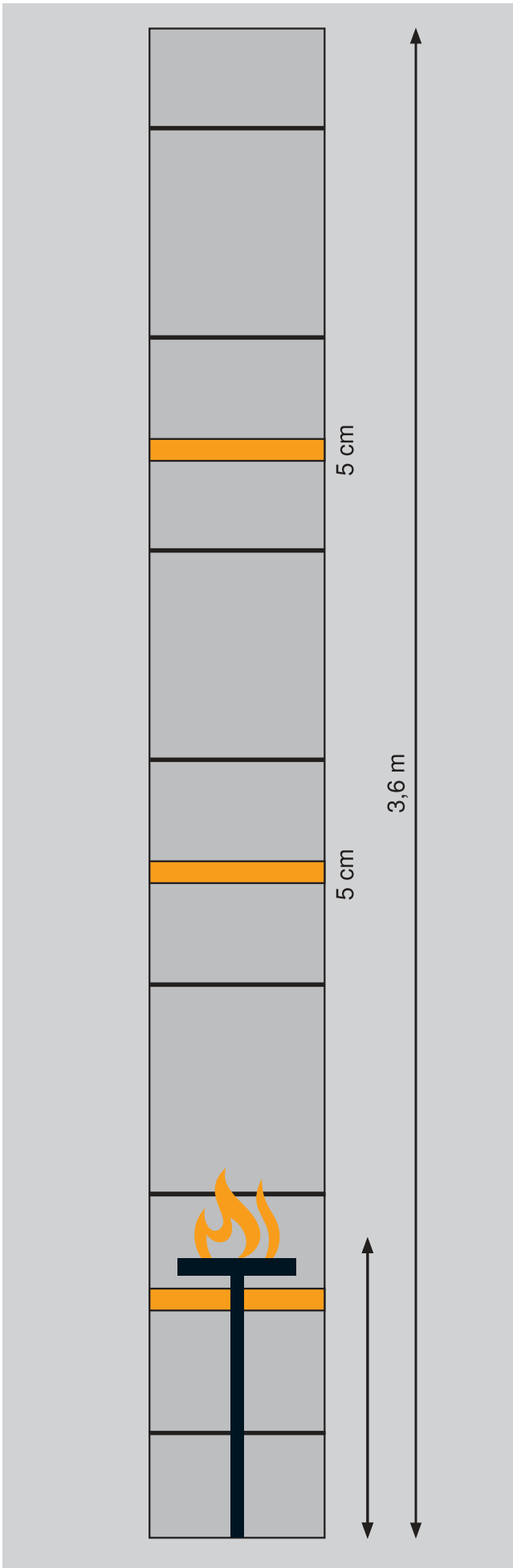
Testing of the cable bandage

2.8.3 Testing

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 [16] and the identical EN 50266-2-2:2001 [17]. A defined, approved burning height must not be exceeded during a period of 40 minutes.



Cutaway through the test body



Structural principle, IEC test

2.8.4 PYROWRAP® Wet WLS cable bandage

The PYROWRAP® Wet FSB-WLS system can be used to wrap large cable bundles or cable support systems within the fire sections, in order to prevent the spread of a fire. The mesh possesses a fire protection coating, which stops a fire in its tracks at an early stage, e.g. in the case of a short-circuit. If there is fire coming in from the outside, the material is not involved in the course of the fire, effectively preventing the spread of the fire, both in vertical and horizontal directions.

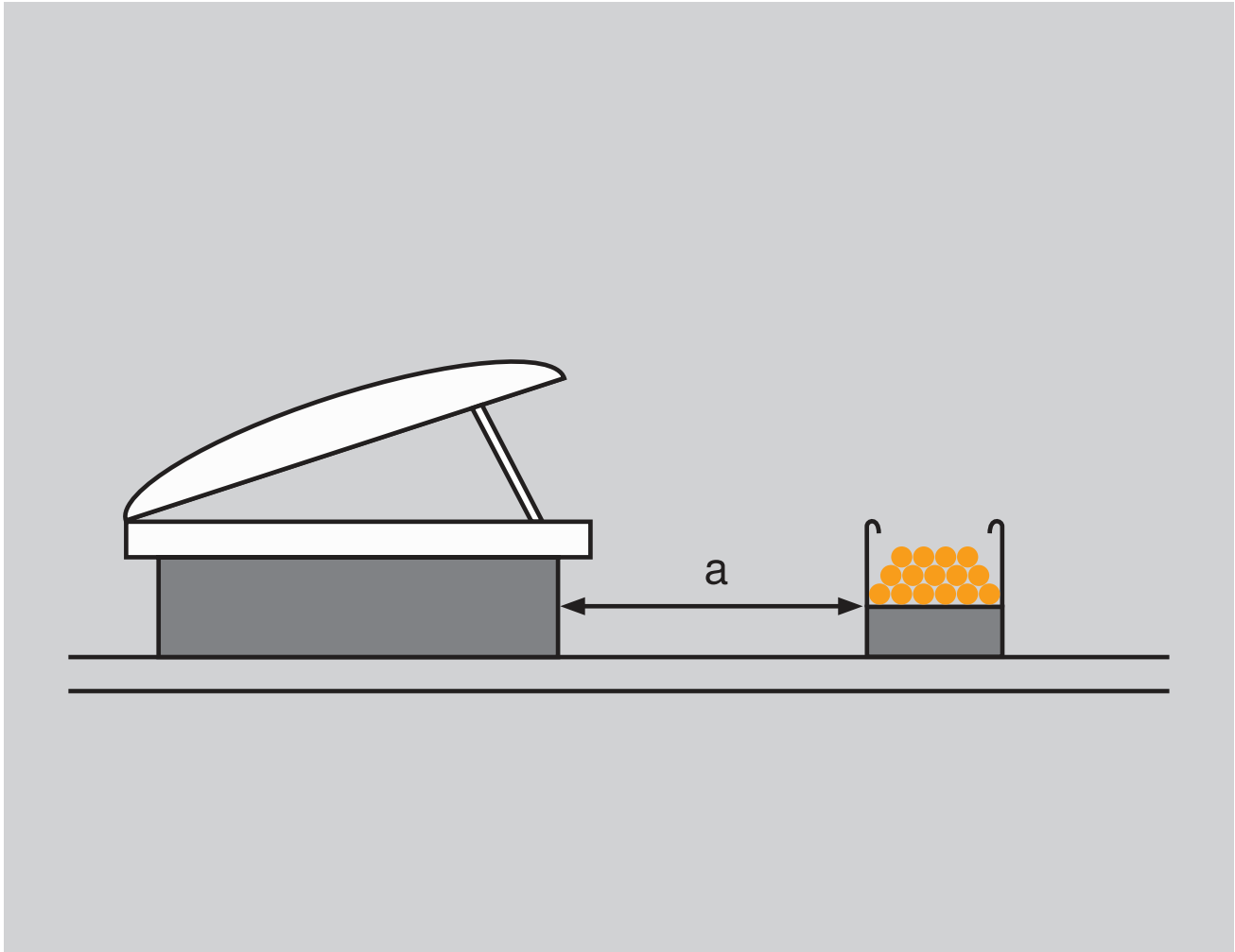
In the escape and rescue routes of small buildings, the mounting of a cable bandage is permitted, as only low smoke development is to be expected and only a small number of people must be evacuated. In larger buildings, the residual risk of smoke development is accepted, even if considerably more people must be evacuated. Here, the fire protection bandage frequently presents the only economic solution compared to fire protection ceilings or panelling with plate materials.



2.8.5 PYROWRAP® Wet WB cable bandage

The PYROWRAP® Wet FSB-WB system comprises a fire protection bandage, which is used in areas with special environmental conditions. The fire protection bandage can be used to wrap large cable bundles or cable support systems, in order to prevent the spread of fire. The bandage is made of a weatherproof material, which is insensitive to various chemicals and oils. It has construction approval from the DIBt as a highly flame-resistant material according to DIN EN 13501-1. When the fire protection coating foams up in the event of fire, this safely prevents the spread of fire via the cables.





Cable support system with small distance to roof cupola

2.8.6 Distances to combustible materials

With certain structure conditions, a distance (a) to the combustible materials must be maintained. For example, if there is a fire, no smoke may enter in inflow air openings of ventilation systems. Combustible materials may not always be located near roof cupolas which can be opened. However, installations are often already there, meaning that the cable routes cannot be changed. Here, only bandaging cables can help, in order to avoid ignition of the installations.

2.8.7 Special applications

Special applications for the cable bandages can be found in the fields of photovoltaics, wind power, tunnels, shipbuilding or in existing buildings, e.g. in wooden constructions in attics. Here too, the protection aim is: Prevent the spread of fires. Whether this is for personal protection or system protection depends on the appropriate installation.



Bandaged cables routed over a firewall



Bandaged rising section in the tower of a wind power plant



Use of the bandage in aggressive environments, e.g. offshore



Bandaged cable support systems in areas with many combustible materials

Use in escape and rescue routes

Bandages are used in escape and rescue routes if the following measures are not possible due to local circumstances or insufficient space:

- Mounting of fire protection-classified suspended ceiling
- Panelling with plates
- Installation of a fire protection duct

In so doing, the bandages match the route of the previously installed cables, which is not possible without additional work in the case of fire protection ducts.

As cable bandages are a combustible, although flame-resistant, material, they may formally not be used in escape and rescue routes due to their flammability. The following applies: Fire load through installations in escape and rescue routes = 0 kWh/m². On account of the function and the proof of the fire behaviour, the cable bandage is often the last economic option. In this case, before mounting, always obtain the approval from the client, e.g. construction supervision or fire brigade.

CAUTION!

The cable bandages were originally developed in order to prevent fire expansion within fire sections. The effectiveness of the cable bandage can therefore not be compared to the performance of a fire protection duct in escape and rescue routes.



Chapter 3: Securing of emergency and escape routes - protection aim 2

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In the event of a fire, escape and rescue routes are the central life-line and must always remain usable.

3 Protection of escape routes - protection aim 2

Some 95% of all deaths during fires are caused by smoke poisoning. To be able to evacuate people safely out of the building during a fire, escape and rescue routes must always stay free of smoke and fire. In a fire, escape and rescue routes are the central lifeline and must always remain usable.

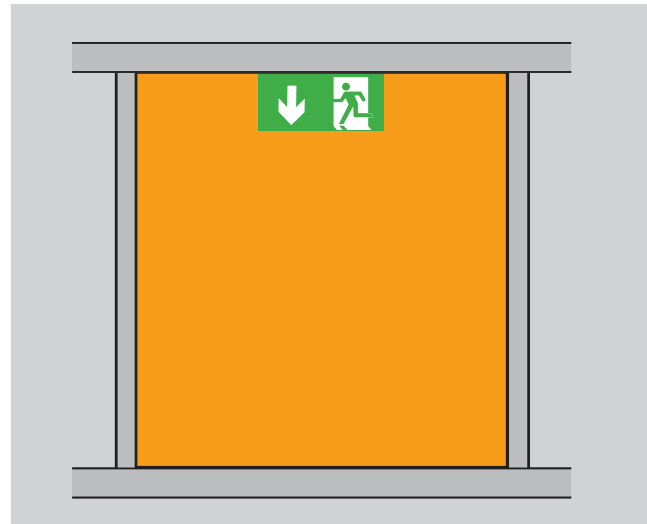
3.1 What is an escape and rescue route?

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 a fire. It is therefore obligatory to equip buildings with at least one constructive escape and rescue route. Additional escape and rescue routes may also be necessary, depending on the type of building. These include:

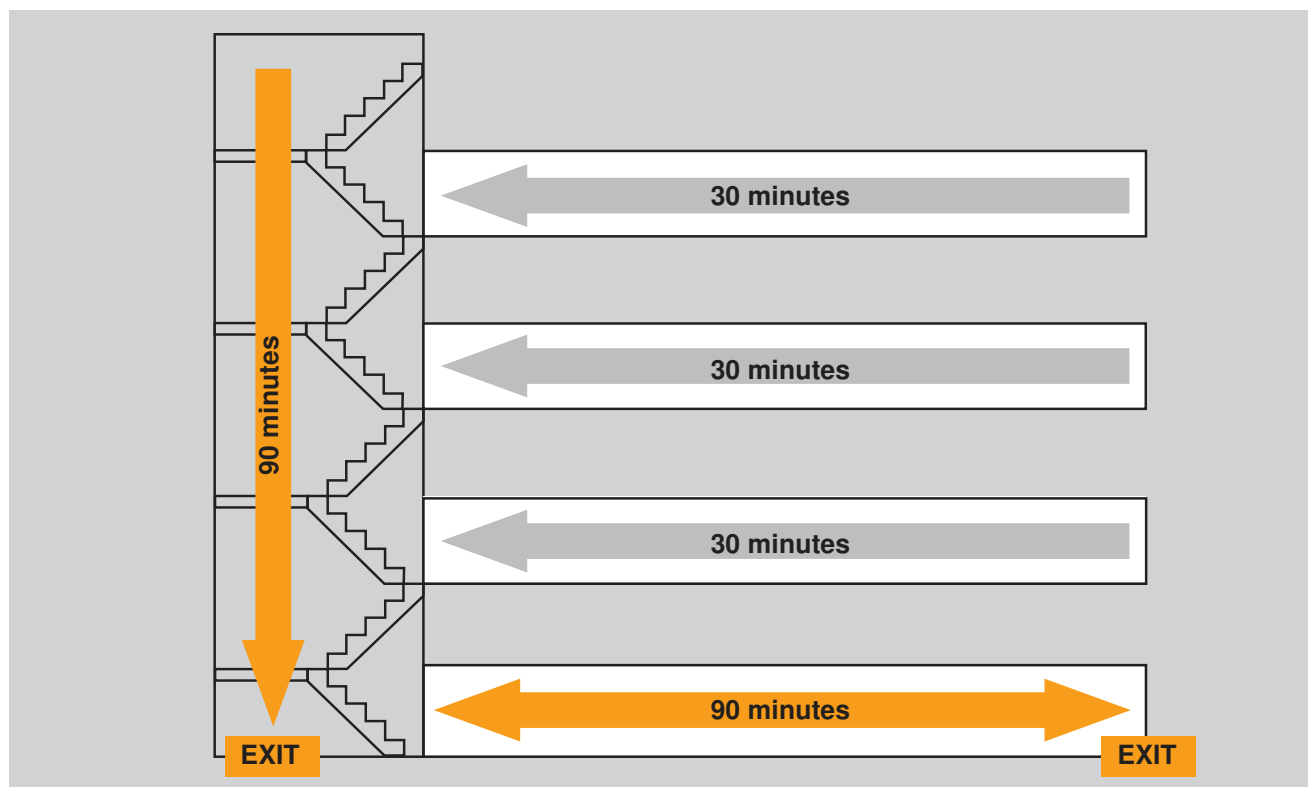
- Necessary staircases (vertical access)
- Connecting rooms between the necessary stairwells and exits to the outside
- Necessary corridors (horizontal access)

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 escape and rescue routes also aid the local fire brigades as a point of attack.

In principle, the escape and rescue routes represent areas free of fire, i.e. installations consist of non-combustible or flame-retardant materials, in order to prevent the spread of a fire. The fire resistance period of the surrounding components is at least 30 minutes (flame-retardant). Staircases and the vestibules between a staircase and the exit into the open air must be designed to be fire-resistant, with a fire resistance of 90 minutes.



Area to be protected (orange) in an escape route



Escape and rescue routes with requirements for 30 or 90 minutes



3.1.1 Problem: Fire loads

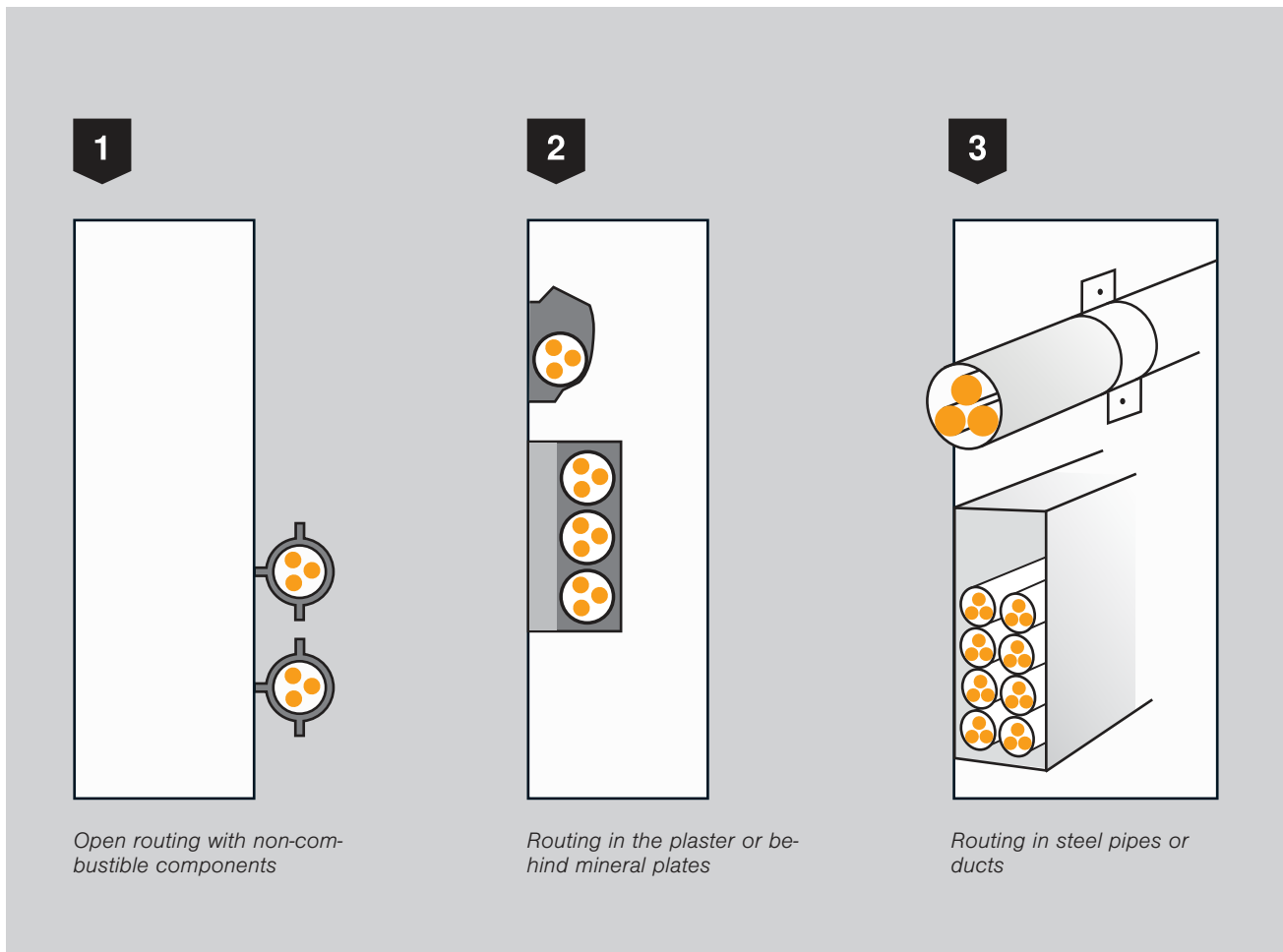
In the area of escape and rescue routes, an installation must not pose an additional fire load. This requirement must be fulfilled with the appropriate installation types:

- Concealed installation
- Use of non-combustible materials
- Installation above suspended fire protection ceilings
- Installation in underfloor ducts
- Installation in fire protection ducts

However, there are exceptions here: The cables required for the operation of an escape and rescue route may be routed in the open. For example, a luminaire in a corridor is made of combustible plastic. The short branch cable to supply the luminaire barely increases the risk of a fire and is thus approved. Even spot fire loads, such as Wi-Fi routers or devices for household and fire brigade radio, do not represent an increased risk. Spot fire loads do not contribute to the fire spread in the straight direction along the corridor.

A massive volume of cables, routed openly in a corridor to supply other areas of the building, is not accepted. These installations make a considerable contribution to fire spread, as they run like fuse cords along the corridor. Systems tested and approved for fires must be installed here.

*Fire load through installations
in escape and rescue routes
= 0 kWh/m²*



3.1.2 Approved installation options

As, in most corridors, the installations of all the different networks meet - electrics, sanitation, ventilation and air-conditioning - the electrical installation is a special case. Electricity is the #1 cause of fire, which is also responsible for the ignition of combustible materials, such as cable insulation, insulation layers of pipes, etc. Under normal circumstances, a correctly executed electrical installation with a correctly selected wire cross-section, correct fuses and avoidance of damage during drawing in would not be dangerous. Excessive heating due to improper design and dimensioning of the cables or damage to the insulation have frequently been the cause of fires.

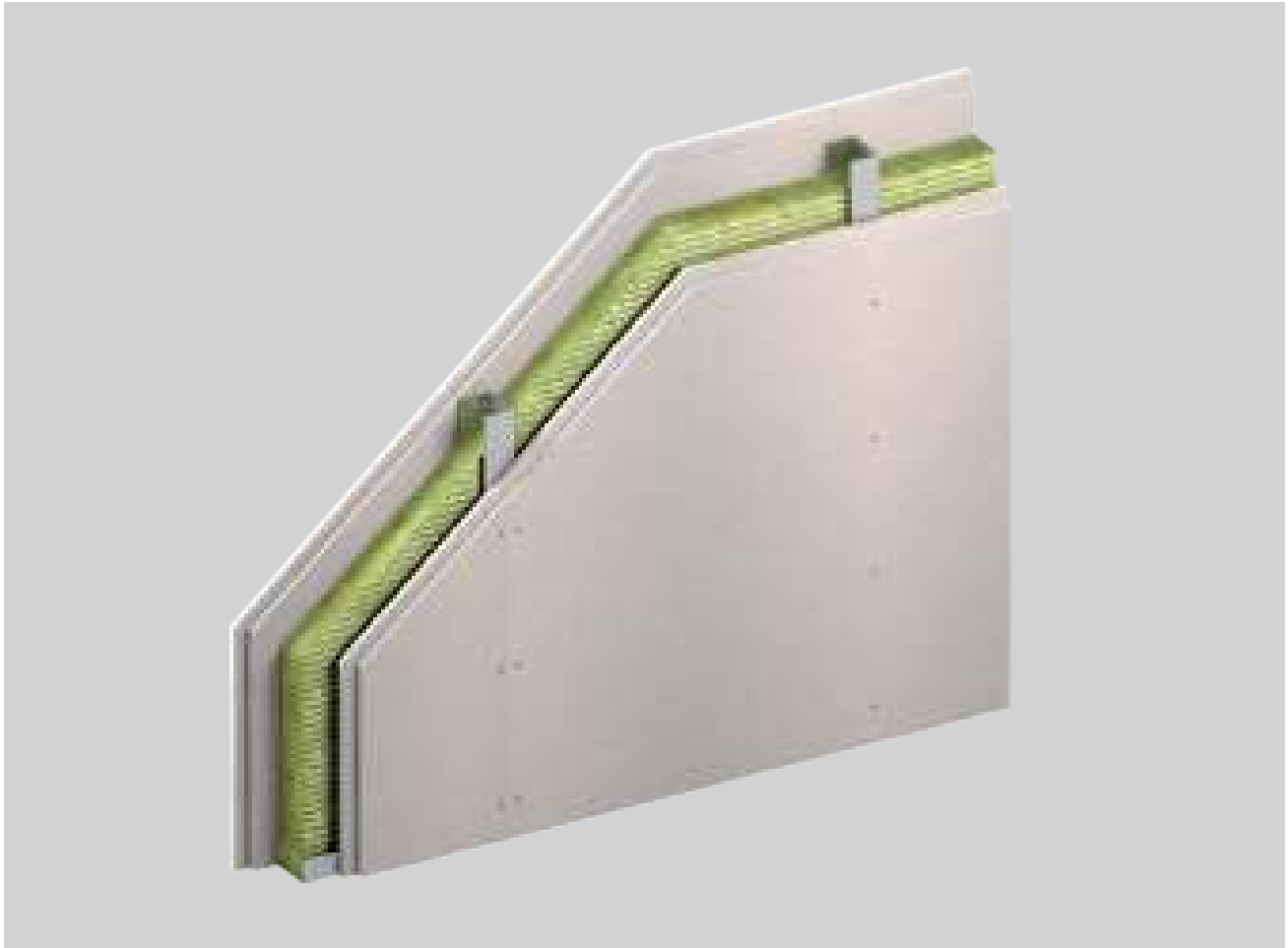
The following cable installations are permitted in escape and rescue routes:

- Individual, also arranged next to one another, fully concealed
- In solid components with milled slots, with 15 cm plaster coverage or cover with 15 mm-thick, non-combustible plates
- Within light-duty partitions, however only for the supply of consumers mounted on this component

Electrical cables may be installed uncovered, if they are only used to supply rooms and corridors or are non-combustible. However, such cables do not occur in practice.

For fastening, the cable routing ducts or electrical installation pipes, made of non-combustible materials (steel), must be used. Accordingly, steel anchors are used for fastening.

The option of open routing plays no role with, for example, non-combustible sanitary pipes made of steel, copper and cast materials, etc. However, if they possess combustible insulation, this makes things more difficult. Aid can be obtained through metal panelling, replacing the insulation with non-combustible insulation or using tested and approved fire protection ceilings. These separate the areas with combustible installations above the false ceiling from the escape and rescue route.



Partition construction with plasterboard plates

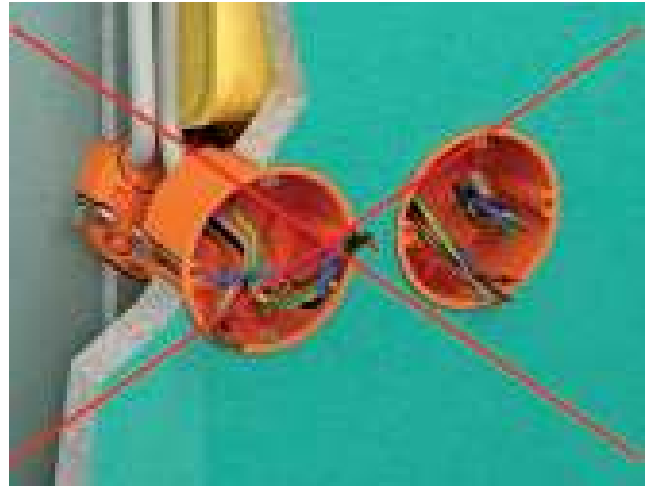
3.2 Installations in lightweight partitions

Frequently, lightweight partitions in stand-off design are installed in escape and rescue routes. The walls are made of metal profiles, which are closed on both sides with two sides of plasterboard of 12.5 mm thickness. Filling the interspace with mineral wool can be a fire protection or noise protection requirement. This design fulfils fire resistance periods of at least 30 minutes.

The recesses in the metal profiles are used to route cables. If switches or sockets are inserted in the lightweight partitions, then cavity wall sockets are used. The cavity wall sockets may be used on one side without special measures. The internal mineral wool may be compressed to a thickness of 30 mm. Opposing installation in flame-retardant walls is not approved with standard cavity wall sockets. Here, special fire protection cavity wall sockets are required, which have been proven to be tested for this application.



Use of special fire protection cavity wall sockets, installed on the other side next to doors with fire resistance.



Unapproved installation of opposing standard cavity wall sockets in lightweight partitions with fire resistance.



Offset installation of standard cavity wall sockets in a lightweight partition, separated by metal stands.



Approved installation of opposing standard cavity wall sockets besides doors without fire resistance.



F30 ceiling with fire from below



F30 ceiling with fire from above

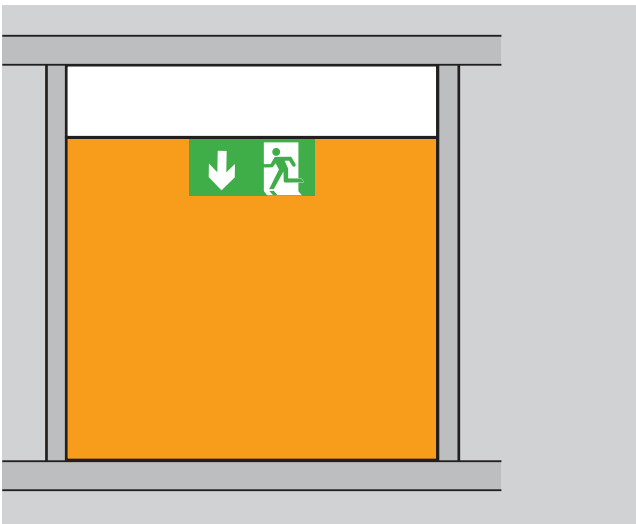
3.3 Installation in false ceilings

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. If there is a fire in the cables installed there, the escape and rescue route can still be used. However, there must be a guarantee that the suspended ceilings are not subjected to additional mechanical loads through, for example, falling cables or parts of the support system. In addition, the fire protection ceilings protect the combustible installations against a fire from below, preventing the fire from spreading along the corridor via the burning installations.

Only the following systems for electrical installations above suspended fire protection ceilings in the area of escape and rescue routes:

- Routing systems for the maintenance of electrical functionality, tested according to DIN 4102 Part 12 [18]
- Special routing systems, tested for fire protection for this application

Systems that maintain the electrical functionality have strictly regulated system parameters, which is why they can only be used with restrictions for electrical installation in false ceilings. 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.



Escape route with false ceiling



Systems for the maintenance of electrical functionality only carry low loads



Cable tray with high mechanical load before...



...and after fire testing

3.3.1 Tests and documentation

Suspended ceilings with fire protection properties (fire protection ceilings or F 30 ceilings) often possess general construction test reports and classification reports according to the relevant testing and classification standards. There are various manufacturers and providers for these. However, the situation is rather different in the case of support systems above fire protection ceilings.

To be able to offer practical solutions conformant with the directives for electrical installations above suspended fire protection ceilings, fire tests are carried out according to DIN 4102 Part 12 and Part 4 [19]. The following are tested, for example:

- Cable support systems for wall and ceiling mounting
- Grouped supports for wall and ceiling mounting
- Pressure clips for ceiling mounting
- Ceiling supports for ceiling mounting
- Cable systems for suspending cable trays

All the systems are usually made of steel, as non-combustible materials are required. The appropriate fastening anchors are also subject to this requirement. Chapter 5 "Anchorings" deals with this in more detail.

The following requirements for false ceiling systems are tested in case of fire:

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

The tests are carried out using the standardised temperature-time curve. A full fire is then simulated in the false ceiling area. In most cases, the fire resistance length is set at 30 minutes, but, in special cases, it can be 90 minutes. The test results can be used to make statements on practical execution, e.g. on compliance of spacing distances to the false ceiling.



There is no testing standard for installations above fire protection ceilings and thus no classification is possible. Test criteria are the deformation of the support systems, as well as possible falling due to heat. The tests need not be carried out by an accredited testing institute but can, in principle, be carried out and documented by the manufacturer themselves.

The manufacturer's documentation should contain all the relevant parameters, such as the maximum mechanical loads, support spacings, securing measures and deformation behaviour. Such a system then fulfils construction law requirements, e.g. those of the cable system directive.

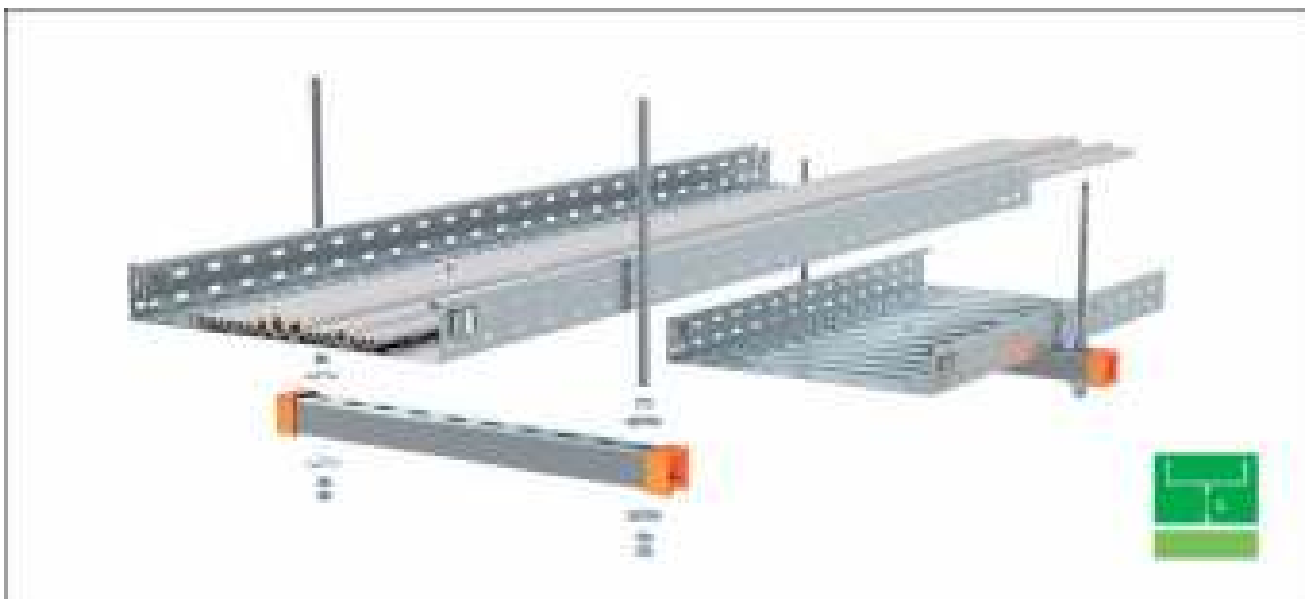
All the OBO routing types are tested in accordance with DIN 4102 Part 12. In so doing, the mechanical resistance above fire protection ceilings is investigated and the deformation behaviour recorded. Fire test reports of the Braunschweig Materials testing Institute and test reports from OBO Bettermann document the resistance and deformation behaviour of the routing variants, clearly proving the applicability of the systems tested in this way.



3.3.2 RKSM cable trays

The tested RKS-Magic cable tray system is suitable for installation in the false ceiling area of escape and rescue routes. In a fire, the system has a proven mechanical stability of 30 minutes. The RKS-Magic® cable tray can be mounted under the ceiling or on the wall with brackets. The brackets are additionally secured on the ceiling with a threaded rod to prevent them bending in cases of fire. A further option for ceiling mounting is the support of the cable tray on profile rails, each mounted under the ceiling with two

threaded rods. As the cable tray deforms in the event of a fire, sufficient distance to the false ceiling must be maintained. This minimum distance is documented in the proof of testing for the various versions of the RKS-Magic® cable trays. If the cable loads and tray widths listed in the proof of testing are maintained and the minimum spacings to the false ceiling taken into account, then multi-layer variants can also be implemented.





3.3.3 SKSM/SKS cable trays

The tested SKS-Magic® and SKS cable tray systems are suitable for installation in the false ceiling area of escape and rescue routes. In a fire, the systems have a proven mechanical stability of 30 minutes. The SKS-Magic® and SKS cable trays can be mounted under the ceiling or on the wall with brackets. The brackets are additionally secured on the ceiling with a threaded rod to prevent them bending in cases of fire. As the cable trays deform in the event of a fire, sufficient distance to the false ceiling must be maintained. This minimum distance is documented in the proof of testing for the various versions of the SKS-Magic® and SKS cable trays.

If the cable loads and tray widths listed in the proof of testing are maintained and the minimum spacings to the false ceiling taken into account, then multi-layer variants can also be implemented. A further option for ceiling mounting is the support of the cable trays on profile rails, each mounted under the ceiling with two threaded rods. Even with this mounting variant, sufficient distances to the false ceiling must be maintained. A two-layer arrangement of the cable trays is possible, providing that the approved tensile stress in the threaded rods is maintained in case of fire.



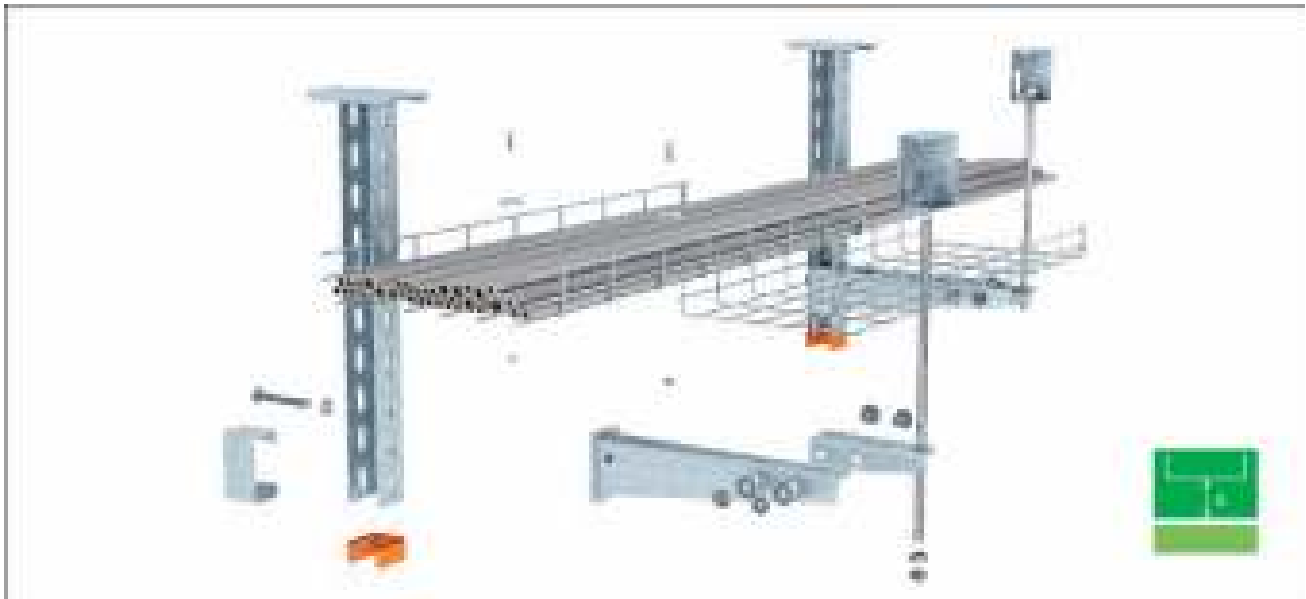


3.3.4 MKSM/MKS cable trays

The tested MKS-Magic® and MKS cable tray systems are suitable for installation in the false ceiling area of escape and rescue routes. In a fire, the systems have a proven mechanical stability of 30 minutes. The MKS-Magic® and MKS cable trays can be mounted under the ceiling or on the wall with brackets. The brackets are additionally secured on the ceiling with a threaded rod to prevent them bending in the event of a fire. As the cable trays deform in a fire, sufficient distance to the false ceiling must be maintained. This minimum distance is documented in the proof of testing for the various versions of the MKS-Magic® and MKS cable trays.

If the cable loads and tray widths listed in the proof of testing are maintained and the minimum spacings to the false ceiling taken into account, then multi-layer variants can also be implemented. A further option for ceiling mounting is the support of the cable trays on profile rails, each mounted under the ceiling with two threaded rods. Even with this mounting variant, sufficient distances to the false ceiling must be maintained. A two-layer arrangement of the cable trays is possible, providing that the approved tensile stress in the threaded rods is maintained in case of fire.



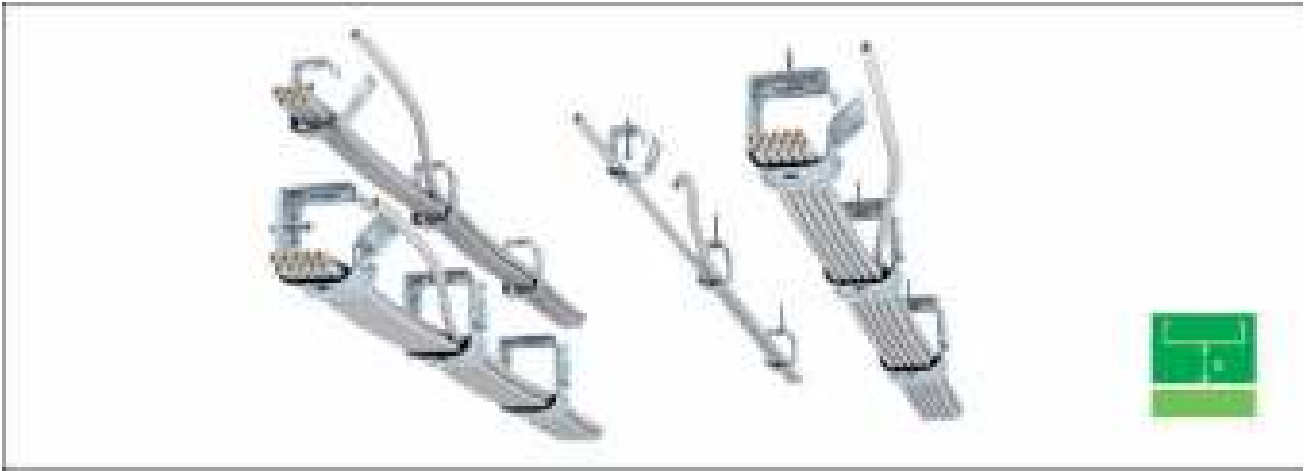


3.3.5 GRM cable trays

The tested GR-Magic® mesh cable tray system is suitable for installation in the false ceiling area of escape and rescue routes. In the event of a fire, the system has a proven mechanical stability of 30 minutes. The GR-Magic® mesh cable tray can be mounted under the ceiling or on the wall with brackets. The brackets are additionally secured on the ceiling with a threaded rod to prevent them bending in cases of fire. As the mesh cable tray deforms in a fire, sufficient distance to the false ceiling must be maintained. This minimum distance is documented in the proof of testing for the various versions of the GR-Magic® mesh cable tray. If the cable loads and tray widths listed in the proof of testing are maintained and the minimum spacings to the false ceiling taken into account, then multi-layer variants can also be implemented.

A further option for ceiling mounting is the support of the mesh cable tray on profile rails, each mounted under the ceiling with two threaded rods. Even with this mounting variant, sufficient distances to the false ceiling must be maintained. A two-layer arrangement of the cable trays is possible, providing that the approved tensile stress in the threaded rods is maintained in the event of a fire.

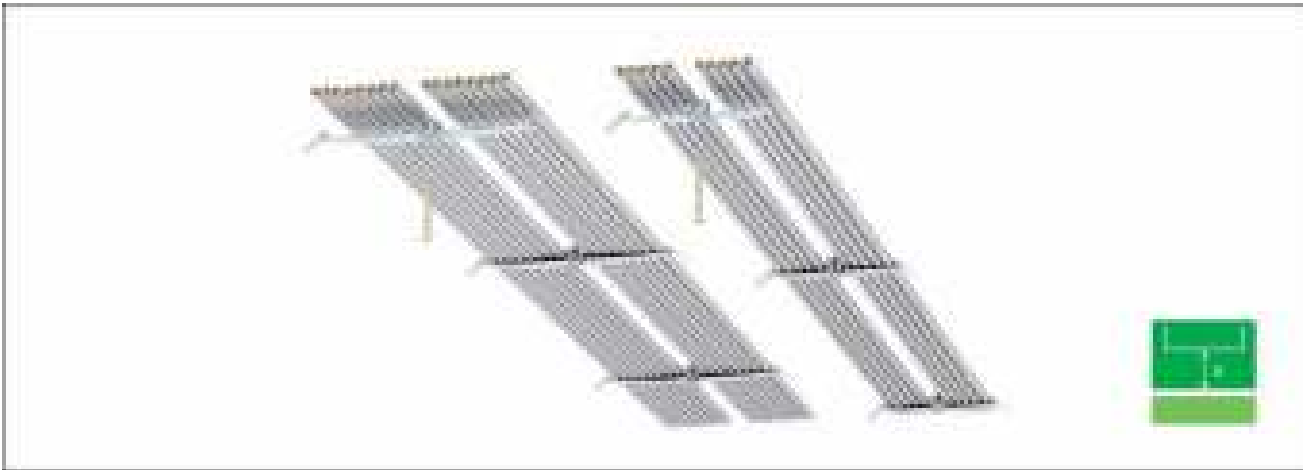




3.3.6 Grip M grouped supports

The tested Grip M grouped supports are suitable for installation in the false ceiling area of escape and rescue routes. In the event of a fire, the grouped supports have a proven mechanical stability of 30 to 90 minutes. They can be mounted under the ceiling or on the wall. The grouped supports are made of sheet steel and can be opened and closed easily without

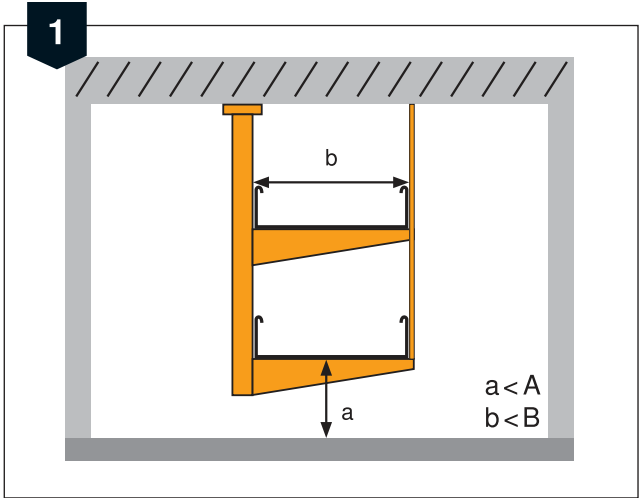
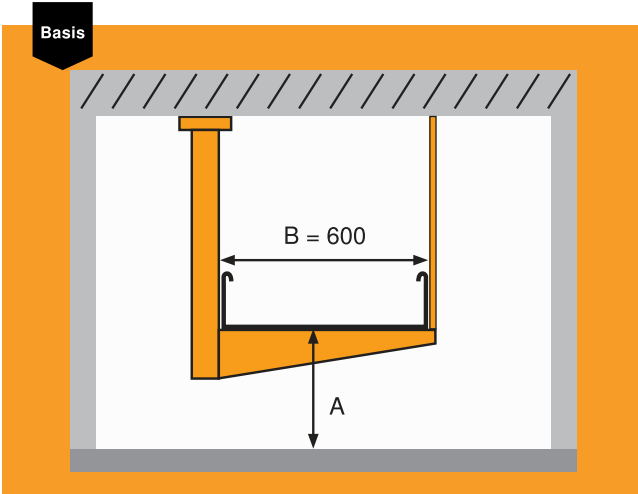
the use of tools. To allow simple cable insertion, the supports remain open during cable routing. Then, the grouped supports are closed through simple locking. The construction of the grouped support and weight of the installed cables prevent the lock from opening itself unintentionally.



3.3.7 Pressure clips

The tested pressure clips are suitable for installation in the false ceiling area of escape and rescue routes. In the event of a fire, the pressure clips have a proven mechanical stability of 30 minutes. They are mounted under the ceiling. The pressure clips are made of

sprung, rustproof steel. For installation, the hips of the pressure clips are simply bent downwards without tools and the cables pushed in from the side. The edges of the clip are sloping to exclude the possibility of damage to the cables.

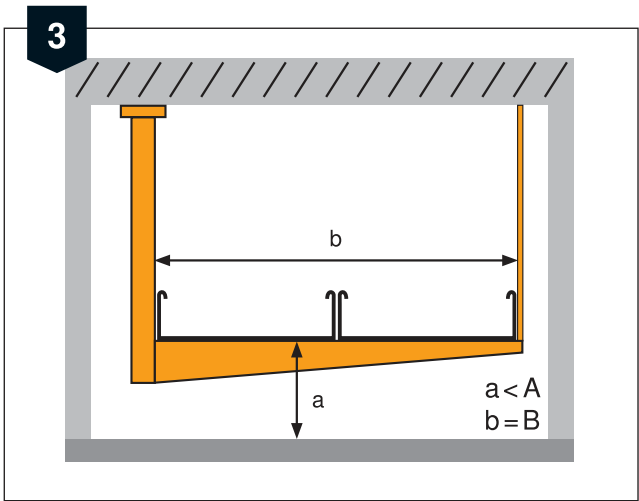
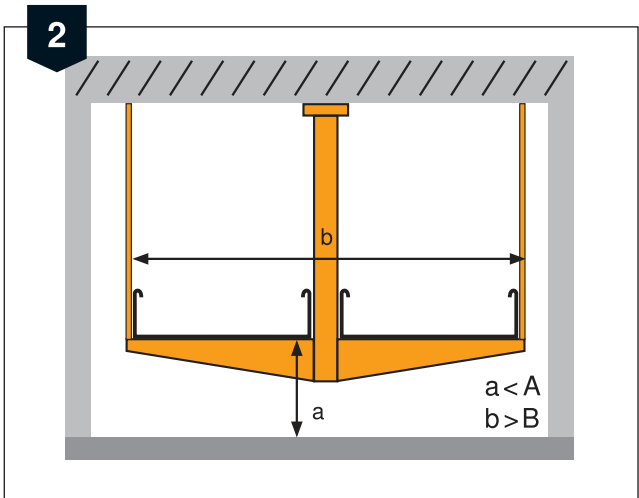


3.3.8 Selection aid

You can choose between the following when selecting the suitable system for fireproof fastening of large cable loads:

- Determine the cable volume
- Determine the required space
- Specify the distances to the fire protection ceiling
- Select the routing system

With a small amount of cables, this produces the selection of grouped supports, pressure clips and ceiling supports. For high cable loads cable support systems are used.



The basic data was determined in the fire tests. This data allows the design of various variants if, for example, there is no mounting space available at the side or if deformation should be restricted further.

1	2	3
Two layers on top of each other	Symmetrical on both sides	Two trays on one bracket
Height available	Low height available	No height available
Deformation "a" smaller than base	Deformation "a" smaller than base	Deformation "a" smaller than base
Side space requirement ↓ Distance "a" ↓	Side space requirement ↓ Distance "a" ↓	Side space requirement ↓ Distance "a" ↓

Use of the variants



3.3.9 Existing systems

In existing systems, it is important to check which components were used in the existing support systems: Were steel components and steel anchors used

consistently? Are the cable trays screwed together? Are the support spacings comparable to those of the tested systems?



If these basic requirements are fulfilled, then the existing systems can be used. It is possible that the addition of extra fastening points will be sufficient to prevent slippage or excessive deformation in the event of a fire.

CAUTION: Tested false ceiling systems do not fulfil the requirements for the maintenance of electrical functionality!



EJK screed-covered duct system



OKA open trunking system

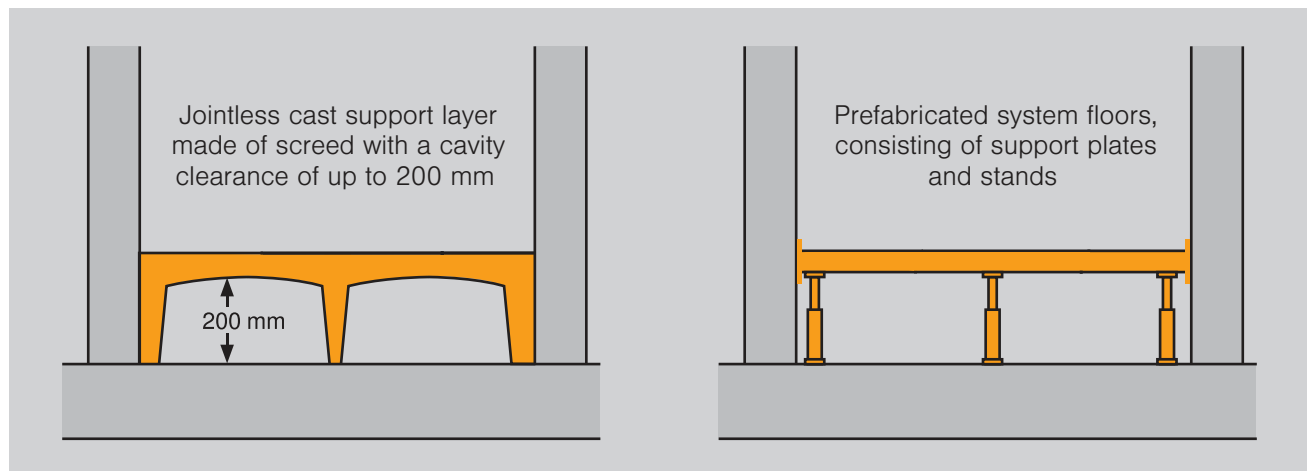
3.4 Installations in underfloor systems

Underfloor systems are frequently routed in system floors. System floors are floor constructions with a modular design, which consist of a sub-construction and a carrier layer, which are routed on the floor coverings. The cavity under the carrier layer can be used for installations for data and power supply for all kinds of supply and disposal lines.

In Germany, the Sample System Floors Directive (M-SysBöR) [20] applies for fire protection measures in underfloor systems. It should be regarded as a supplement to the cable systems directive and deals primarily with the installation of underfloor systems in emergency and escape routes. However, other rooms of a building may be subject to fire protection requirements for the system floors.

System floors are primarily approved in the necessary staircases, in rooms between necessary staircases and exits to the open air, as well as in the necessary corridors and other rooms. System floors are forbidden in safety stairwells. The system floors directive distinguishes between cavity floors and raised floors.

Whilst cavity floors have a poured support layer made of screed, with a maximum cavity of 200 mm, raised floors are made of prefabricated support plates on a stand structure. In most emergency and escape routes, poured floors are used. If underfloor systems are used here to supply electrical energy, these ducts must fulfil certain requirements. Only inspection openings are permitted in these areas.

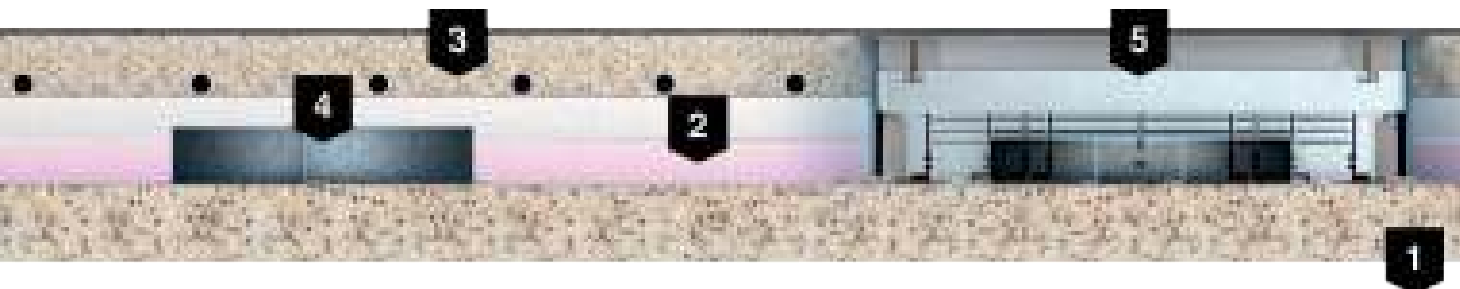


Definition of system floors: Cavity floor (left), raised floor (right)

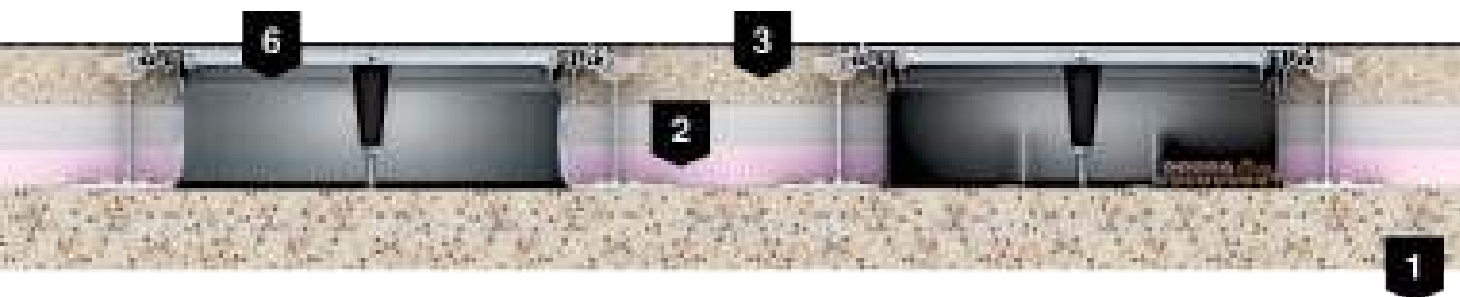
Outside the emergency and escape routes, system floors only have few fire protection requirements placed on them. The fire loads installed beneath the floor are assigned fully to the room. With raised floors of a height greater than 500 mm, the support structure must have a fire resistance period of 30 minutes. This is intended to prevent the rescue teams of the fire brigade from falling through the floor when entering the building. Raised floors, also those used for

room ventilation, must be equipped with smoke detectors. These must switch off the ventilation system. To minimise the risk of fire through the electrical installation, cables are routed beneath the raised floor in fire protection ducts. If there is a cable fire, these classified ducts ensure that the fire and smoke cannot spread unimpeded in the raised floor.

EÜK screed-covered duct system



OKA open trunking system



3.4.1 EÜK screed-covered duct system

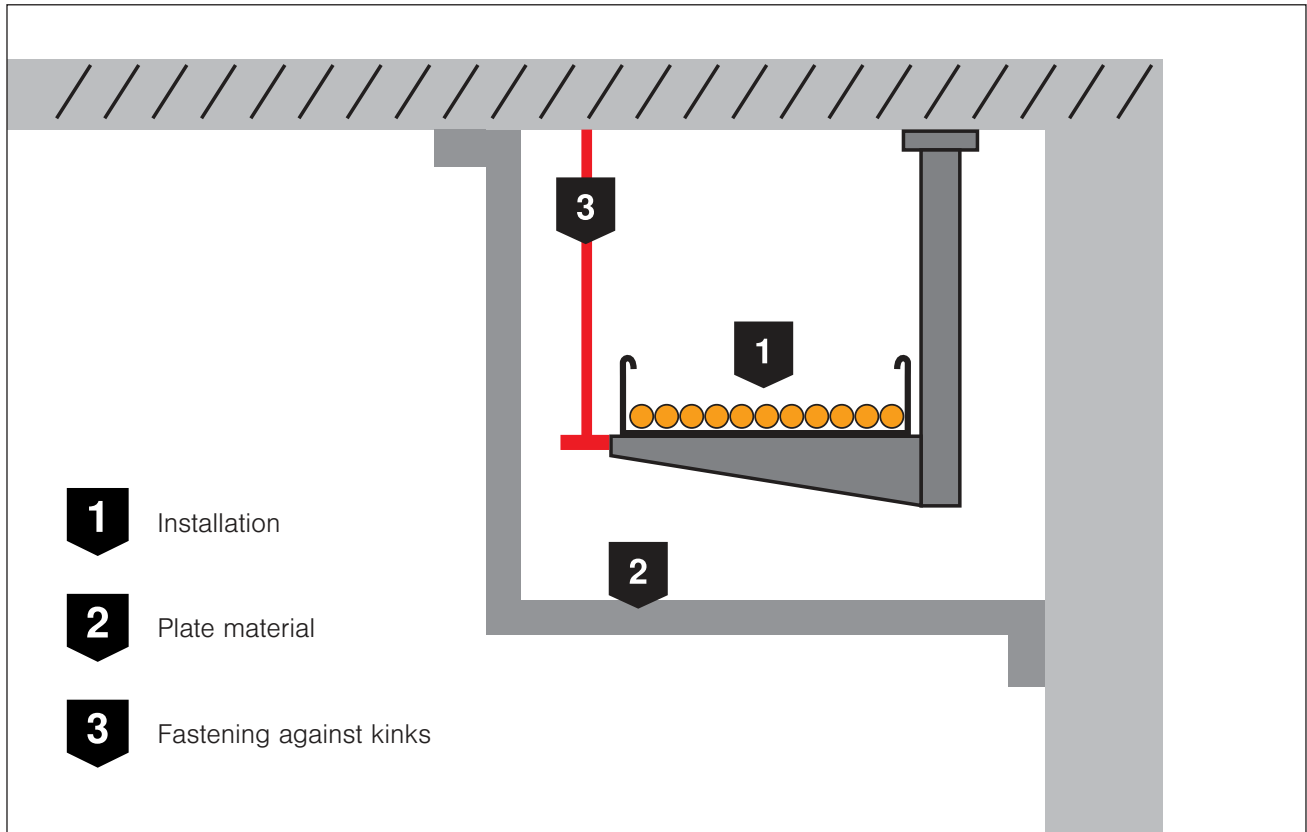
The screed-covered duct system is suitable for all screed types in all routing types, also in hot screed. The electrical installation ducts form a tight, hidden cable routing grid in the screed. Underfloor sockets allow the expansion with device installation units and access to the electrical installation.

3.4.2 OKA open trunking system

The electrical installation trunking can be adjusted to the millimetre to the upper edge of the screed. OKA trunking is suitable for screeds in all routing types, with the exception of heated screed. The benefit when changing the use of the room: The screed-flush electrical installation trunking can be opened along their entire length, allowing flexible cable routing. Depending on the screed height, device installation units are either installed in the trunking route or in extension units which are mounted at the side.

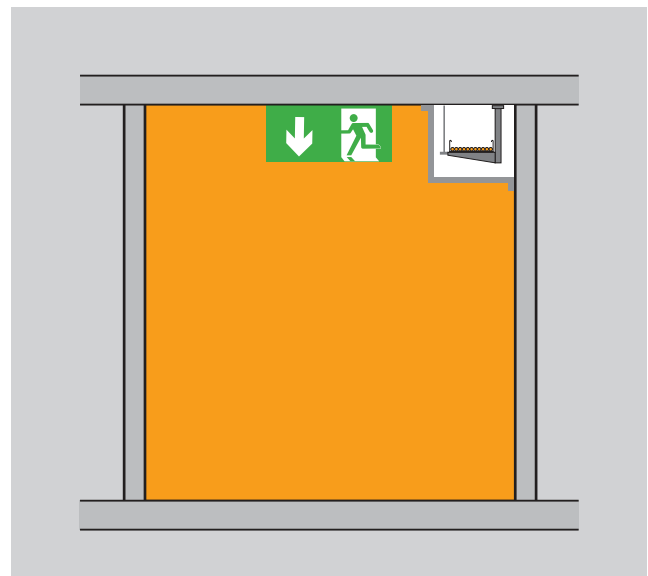
- 1** Raw floor
- 2** Insulation
- 3** Floor
- 4** Duct, screed-covered
- 5** Underfloor box
- 6** Open trunking

The EÜK underfloor ducts and the OKA open trunking fulfil the fire protection requirements for escape and rescue routes: They close tightly and possess non-combustible covers.



3.5 Shielding with plate material

One 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 must be no mechanical load on the plates meaning that the installations are secured against fire within the plates. This shielding involves large amounts of work which is done by drywall engineers and insulation engineers on the construction site. These constructions must possess proof of usability. Often, this is a general construction test report of a materials testing institute.



Escape route with lined cable support system

3.6 Cable routing in fire protection ducts

Fire protection ducts are particularly suitable for installations in escape and rescue routes. The ducts offer protection against the effects of a cable fire, in which a lot of very dense, black smoke is created. They are available in various designs as

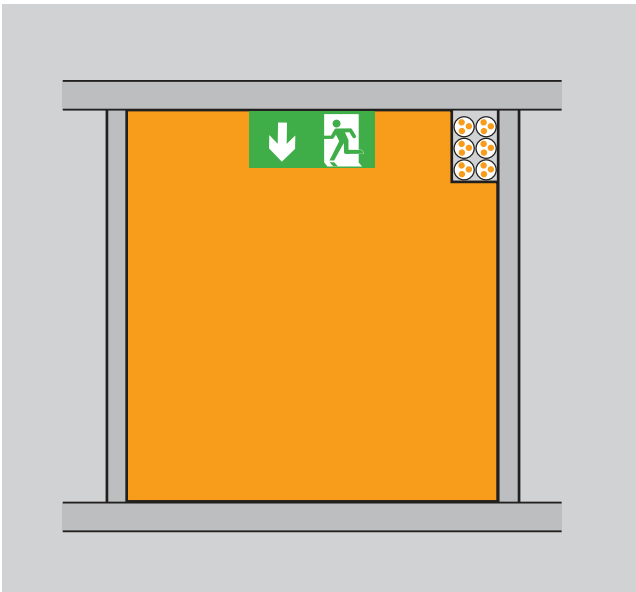
- Metal duct with linings made of calcium silicate or mineral wool plates
- Metal duct with intumescent inner coating
- Prefabricated, stable lightweight concrete ducts
- Self-build ducts made of non-supporting, coated mineral fibre plates
- Self-build ducts made of silicate plates

The dimensions of the variants are dependent, on the one hand, on the construction, but, on the other, also on the fire resistance class they must fulfil.

3.6.1 Tests and proofs of application

Fire protection ducts are tested in an independent materials testing institute. The electrical cables are burned within the duct. During the entire classified time specified by the testing standard, neither fire nor smoke may escape from the duct system. Cable exits are also tested. In this manner, it is possible to prove that the fire load is effectively encapsulated in the duct and that the fire protection duct offers secure protection of escape and rescue routes against the effects of a cable fire.

In Germany, fire protection ducts for use in escape and rescue routes are classified as I ducts according to DIN 4102 Part 11 [21]. There are I30 (fire-retardant) to I120 (fire-resistant) versions. According to the European Classification Standard EN 13501, ducts can have the properties EI 90 (i→o) (see Chapter 1). Here, "i→o" stands for the flaming direction: Tested and approved with a fire load from the interior to the exterior and vice versa. The applicability is again documented in a test report, a classification report from a material testing institute or a European Technical Evaluation.



Escape route with fire protection duct





Metal duct with mineral fibre plates



*Metal duct with calcium silicate plates;
blunt connection*



*Metal duct with calcium silicate plates;
connection with tongue and groove*



Metal duct with intumescent inner coating



Duct made of fibre-glass reinforced light-weight concrete



Duct made on construction side of fire protection plates



Space requirement with the same usable cross-section: Comparison between a coated metal duct and a fire protection duct lined with plates.



3.6.2 Versions

The PYROLINE® fire protection ducts are available in various versions and classification combinations.

All the cables are approved according to DIN 4102 Part 11 as the escape and rescue route ducts for the encapsulation of the fire load. The lightweight concrete ducts BSK (H) 09 and BSK 12 were tested and approved for the maintenance of electrical functionality to DIN 4102 Part 12.

3.6.3 Support systems for fire protection ducts in escape and rescue routes

Support systems for fire protection ducts in escape and rescue routes must carry almost only the cable and duct weight. Neither the support systems nor the anchors used come into contact with the high temperatures if there is a fire. The cable fire occurs within the duct. For these reasons, the load capacity values of the "cold" state are completely sufficient. It is still wise to use fire-tested mounting systems and anchors, as they form part of safety-relevant systems.



Classification as an escape route duct



Classification for the maintenance of electrical functionality



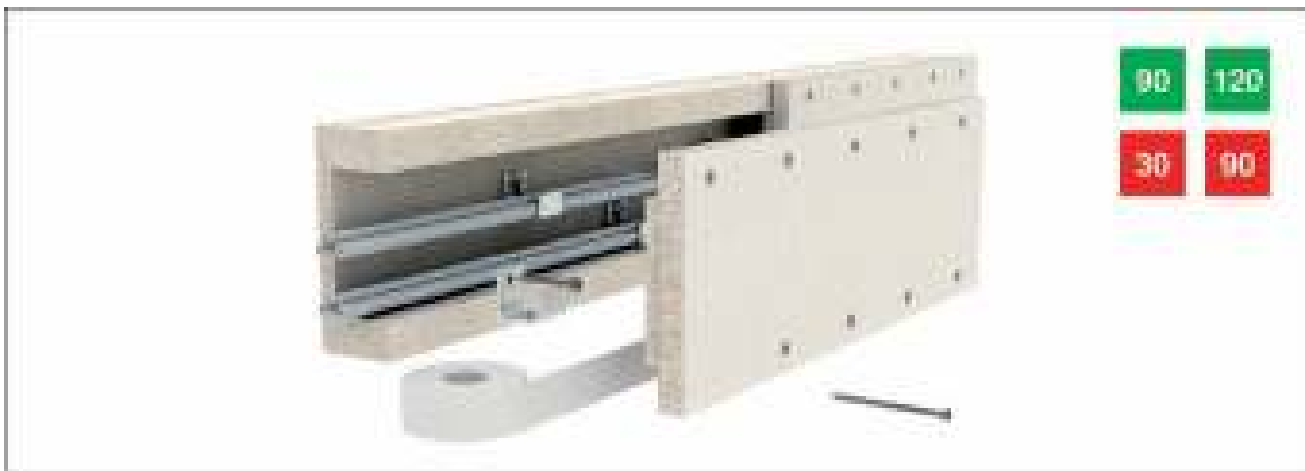
Time in minutes



3.6.4 PYROLINE® Rapid

OBO's PYROLINE® Rapid fire protection duct is made from sheet steel with a profiled lid closing contour and an intumescent interior coating. If there is a fire, this provides active fire load encapsulation and safe prevention of the fire spread. This means that the escape and rescue routes remain free from fire and smoke. The PYROLINE® Rapid is tested and approved as an escape route duct for the classes I 30 to I 120. The shape matches the standard Rapid 80 cable routing duct. The fire protection duct can be in-

stalled directly on the wall or the ceiling. Mounting on wall brackets or on a support system suspended from the ceiling is also possible. The lids can be engaged easily in the base, simultaneously creating the equipotential bonding. The connectors can also be used for suspension. Even overhead mounting is possible, as special brackets keep the cable load away from engaged lids. All the components are prefabricated. There are also no screw ends in the interior of the ducts, meaning that cables cannot be damaged.



3.6.5 PYROLINE® Con D

The PYROLINE® Con D fire protection duct consists of fibre-glass light concrete fire protection plates which are resistant to water and frost. The fire protection plates, which are classed as non-combustible (material class A1), have a compacted surface, which is thus hard, smooth and wear-resistant. The OBO PYROLINE® Con D is used as an I duct to protect escape and rescue routes against the effects of a possible cable fire. This means that the escape and rescue

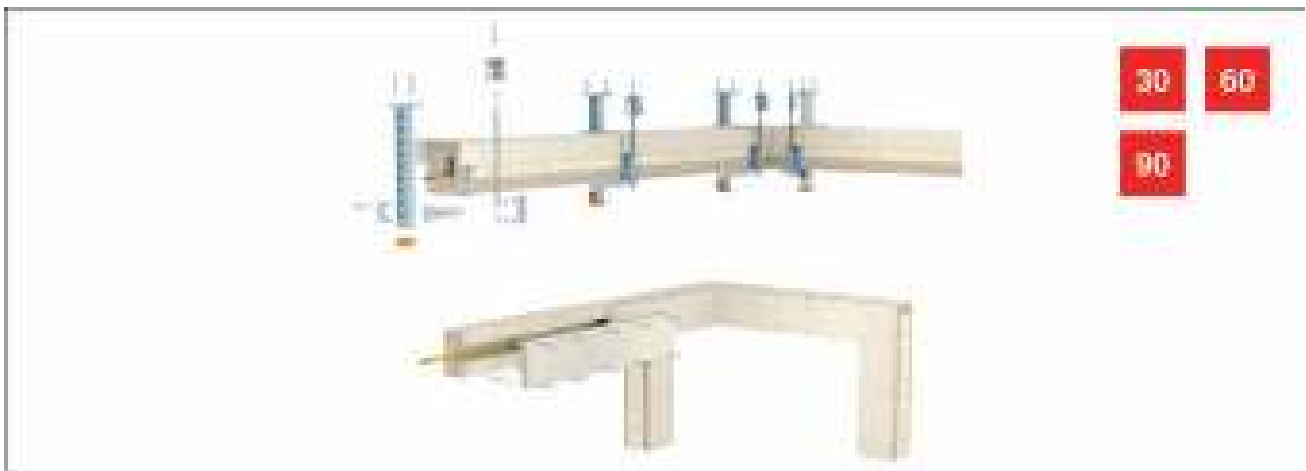
routes remain free from fire, smoke and heat. As an E duct, PYROLINE® Con D allows the maintenance of electrical functionality of the safety-relevant circuits. The fire protection duct is mounted directly on walls and ceilings. Possibly necessary fittings can be created simply and flexibly on-site according to requirements. The fire protection ducts can be painted or papered over, as required.



3.6.6 PYROLINE® Con S

The PYROLINE® Con S fire protection duct, like the PYROLINE® Con D, consists of fibre-glass light concrete fire protection plates which are resistant to water and frost. The OBO PYROLINE® Con S is used as an I duct to protect escape and rescue routes against the effects of a possible cable fire. This means that the escape and rescue routes remain free from fire, smoke and heat. As an E duct, it allows the maintenance of electrical functionality of the safety-relevant

circuits. The fire protection duct can be installed on wall brackets or on one of the support systems suspended from the ceiling. Mounted connectors permit quick connection of the duct sections in situ, while loosely placed covers permit quick inspection and re-assignment. The duct allows elegant avoidance of objects from other areas such as heating, ventilation and sanitary applications.



3.6.7 PYROLINE® Fibre Optics

The PYROLINE® Fibre Optics fire protection duct is used to install and route fibre optic cables. It is used as an E duct for the maintenance of electrical functionality (class E30–E90) according to DIN 4102-12. PYROLINE® Fibre Optics consists of fibre-glass light concrete fire protection plates, which are resistant to water and frost. The fire protection plates, which are classed as non-combustible (material class A1), have a compacted surface, which is hard, smooth and wear-resistant. An ablation coating is applied to the inner sides of the fire protection duct as additional heat insulation in the event of a fire. The PYROLINE® Fibre

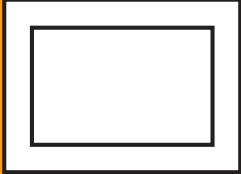
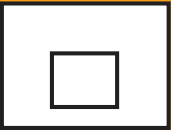
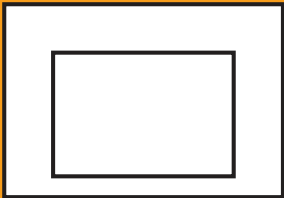
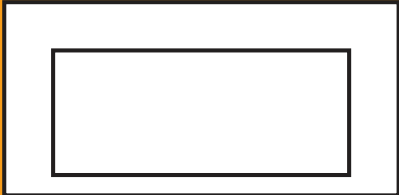
Optics fire protection duct is mounted directly either on solid walls and ceilings. Possibly necessary fittings can be created simply and flexibly on-site according to requirements. A second variant of the PYROLINE® Fibre Optics fire protection duct is installed on wall brackets or on a support system suspended from the ceiling. Mounted connectors permit quick inspection and reassignment. The fire protection ducts can be painted or papered over, as required. The minimum approved bend radii for fibre optic cables can easily be maintained in the fire protection ducts.



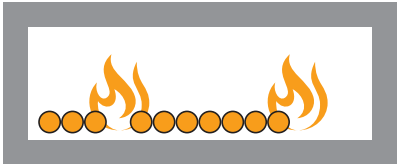
3.6.8 PYROLINE® Sun PV

The PYROLINE® Sun PV fire protection duct is the ideal fire protection duct for fireproof routing of photovoltaic DC cables. If there is a fire, its non-conductive surface ensures protection against dangerous contact voltages. In addition, the duct fulfils the requirements as an I duct according to DIN 4102 Part 11 for cable installations in emergency and escape routes. In addition, it meets the requirements of the VDE application

rule AR 2100-712. The fire protection duct can be installed directly on the wall or the ceiling. The appropriate connection armatures mean that suspended mounting is also possible. The duct is made of water and frost-resistant glass fibre lightweight concrete fire protection plates (non-combustible, material class A1), meaning that it is suitable for external areas.

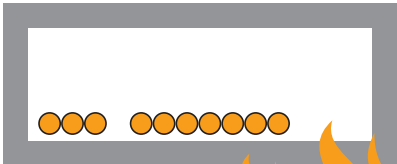
BSKM I duct			
	70 x 40		110 x 70
			250 x 100
BSK09 I/E duct		BSKH 09 I/E duct	
	Internal dimensions 60 x 50		Internal dimensions 60 x 50
	110 x 50		110 x 50
	210 x 50		210 x 50
	160 x 105		160 x 105
	260 x 105		260 x 105
BSK 12 I/E duct			
	Internal dimensions 60 x 50		Internal dimensions 160 x 105
	110 x 50		
	210 x 50		260 x 105

Escape and rescue route Protection against the effects of cable fires for safe use of escape and rescue routes				
Fire protection duct	Type	Class "I" [minutes]	Mounting Direct	Mounting Suspended
PYROLINE®Sun PV	BSKP 0406	30	✓	✓
PYROLINE®Con D -	BSK 09...	90	✓	✗
PYROLINE®Con S	BSKH 09...	90	✗	✓
PYROLINE®Con D -	BSK 12...	120	✓	✗
PYROLINE®Rapid	BSKM...	120	✓	✓



Fire in the duct - Class "I"

Maintenance of the electrical supply Maintenance of the electrical supply to safety-relevant systems if there is a fire on the outside				
Fire protection duct	Type	Class "E" [minutes]	Mounting Direct	Mounting Suspended
PYROLINE® Con D -	BSK 09...	30	✓	✗
PYROLINE® Con S	BSKH 09...	30	✗	✓
PYROLINE® Con D -	BSK 12...	90	✓	✗
PYROLINE® Fibre Optics	BSKF 0808	90	✓	✗
PYROLINE® Fibre Optics	PYROLINE® Fibre Optics	90	✗	✓



Fire outside the duct - Class "E"

Table 7: Selection aid, fire protection ducts

3.6.9 Selection aid

When selecting the suitable fire protection duct system, the following questions must be asked first:

- Should the duct protect the escape route against the effects of a cable fire?
- Must the duct protect the cables of a safety-relevant electrical system against a fire?
- Are they fibre optic cables, which must be routed in a manner that is protected against fire?
- Are the routed cables DC cables for photovoltaic systems?

After determining the expected cable volume, you can select the appropriate duct size. Here, attention may need to be paid to the existing installation space: With this decision, the ratio of the external dimensions to the capacity is at the forefront.

Some 90% of the fire protection ducts are used in escape and rescue routes. However, in recent years, they have increasingly been used to protect the cables against fires from the outside.



Chapter 4: Maintaining the electrical supply for safety-relevant electrical systems – protection aim 3

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4 Maintaining the functionality of safety-relevant electrical systems – protection aim 3

If there is a fire, escape and rescue routes must remain usable and important technical equipment, such as emergency lighting, fire alarm systems and smoke extraction systems, must continue to function. In addition, certain technical systems must support the fire brigades in fighting fires for a sufficiently long period of time. To guarantee the power supply, meaning that the electrical functionality is maintained with the technical equipment and systems if there is a fire, the appropriate installations must be equipped with special cables and routing systems.

4.1 Where is the maintenance of the electrical supply required?

Technical equipment that maintains the electrical functionality is required for the following buildings and areas: Hospitals, hotels, restaurants, tower blocks, meeting places, shops, closed indoor car parks, metro systems, the chemical industry, power stations and tunnels. These buildings are frequently visited by large numbers of people, creating an increased safety risk for gatherings of people. However, with certain systems, property and the environment must also be protected.



The requirement for electrical installations that maintain the electrical functionality is a component part of the construction regulations. Maintaining the electrical functionality only relates to those areas which provide the power supply to safety-relevant electrical systems, such as emergency lighting, alarm systems, fire alarm systems, automatic extinguishing systems, smoke extraction systems, etc. Here, the regulations require that the power supply must be guaranteed for a specific period of time, even if there is a fire.



4.2 What should the maintenance of electrical functionality achieve

30 minutes: Maintenance of the electrical supply for rescue and a safe evacuation.

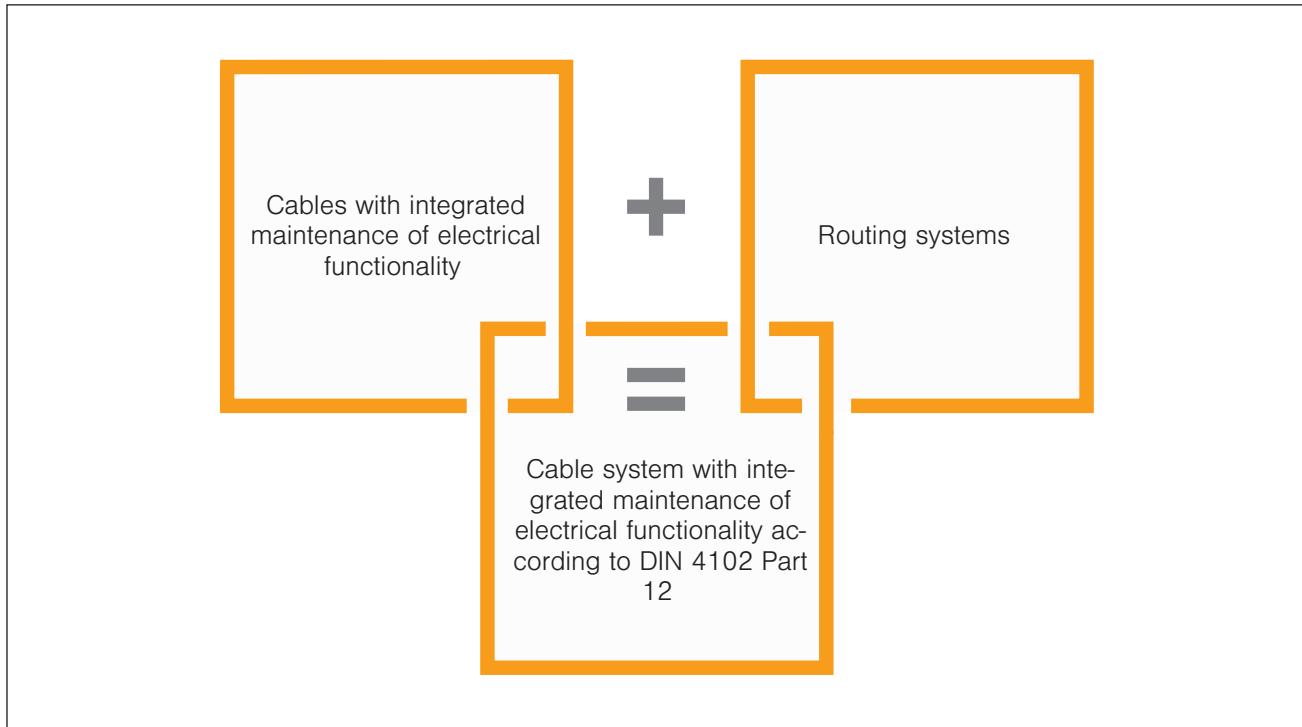
The first 30 minutes after the start of a fire play an important role when clearing the affected building. During this time, the maintenance of the electrical supply must be guaranteed for the following units:

- Safety lighting systems
- Lifts with fire control
- Fire alarm systems
- Alarm systems and systems for issuing instructions
- Smoke extraction systems

60/90 minutes: Maintenance of the electrical functionality for effective firefighting and difficult evacuation

To support firefighting operations, it is imperative that certain technical equipment is supplied with sufficient power for 60 or 90 minutes after a fire breaks out in a building. This equipment includes:

- Automatic extinguishing systems
- 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



4.3 Cable systems with integrated maintenance of electrical functionality

4.3.1 Definition of a cable system

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

4.3.2 Testing and classification standards

There is currently no European standard on the maintenance of electrical functionality, but there are some national test regulations, e.g. according to PAVUS in the Czech Republic. The most widely spread and accepted is testing according to DIN 4102 Part 12. Work is currently being carried out on the European standards. The appropriate proofs of suitability are issued on the basis of this standard.

In future, safety cables and support systems will be inspected separately, so that components can be combined which have the same maintenance of electrical functionality class.



Test structure of a cable system that maintains electrical functionality

4.3.3 Fire tests

The proof of the maintenance of functionality of electrical installation material must be obtained by a fire test, carried out by an independent materials testing agency.

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 criterion is: No failure of the cables through short-circuits or conductor breaks during the required testing time.



Furnace at a testing office



Safety cables before...



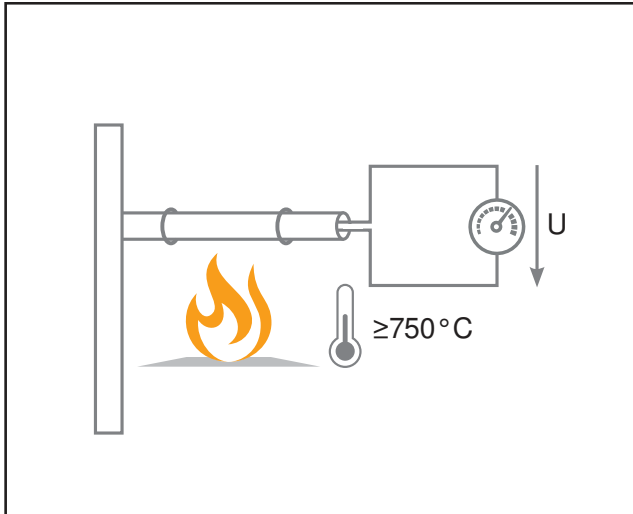
...and after fire testing

4.3.4 Cables

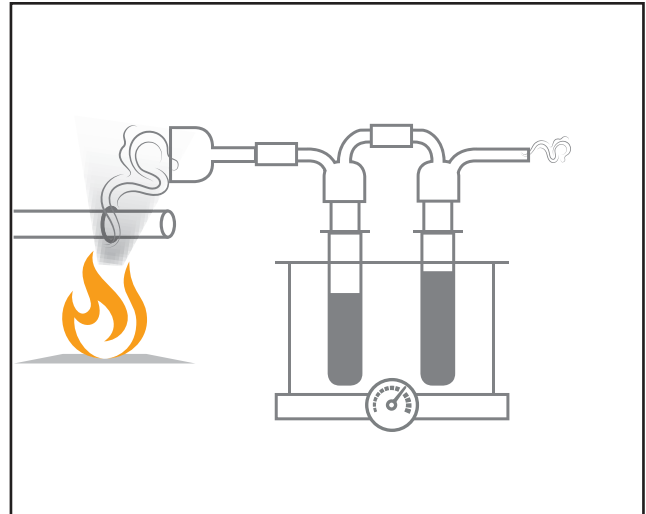
If there is a fire, the cables are subjected to extreme loads from flames and heat. Nevertheless, cables used for a safety installation must be able to withstand temperatures of up to 1,000 °C and higher for a specific period of time, without there being a short-circuit of the copper conductors. As the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

Due to the temperature development in the cable, in the case of cables that have integrated maintenance of electrical functionality, the insulation has a special

role to play. There are two construction types: The cables possess a special coil around the copper conductors made of glass silk or mica tape. If there is a fire, then the cable insulation burns completely, creating an insulating layer of ash. This is kept together by the coils and ensures that the copper conductors are kept apart and that no short-circuit of the support system can occur. 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 naturally also to the support system.



Testing of the insulation maintenance on a cable



Measurement of the pH value when burning the insulating material

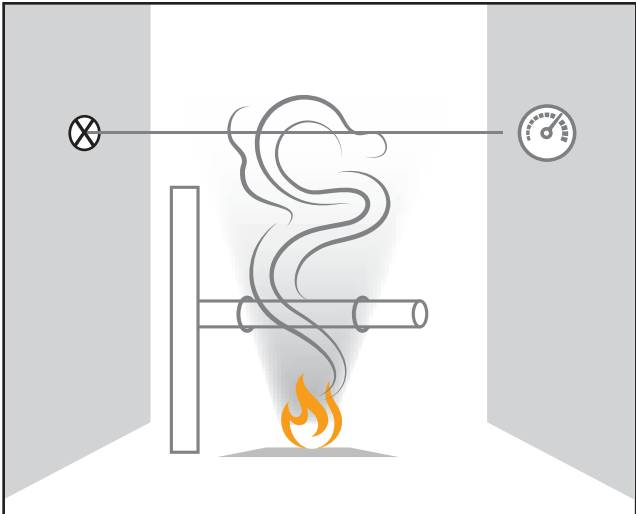
Insulation maintenance

So-called insulation maintenance, i.e. how long the insulation around the cables can resist the temperatures, is tested in a special process. However, there are many misunderstandings here, which can be caused by the abbreviations "FE 90" and "FE 180". They do not stand for "Maintenance of electrical functionality for 90/180 minutes" but for "Flame exposure".

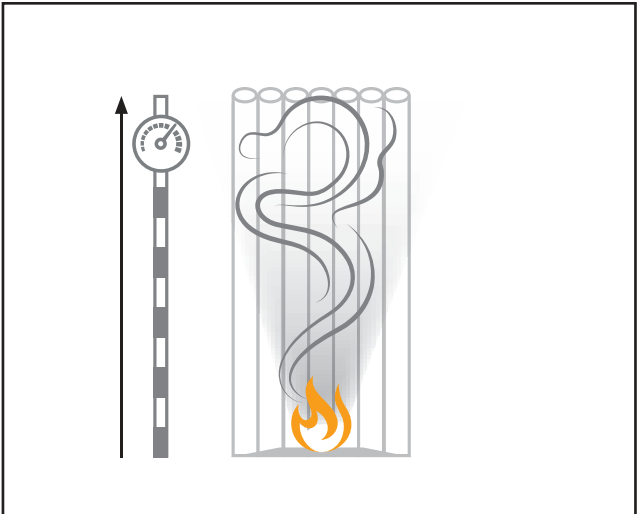
The "flame impact time" is a testing criterion according to DIN VDE 0472-814 [22] and IEC 60331-11, -12 and -13 [23]. Here, cable samples are subjected to direct flaming at a constant temperature of at least 750 °C for a period of 90 minutes (IEC) or 180 minutes (VDE). During this time, none of the fuses monitoring the individual wires may drop. This test of "insulation maintenance" may not, under any circumstances, be confused with the test of the maintenance of electrical functionality of cable systems and only applies to small wire cross-sections.

Cables with improved behaviour in case of fire

Cables that have integrated maintenance of electrical functionality are ranked amongst cables with improved behaviour in a fire. They are always manufactured from halogen-free plastic. These materials, which contain neither chlorine, bromine nor fluorine, do not form any corrosive fire gases on combustion. This is proven through the combustion of the insulating material and measurement of the pH value and the conductivity according to EN 50267-2, -3 [24] / IEC 60754-2 [25].



Smoke density measurement



Testing of the vertical fire spread

In addition, cables that have integrated maintenance of electrical functionality produce low smoke levels and reduce the spread of fires. These additional positive properties in case of fire are also checked using fire tests on cable samples. The smoke density is measured according to IEC 61034-1 and -2 [26] and EN 61034-1, -2 [27]. The light intensity is measured using photoelectrics, whereby the minimum value may not fall below 60% of the nominal output of the light source due to the created smoke.

The spread of fires is tested in a vertical arrangement according to EN 50266-2-4 [28] and IEC 60332-3-24 Cat. C [29]. 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. Cables are considered construction products and must be tested and evaluated according to European criteria regarding the fire behaviour. According to EN 13501-6 [30], they receive the abbreviations shown in Table 8, depending on their fire behaviour. The smoke development (-s), drip behaviour (-d) and corrosivity (-a) are evaluated.

In future, the European classes B2_{ca} and C_{ca} will become the standard for cable installations in special constructions.

Euro class	Additional class			Safety requirement
Flame spread/ heat development	Smoke creation/ density	Burning drops	Acid development/ corrosivity	
A _{ca}				Very high
B1 _{ca}				Very high
B2 _{ca}	s1	d1	a1	Very high
C _{ca}	s1	d1	a1	High
D _{ca}	s2	d2	a1	Medium
E _{ca}				Low
F _{ca}				None

Table 8: Euro classes of fire behaviour of cables with assignment to building requirements

		Smallest bend radius for cable diameter in mm		
	Smoke	$\varnothing \leq 8$	$8 < \varnothing \leq 12$	$12 < \varnothing \leq 20$
Cable with rigid conductors	When used correctly	$4 \times \varnothing$	$5 \times \varnothing$	$6 \times \varnothing$
	Careful bending	$2 \times \varnothing$	$3 \times \varnothing$	$4 \times \varnothing$
Cable with flexible conductors	Fixed routing	$3 \times \varnothing$	$3 \times \varnothing$	$4 \times \varnothing$
	Flexible application	$4 \times \varnothing$	$4 \times \varnothing$	$5 \times \varnothing$

Table 9: Guide values for bend radii

External diameter of the cables in mm	Maximum distance in mm	
	Horizontal	Vertical
≤ 9	250	400
$9 < \varnothing \leq 15$	300	400
$15 < \varnothing \leq 20$	350	450
$20 < \varnothing \leq 40$	400	550

Table 10: Guide values for fastening spacings

Increased resistance of the electrical conductors in a fire

If there is a fire, the temperature of the copper conductor increases, also meaning a change to the specific electrical resistance. In consequence, the cable cross-section may no longer be sufficiently large. Due to the resistance increase, the voltage drop also increases and the required power cannot be provided for the electrical system. The cable manufacturers offer calculation programs for this, which take the fire and the necessary cross-section increase into account. This means that the cable system can be designed safely for safety-relevant systems.

Directives for fastening spacings and bend radii

The electrical regulations specify the values for the maximum fastening distances and bend radii of the cables. The parameters in Tables 9 and 10 apply according to DIN VDE 0100-520 [31]. The fastening spacings determined during the fire tests may deviate considerably from the data of the electrical regulations. However, the testing standard indicates that accompanying standards must be complied with. In consequence, the lowest tested or standardised fastening spacings must be complied with.

	Classification to (examples):			
Maintenance of electrical functionality in minutes	DIN 4102-12	NBN 713.020	NEN 2535	EN 13501-2
≥ 30	E 30	-	FB 30	P 30
≥ 60	E 60	Rf1	FB 60	P 60
≥ 90	E 90	Rf1½	FB 90	P 90

Table 11: Maintenance of electrical functionality classes and their abbreviations [32;33]

4.3.5 Classifications and certificates

Depending on the length of time achieved, the cable systems are assigned to the classes E 30 to E 90 according to DIN 4102-12. According to the European classification standard EN 13501, a cable system is given the abbreviation "P" and "PH" with the appropriate time in minutes after a successfully completed test. In Germany, the result of the fire test is documented in a construction test certificate. For cable systems, this test certificate is considered the proof of the maintenance of electrical functionality in combination with the listed cables.



Test certificate, NRW materials testing institute



After erection, each cable system must be permanently labelled with a sign. This labelling must contain the following information:

- Name of builder of the cable system (installation engineer)
- Maintenance of electrical functionality class "E" or "P"
- Test certificate number
- Owner of the test certificate
- Year of manufacture



4.4 Maintenance of the electrical supply with fire protection ducts

Cable systems according to DIN 4102 Part 12 also include cable ducts. The different construction types of the ducts must ensure that the cables routed in the interior continue to function in a fire on the outside. This is ensured using different duct materials (see also Chapter 3).

Therefore, no special cables that maintain the electrical function need be routed in fire protection ducts and it is possible to use normal, PVC-insulated cables, tested according to the standard. As cables with integrated maintenance of electrical functionality 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 that maintain electrical functionality, for example. However, these cable types can be routed in the fire protection duct, achieving the protection aim of the safe supply of a safety-relevant system.



4.4.1 PYROLINE® Con D/S

The PYROLINE® Con D/S fire protection duct consists of fibre-glass light concrete fire protection plates which are resistant to water and frost. The fire protection plates, which are classed as non-combustible (material class A1), have a compacted surface, which is thus hard, smooth and wear-resistant. The OBO PYROLINE® Con D/S is used as an I duct to protect escape and rescue routes against the effects of a possible cable fire. This means that the escape and rescue routes remain free from fire, smoke and heat. As an E duct, PYROLINE® Con D/S allows the maintenance of electrical functionality of the safety-relevant circuits. The fire protection duct is mounted directly on solid walls and ceilings. Possibly necessary fittings can be created simply and flexibly on-site according to requirements. The fire protection ducts can be painted or papered over, as required.



4.4.2 PYROLINE® Fibre Optics

Communication systems must continue to function even if there is a fire. Ever more often, they are equipped with fibre optic cables, in order to process large data volumes securely. In industrial systems too, optical data transmission systems are used for process control. In the event of a fire, the processes must be ended in a controlled fashion, in order to prevent damage to people and the environment. For this reason, the fibre optic cables must be routed with special protection in a fire.

Fibre optic cables cannot be evaluated according to the testing standard DIN 4102 Part 12, as the basic criteria only relate to copper conductors. The PYROLINE® Fibre Optics fire protection ducts protect the fibre optic conductors against an external fire for a period of 90 minutes. The achieved class of maintenance of electrical functionality is "E 90".

4.4.3 Support systems for fire protection ducts in systems that maintain electrical functionality

For the maintenance of electrical functionality, the support structures are not defined exactly in the approvals of the fire protection ducts. With these mounting variants, it must be ensured that the ducts do not slide off the support systems. For pendulum suspensions or suspended support-bracket combinations with additional threaded rod locking at the bracket tip, the electrical maintenance of functionality was proven in fire tests. In practice, these support systems have also proved their worth in the suspension of fire protection ducts.

4.5 Maintaining the electrical function with cable support systems

There are various routing options for routing cables with integrated maintenance of electrical functionality. 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.

4.5.1 Standard support structures

The standard specifies that not just the cables themselves maintain the functionality of an electrical cabling system but also the routing systems do. 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 maintenance of electrical functionality of their safety cables for the standard support systems.

DIN 4102 Part 12 defines three standard routing systems:

- Routing on cable ladders
- Routing on cable trays
- Individual cable routing under the ceiling

The individual clips or profile rails and clamp clips, with and without long troughs, belong to the individual routing of the cables under the ceiling defined in test standard DIN 4102 Part 12.

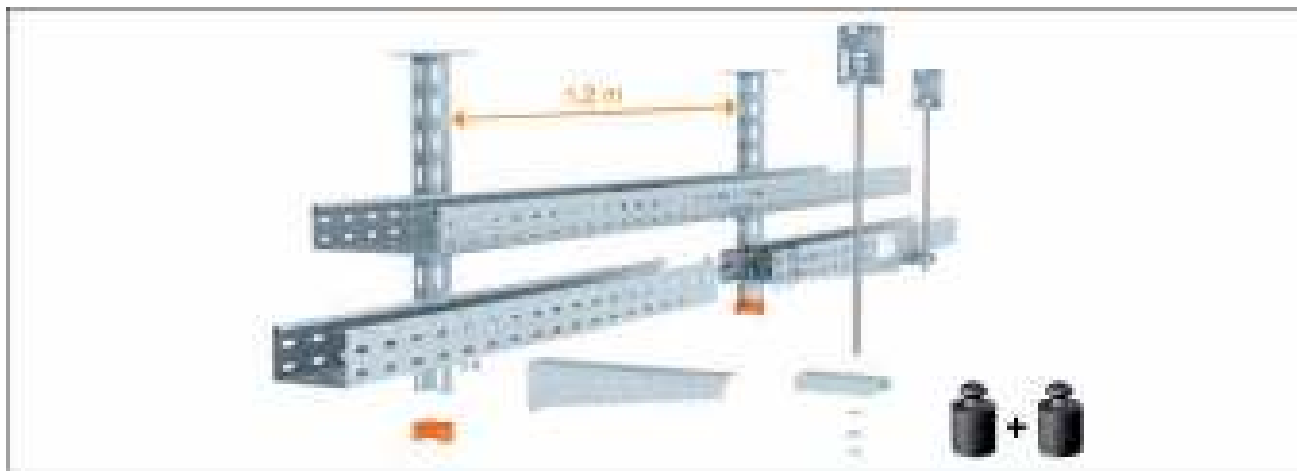
The parameters of the horizontal routing types were transferred to vertical installations, making the use of vertical sections possible.

	Cable tray	Cable ladders	Rising sections
Fastening spacings [m]	1.2	1.2	1.2
Width, maximum [mm]	300	400	600
Maximum cable load [kg/m]	10	20	20
Max. number of layers	6	3	1
Threaded rod locking	Yes	Yes	-

Table 12: Parameters of the standard support structures - cable trays and ladders

		Individual clips	Clamp clips without long troughs	Clamp clips with long troughs
Fastening spacings [m]	Horizontal	30	30	60
	Vertical	30	30	-
Cable diameter [mm]		Unlimited	Unlimited	Unlimited
Cable bundle, maximum [n x mm]		3 x 25	3 x 25	3 x 25

Table 13: Parameters of the standard support structures - individual routing with clips

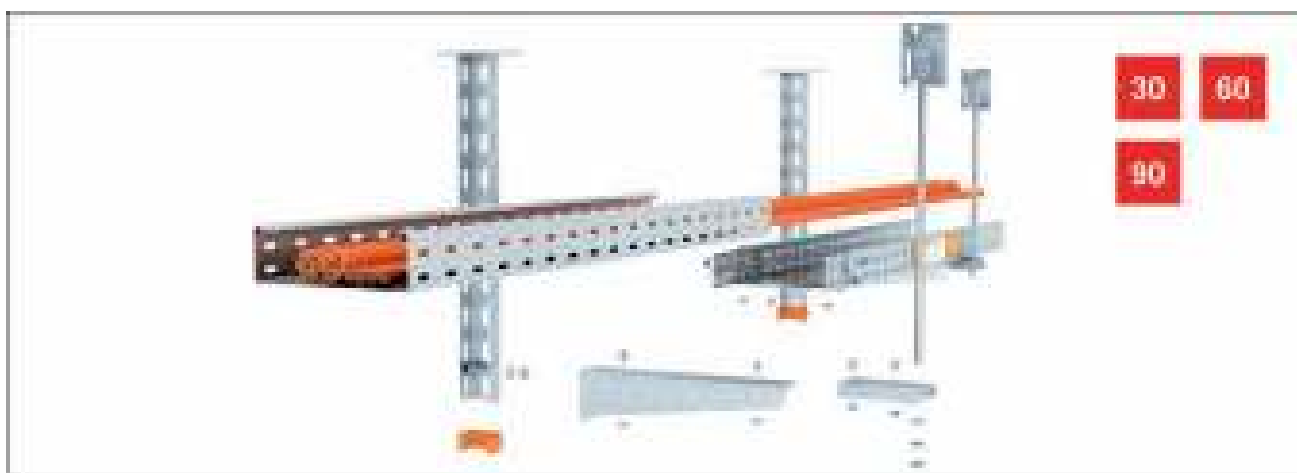


Benefits of standard support structures

- Free choice of cables
- No binding to specific cable types
- Ideal for smaller projects
- Countless installation variants

OBO Bettermann offers the following systems as standard support structures with the maintenance of electrical functionality classes E 30 to E 90 according to DIN:

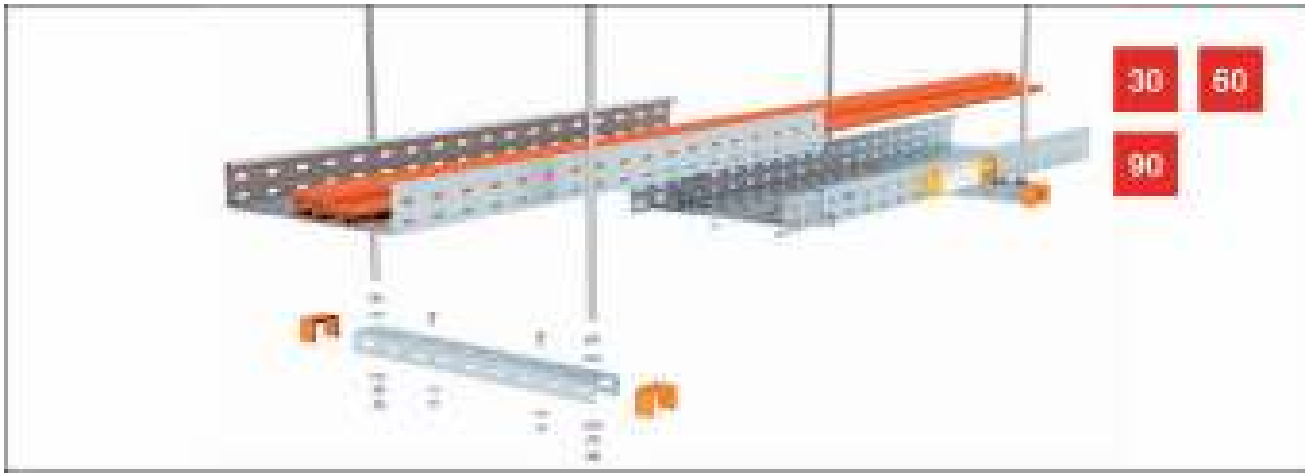
- Cable trays SKS
- Cable ladders LG
- Rising sections in light-duty and heavy-duty versions
- Single and clamp clips, types 732/733 and 2056(U)M
- Strain relief ZSE90 as effective support for vertical routing



SKS cable tray with U suspended support

The routing type of cable trays of type SKS with U suspended supports under the ceiling fulfils all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30 to E 90. The cable trays can be mounted on the U suspended support on one or both sides with up to six tray layers. The threaded rod lock

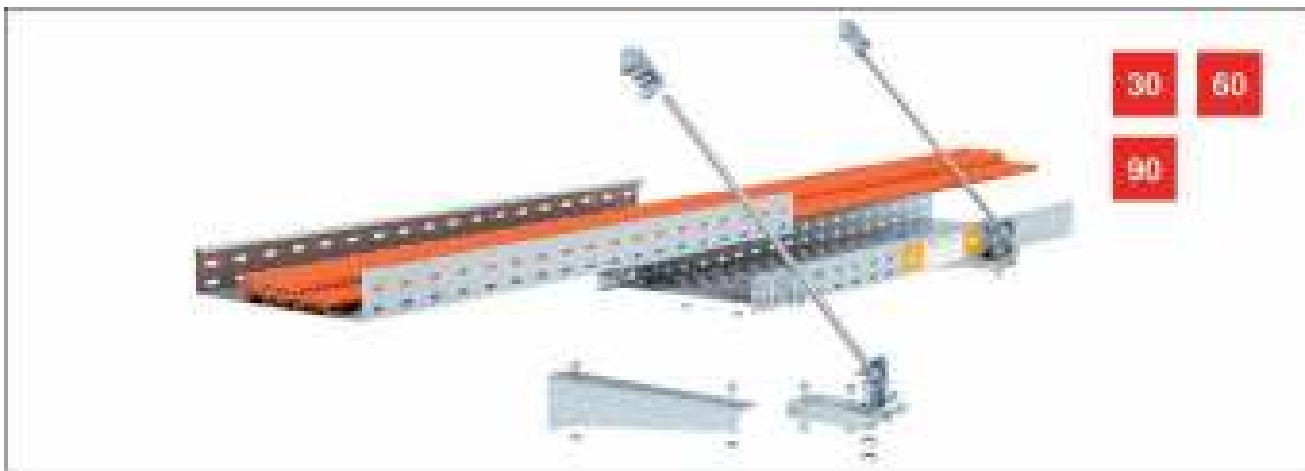
is fastened with a maximum spacing of 100 mm beside the bracket. For this, the ABR connection component should be screwed under the tray base. The position of the joints between the individual support points can be chosen freely. The cable trays are screwed on using connectors in the side rail and an additional joint plate in the base of the tray.



SKS cable tray with U transverse profile

The routing type of cable trays of type SKS with U transverse profiles under the ceiling fulfils all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30 to E 90. This routing variant is a particularly space-saving routing type: The construction height of the transverse profile is just 30 mm.

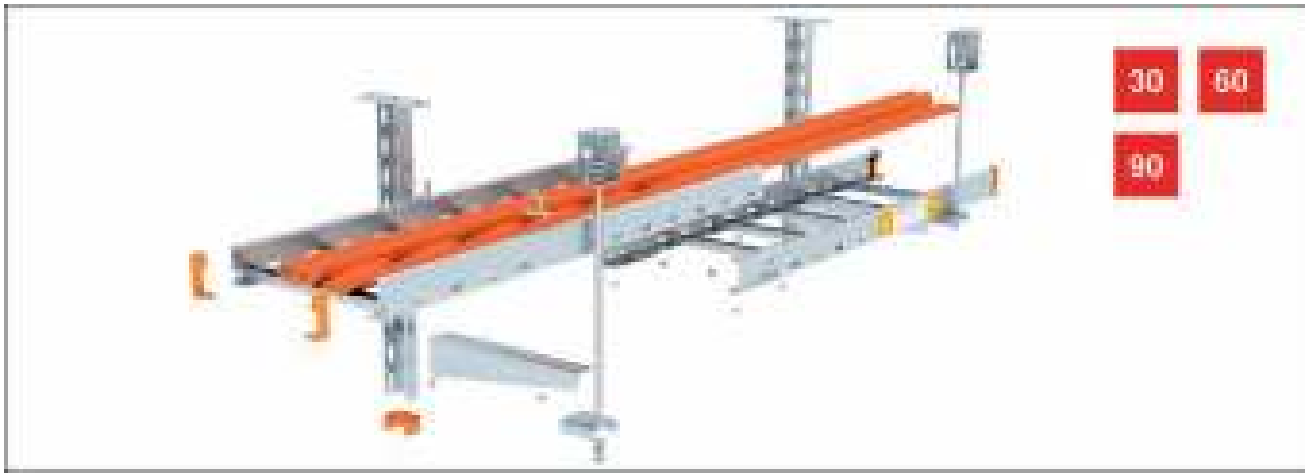
Versions with one or two-layer mounting variants are approved. The position of the joints between the individual support points can be chosen freely. Connectors are screwed into the side rails and an additional joint plate to the base of the tray, in order to interconnect the cable trays.



SKS cable tray, wall mounting

The routing type of cable trays with wall brackets on the wall fulfils all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30 to E 90. When the cable trays are mounted on the wall, up to three tray layers can be arranged vertically. The threaded rod lock is fastened vertically under the ceiling with a maximum spacing of 100 mm beside the bracket using an ABR connection component

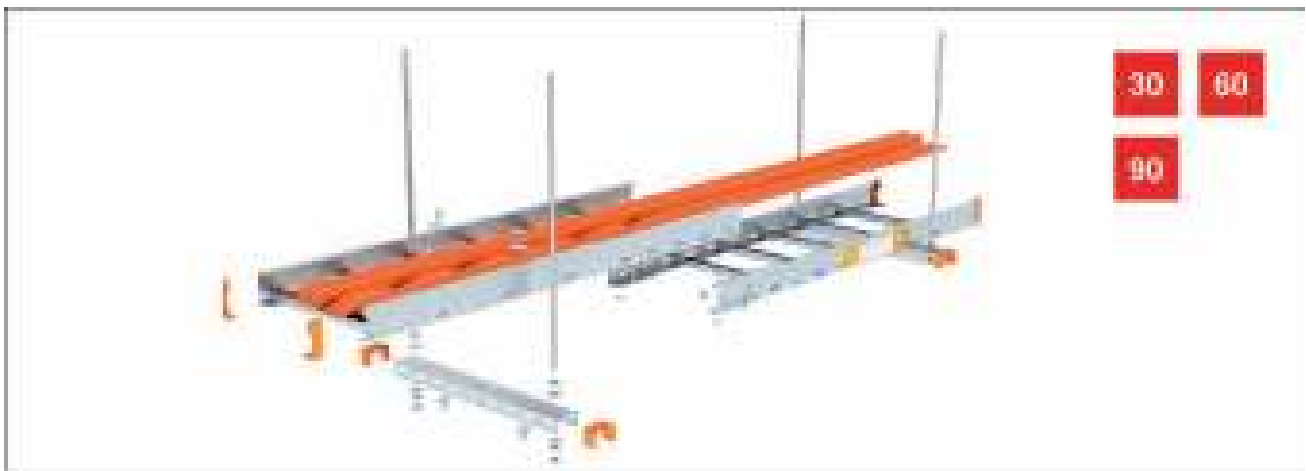
screwed on beneath the tray base. In the case of one-layer section mounting, the threaded rod lock can alternatively be created using sloping connection components at a angle of 45° to the wall. Joints can be positioned freely between the individual support points. Connectors are screwed into the side rails and an additional joint plate to the base, in order to connect the cable trays.



LG-VSF cable ladder with U suspended support

The routing type of cable ladders of type LG with U suspended supports under the ceiling fulfils all the requirements of DIN 4102 Part 12 as a standard support structure. The cable ladders can be mounted on the U suspended support on one or both sides with up to three layers. The threaded rod lock is fastened with a maximum spacing of 100 mm beside the bracket. The ABL connection component need simply

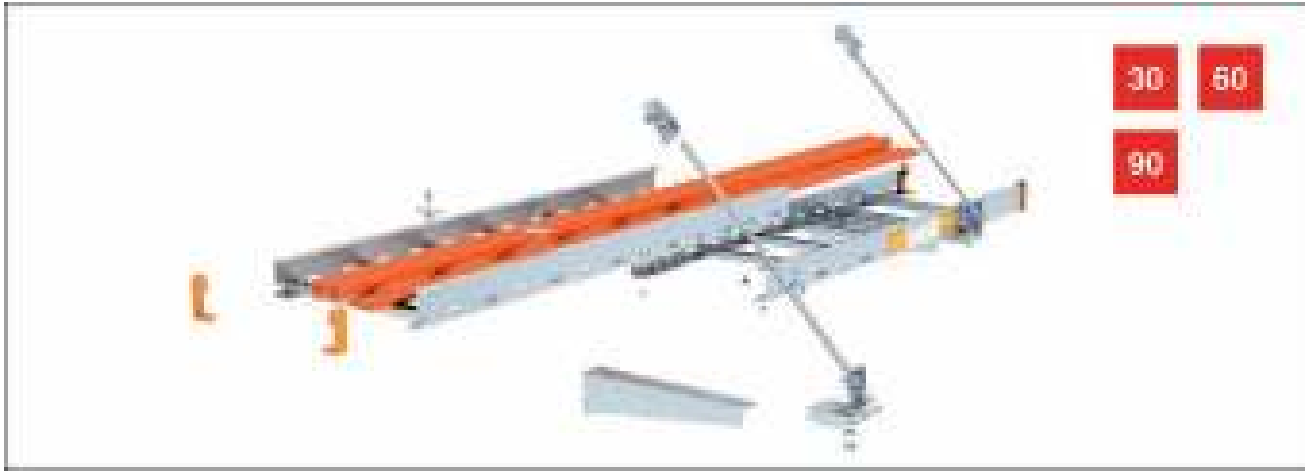
be attached to the lower flange of the ladder rail. Mounting of the threaded rod secures the connection component against slipping. The rung spacing in the cable ladder is 150 mm. Therefore, no additional rung support plates are required. The position of the joints between the individual support points can be chosen freely.



LG-VSF cable ladder with U transverse profile

The routing type of cable ladders of type LG with U transverse profiles under the ceiling fulfils all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30 to E 90. The threaded rod suspension from the ceiling on both sides and the low construction height of the cross-section, just 30 mm, means that this routing type saves a lot of space. Ver-

sions with one or two-layer mounting variants are approved. The rung spacing in the cable ladder is 150 mm. Therefore, no additional rung support plates are required. The joints of the ladder rails are connected using external connectors, which are screwed to the rails. The position of the joints between the cross-sections can be chosen freely.



LG-VSF cable ladder, wall mounting

The routing type of cable ladders of type LG with wall brackets on the wall fulfils all the requirements of DIN 4102 Part 12 as a standard support structure. When cable ladders are mounted on the wall, up to two layers can be arranged on top of one another. The threaded rod lock to the ceiling is fastened vertically without screws using the ABL connection component

attached to the lower flange of the ladder rail. The maximum distance between the connection component and the bracket may be 100 mm. When only one cable ladder is mounted on the wall, the threaded rod lock can alternatively be created using sloping connection components at an angle of 45° to the wall.



4.5.2 Cable-specific routing types

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. Thus 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.

The possibilities of the combination of cables and support systems are fully exploited – the systems are optimised for the appropriate application.

Advantages of cable-specific routing types

- **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)**



The following cable-specific support systems can be considered for an economical electrical installation that maintains electrical functionality: Cable trays with and without threaded rod lock, mesh cable trays, ca-

ble ladders, individual clips, grouped supports and pressure clips. Even electrical installation pipes in proven variants can be mounted.



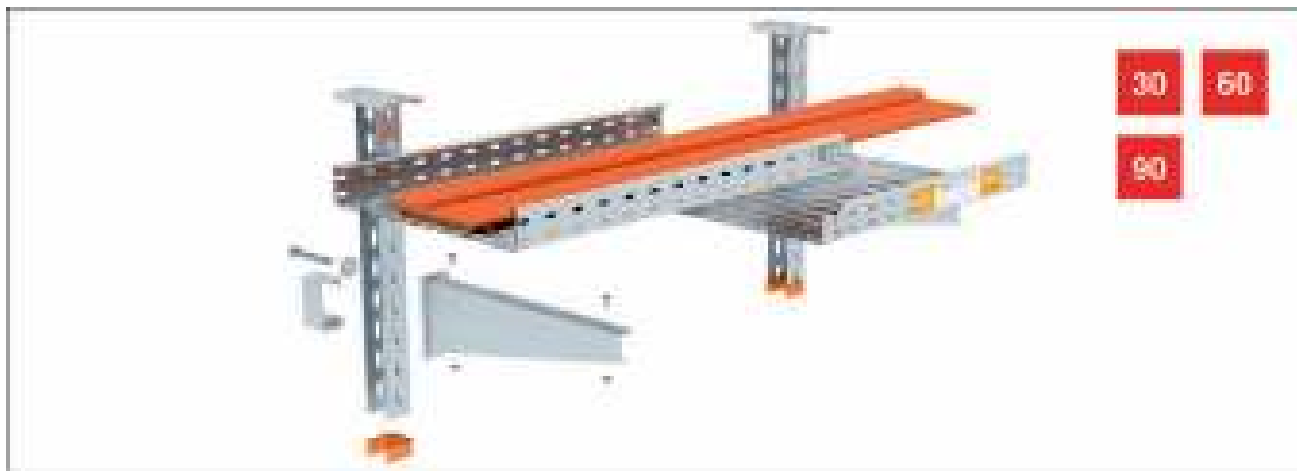
When selecting the products approved for the maintenance of electrical functionality, observe the specifications of the planner and the details of the test certificates. All the parameters on mounting and the usable components must be taken from the test certificates. The approved combination with tested cables must be observed rigidly.

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, observe the approved cable types. The systems were tested at German testing institutes in cooperation with renowned manufacturers of safety cables (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 cable manufacturers from other countries according to DIN 4102 Part 12.

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

- RKSM cable trays
- GRM and G-GRM mesh cable trays
- LKM cable routing ducts
- SL cable ladders
- VA support structure, e.g. for tunnels

Many combinations with cable spacing clips and clamp clips with larger fastening spacing distances were tested and proven by the various cable manufacturers. Even the routing of cables that maintain the electrical functionality in pipes was covered. To obtain a clear overview, OBO compiles a so-called cable list with the tested and approved routing systems and cable combinations available at regular intervals.



RKS-Magic® cable tray

The RKS-Magic® cable tray has been tested as a cable-specific support construction for the maintenance of electrical functionality according to DIN 4102 Part 12 and approved for maintenance of electrical function classes E 30 to E 90. Threaded rod locking is not required at the tip of the bracket. This saves not just material but also considerably simplifies and speeds up the installation of cables. The screwless connection system allows interconnection of the RKS-Magic®

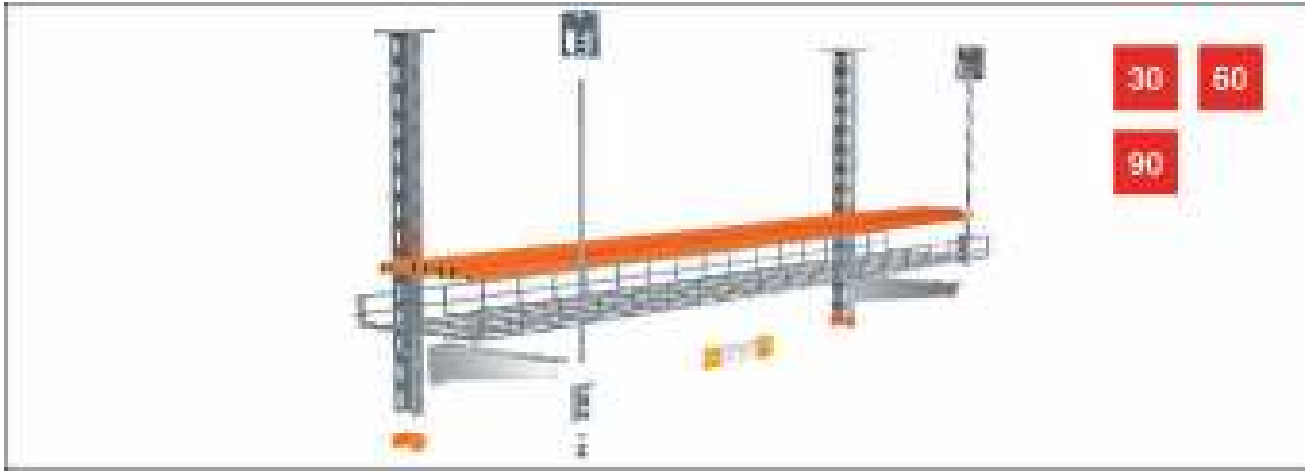
cable trays without tools and in a particularly quick and economic manner. To ensure the maintenance of the electrical supply, only the locking lugs in the base need to be bent after the trays have been connected. The double material thickness in the joint area and the beading in the base mean that the cable tray has a very high load capacity. The installation of fittings in the section route is permitted, as is the mounting of separating retainers.



RKS-Magic® VA cable tray on suspension clamp AHB-T

The RKS-Magic® cable tray, made of rustproof steel with the AHB-T suspension clamp, has been tested as a cable-specific support structure for the maintenance of electrical functionality according to DIN 4102 Part 12 and approved for maintenance of electrical function classes E 30 to E 90. The rustproof steel version permits mounting in areas with more aggressive atmospheres, e.g. in road tunnels. The design of the suspension clamp means that it can be mounted on

straight, slanting or curved ceilings, thus allowing simple, space-saving installation of the cable tray. The benefits of the screwless connection systems of the RKS-Magic® cable trays also apply to this routing type. This makes mounting of RKS-Magic® cable trays, for example in the installation of long sections in increased corrosion protection requirements, an economically viable routing variant. The installation of fittings in the section route is permitted, as is the mounting of separating retainers.



GR-Magic® mesh cable tray

The GR-Magic® mesh cable tray has been tested as a cable-specific support construction for the maintenance of electrical functionality according to DIN 4102 Part 12 and approved for the maintenance of electrical functionality classes E 30 to E 90. The threaded rod lock is mounted directly on the tray rail, using the ABG connection component. This is just at-

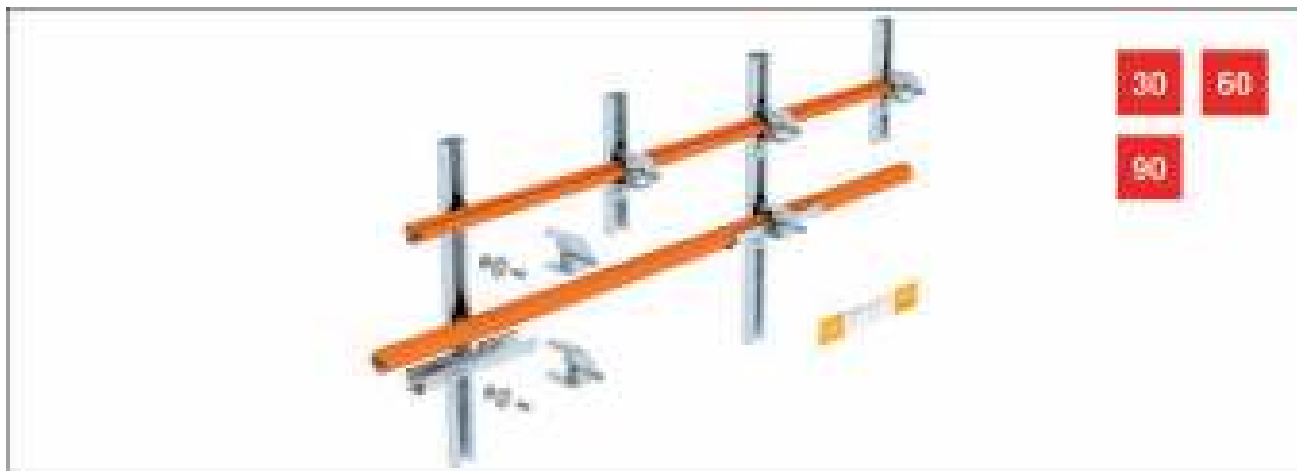
tached to the side lengthwise wires of the mesh cable tray. When the threaded rod has been mounted, the component is secured against unintentional release. The screwless connection system of the GR-Magic® mesh cable trays ensures toolless, and thus particularly rapid and economic, mounting.



GR-Magic® VA mesh cable tray on AHB-T suspension clamp

The GR-Magic® mesh cable tray, made from rustproof steel, has been tested as a cable-specific support structure for the maintenance of electrical functionality according to DIN 4102 Part 12 and approved for the maintenance of electrical functionality classes E 30 to E 90. The rustproof steel version permits mounting in areas with more aggressive ambient conditions. The design of the AHB-T suspension clamp means that it can be mounted on straight, slanting or curved ceil-

ings, thus allowing simple, space-saving installation of the mesh cable tray. The benefits of the screwless connection systems of the GR-Magic® mesh cable trays also apply to this routing type. This makes mounting of mesh cable trays, for example in the installation of long sections in increased corrosion protection requirements, an economically viable routing variant. With this system, the mounting of separating retainers and lids is permitted.

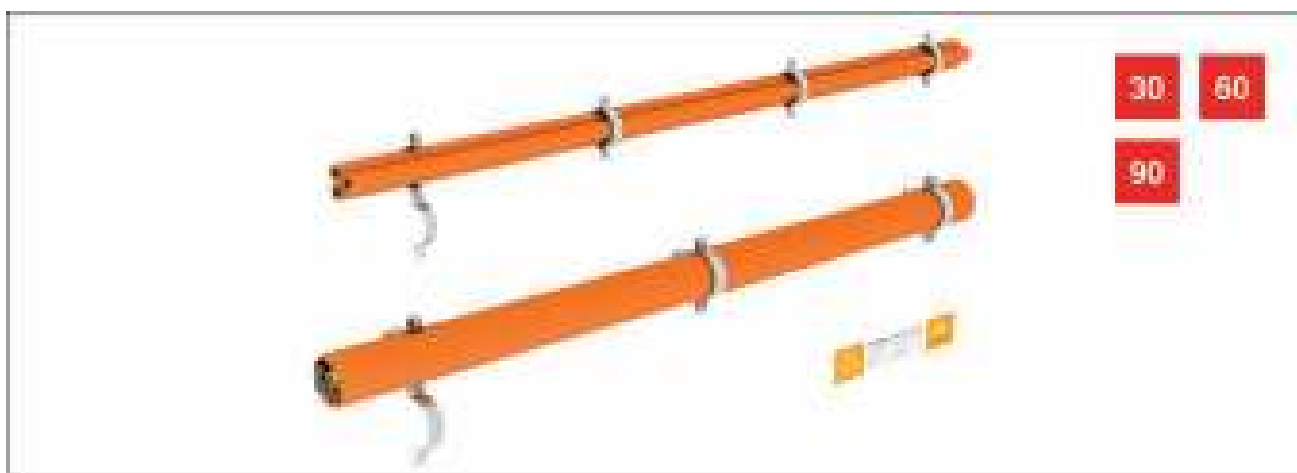


4.5.3 Individual routing systems

Clamp clips with profile rails

The routing types with clamp clips fulfil all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E30 and E90. Mounting as a cable-specific routing type is possible, depending on the specifications of the cable manufacturer. The clamp clips can be used for horizontal cable routing on walls and ceilings and vertical routing on walls. The clamp clips are

made of sheet steel with a riveted metal pressure trough. Long troughs made of galvanised sheet steel can be used to increase the support area for the cables. These are inserted loosely between the cables and the metal pressure troughs of the clamp clips. Bundling of up to three cables in a clamp clip is possible. The individual diameter of the bundled cables may not exceed 25 mm. If only individual cables are installed, then there is no limit to the cable diameter.



Screw-in spacer clip 732/733

The routing types with single clips fulfil all the requirements of DIN 4102 Part 12 as a standard support structure for the function maintenance classes E 30, E 60 and E 90. In addition, mounting of the single clips as a cable-specific routing type is possible, depending on the specifications of the cable manufacturer. The screw-in spacer clips can be used for horizontal cable routing on walls and ceilings and vertical routing on walls. The closed screw-in spacer clips are

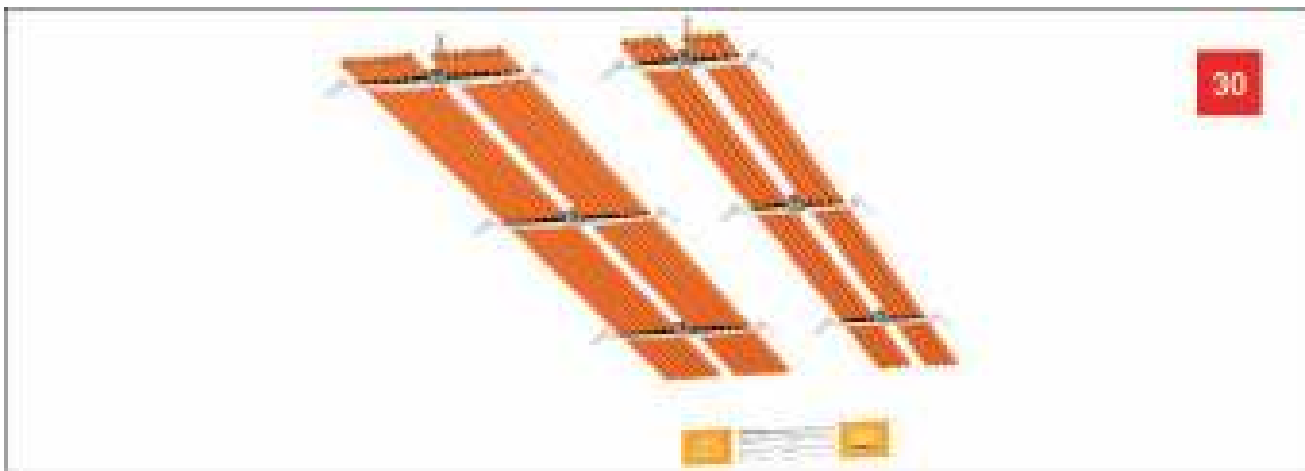
made of galvanised sheet steel. Mounting is carried out either by pushing through the slots of the clips or by screwing onto a fire protection anchor with threaded tip M6. Bundling of up to three cables together in a single clamp clip is possible for mounting as a standard support structure. The individual diameter of the bundled cables may not exceed 25 mm. There is no limit to the diameter of installed individual cables with screw-in spacer clips.



Grip M grouped supports

Cable routing with metal grouped supports is approved as a cable-specific routing type for the maintenance of electrical functionality classes E 30, E 60 and E 90 according to DIN 4102 Part 12. The collecting clamps used are made of sheet steel and can be opened and closed easily without the use of tools. To allow simple cable insertion, the supports can remain

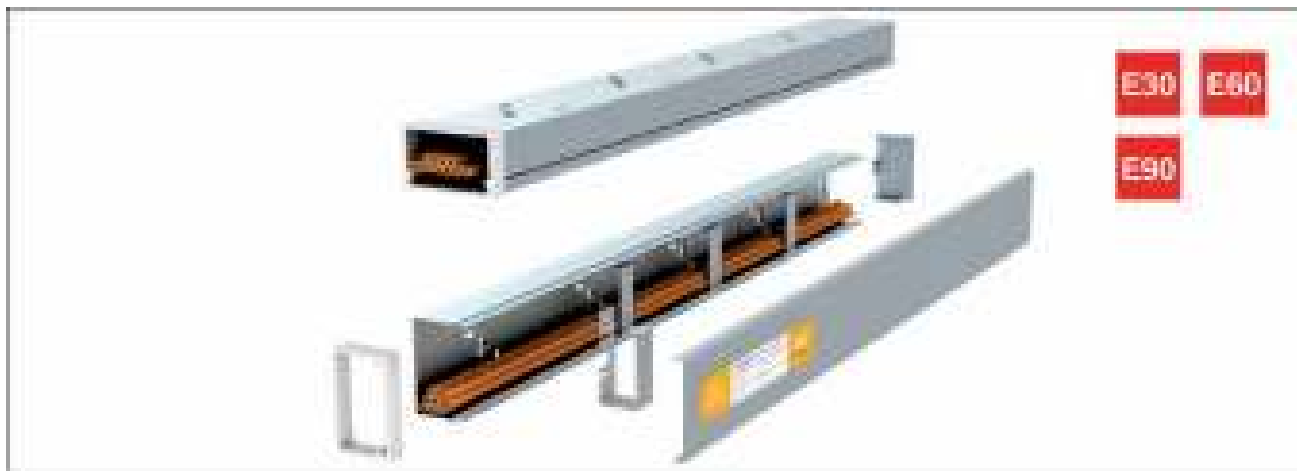
open during cable routing. Grouped supports for wall and ceiling mounting are suitable. Depending on the tested cables and the grouped supports used for the tests, fastening spacings of maximum 0.8 m and a cable assignment of up to 6 kg/m are permitted. The instructions of the various cable manufacturers should be complied with.



Pressure clips

Cable routing with rustproof steel pressure clips is approved as a cable-specific routing type for the maintenance of electrical functionality class E 30 according to DIN 4102 Part 12. This routing variant is ideal when there is only little mounting height available under the ceiling. With just small additions, fire alarm ca-

bles and also power cables for safety lighting systems can be routed in a space-saving way. For installation, the hips of the pressure clips are simply bent downwards and the cables pushed in from the side. The clamping area can be expanded with spacers.



LKM cable routing trunking

Cable routing with metal cable routing trunking, type LKM, is approved as a cable-specific routing type for the maintenance of electrical functionality classes E 30, E 60 and E 90 according to DIN 4102 Part 12. The trunking may be routed horizontally on the wall or under the ceiling and offer additional mechanical protection of the installed cables. This installation variant is also used if, for reasons of appearance, open routing

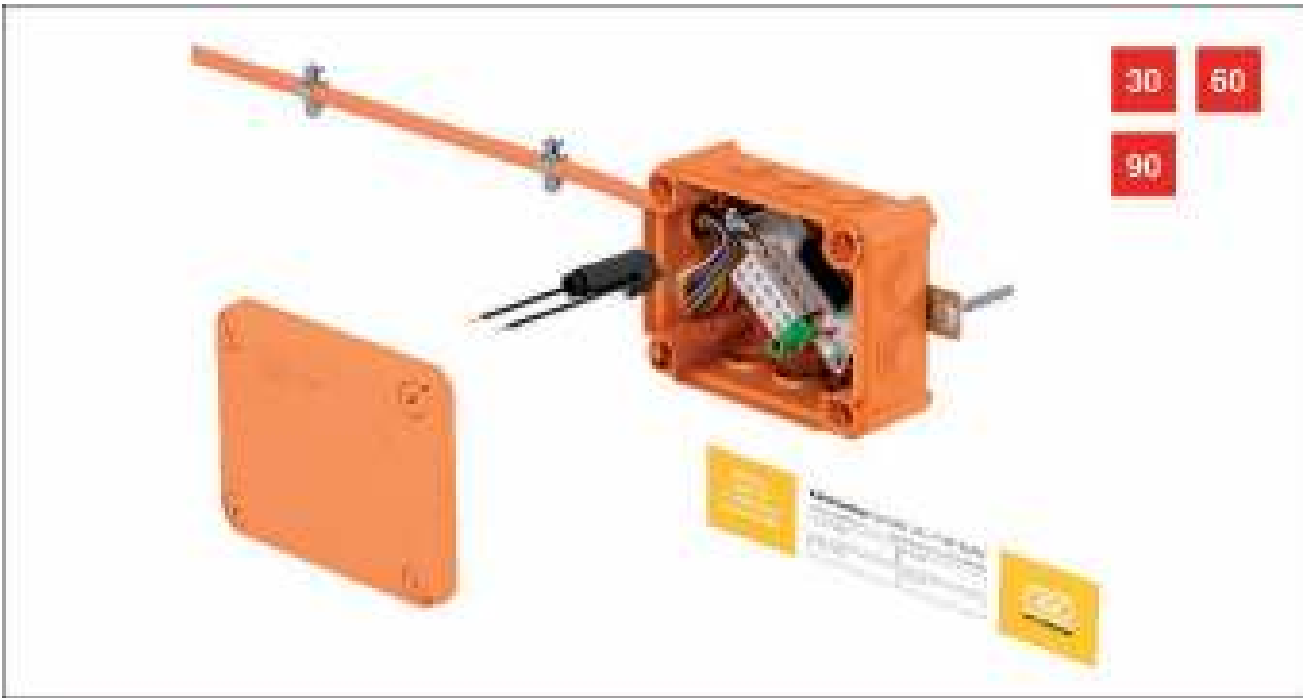
of the cables with maintenance of electrical functionality is not wanted. A retaining clamp is available as an installation aid for the trunking type LKM60100. This prevents cables from falling out in the case of wall and ceiling mounting. When cable installation has been completed, the trunking cover is locked onto the trunking base.



Steel pipe

Cable routing in the steel pipe, in combination with clamp clips or with screw-in spacer clips, fulfils the requirements of DIN 4102 Part 12 as a cable-specific routing type for the maintenance of electrical functionality classes E 30, E 60 and E 90. The steel pipes may be routed horizontally on the wall or under the ceiling and offer additional mechanical protection of the installed cables. Sheet steel clamp clips are used

together with a riveted metal pressure sleeve and the appropriate profile rails, or closed screw-in spacer clips made of galvanised sheet steel. Refer to the available test certificates of the cable manufacturer for the maximum possible dimensions of the pipes, the maximum fastening spacing of the clips and the number of cables to be run in the pipe.



4.5.4 FireBox connection technology

Junction boxes of the FireBox series 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. The T series FireBoxes possess all the benefits of thermoplastic cable junction boxes. These include the high IP protection rating of up to IP66 and the maximum impact resistance of up to IK10 and a high resistance to breakage. Boxes with soft plug-in seals or closed variants are available. Here, the cable glands

can be located freely. Fastening either takes place on the outer straps or through the box base with fire protection screw ties. The high temperature-resistant terminals are pre-mounted on the connection unit. The protective conductor terminal is connected to the support clamp, meaning that covers of the metal parts are not required. The FireBox is tested and approved as a connection socket for maintenance of electrical functionality to DIN 4102 Part 12 with the classes E30, E60 and E90. A separate fuse holder allows protection of a branch.

Clamping capacity of the ceramic terminals

	0.5 mm²	1.5 mm²	2.5 mm²	4 mm²	6 mm²	10 mm²	16 mm²
4 mm²					-	-	-
6 mm²						-	-
10 mm²	-						-
16 mm²	-						

Table 14: Clamping capacity of the ceramic terminals



4.5.5 Difficult installation situations

Local factors on the construction site sometimes require special measures, in order to prevent or compensate impairments of the cable system through 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 maintenance of the electrical functionality, as parts may fall down if there is a fire, damaging the cables that maintain the electrical supply. For this, these cables must be placed directly under the ceiling or on the wall.



Limited space

If there is limited space, then multiple solutions are possible: The cables are either mounted directly under the ceiling using clips or pressure clips, or multiple narrow cable sections are installed on top of each other, instead of on a wide section.

Problematic substrate

There are problematic substrates, such as old ceiling structures, where the load capacity cannot be determined definitely. Therefore, wall mounting is recommended (e.g. for restoration projects) in this case.

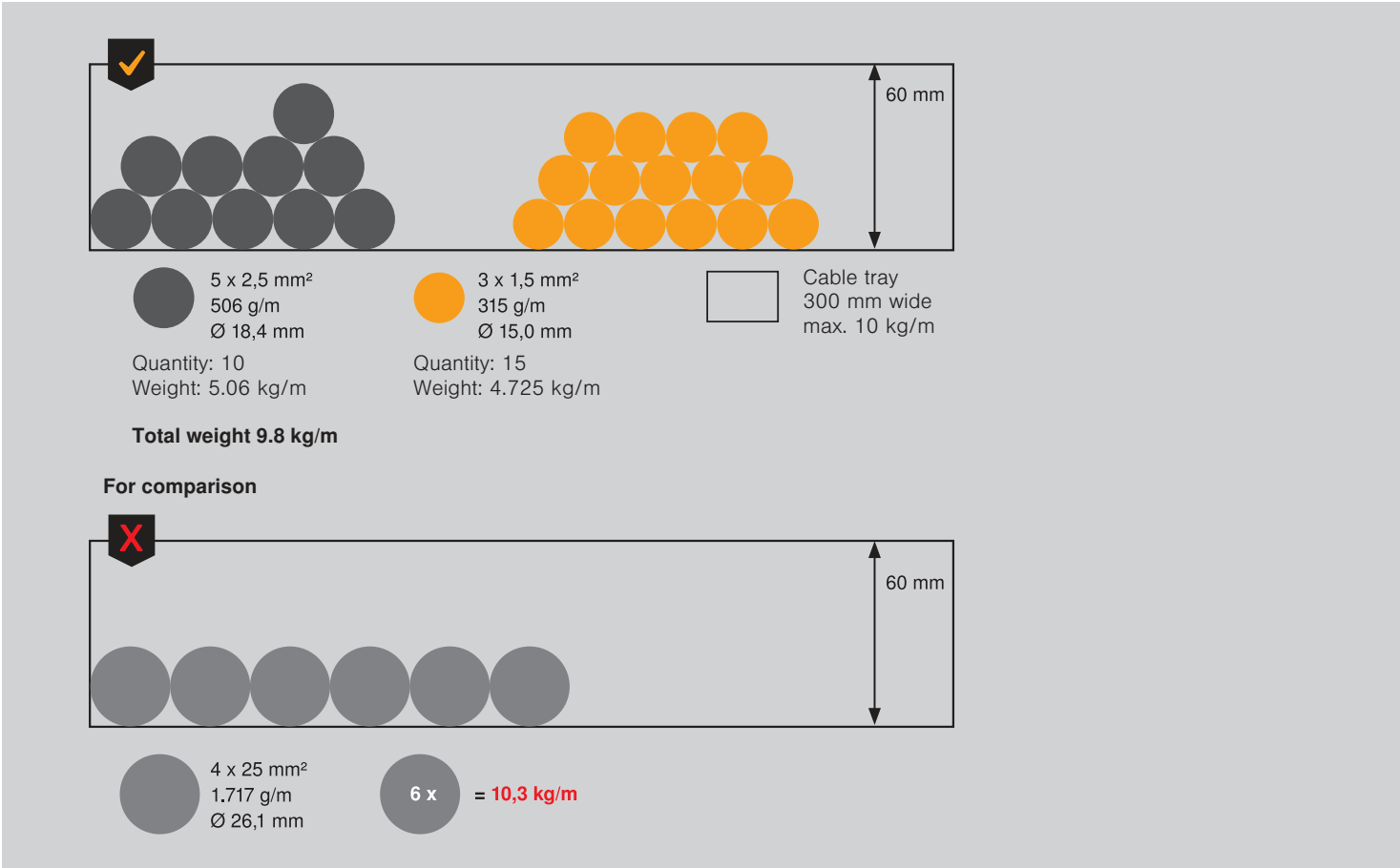
4.5.6 Cable load per cable tray layer

The support systems are designed for exactly defined loads. This also results in a differing quantity of superimposed layers of cable trays and ladders.

The proven possible mechanical loads for cable support systems that maintain electrical functionality are very low, in comparison to cable systems for the "cold" state. For this reason, they may only be as-

signed to a low level. This poses the risk that cable trays, which are visually still free, are used for retrofit installations. This could mean that the approved cable weight is exceeded. The following diagrams show how the maximum weight per tray can be reached with just a few safety cables. It is therefore very important to plan the cable volume exactly.

Standard support structure with cable tray SKS E 90





4.6 Special features of vertical routing

Cables that maintain the electrical functionality cables on rising sections must be effectively supported in the transition area between vertical and horizontal routing, to prevent bending or sliding. Continuous vertical cable systems only receive the appropriate maintenance of electrical function classification when there is effective support or strain relief at a spacing of max. 3.5 m. Strain relief measures can be provided in the variants described below.

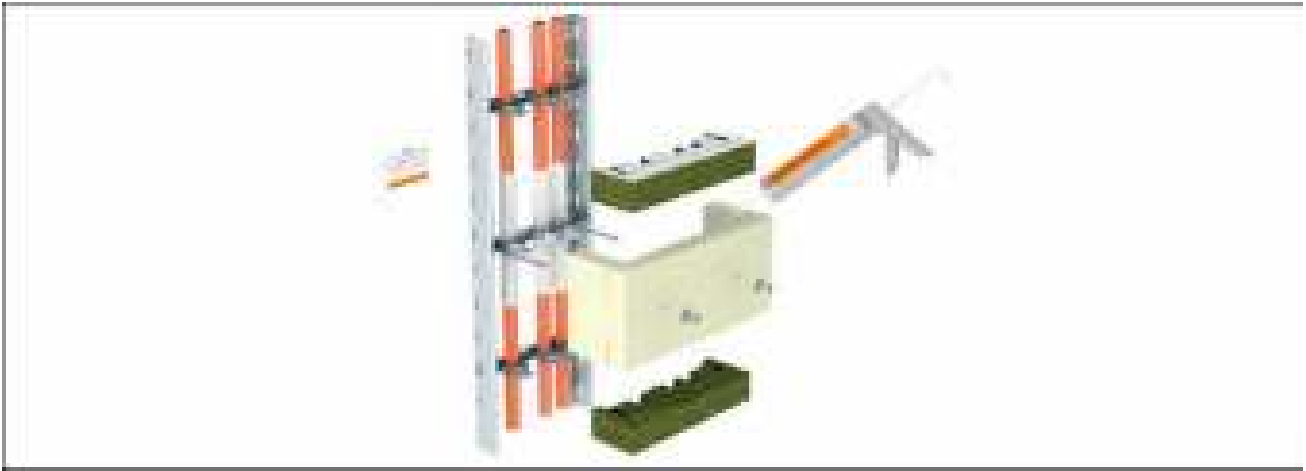
Strain relief through loops

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 spacing 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 must be observed. If there is a fire, the cables deposit themselves on the sides of the clip elements on their forming ash layer. This prevents tearing through the weight of the copper. However, in practice, this variant can often not be implemented due to the large amount of space required at the side.

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 maintenance of electrical functionality 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 floor, as this remains cold due to the insulation function. The cables are clamped according to the regulations and, at a storey height of maximum 3.5 m, "only" have a permitted weight of 3.5 m of copper.

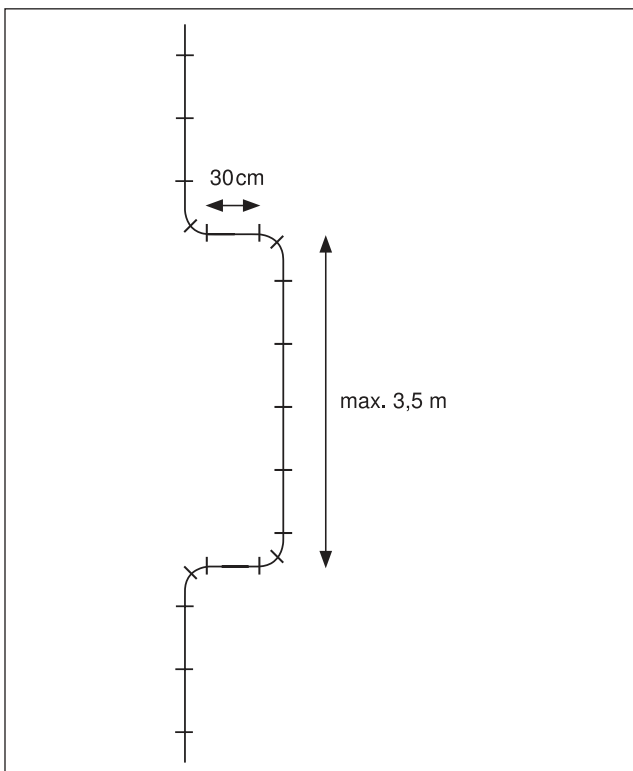




Effective support measure

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, effectively preventing breaking. This universally applicable solution is approved

for all types of vertical ladders and also for individual clips, which carry vertical cables. Ladder rungs can be penetrated, so that mounting is also possible in existing, continuous rising sections. There is no dependence on specific cable types or manufacturers. This means that DIN-conformant and effective support of the vertically installed cables that maintain the electrical supply can be achieved in a way which is extremely economic and space-saving.



Support through side jump or loops

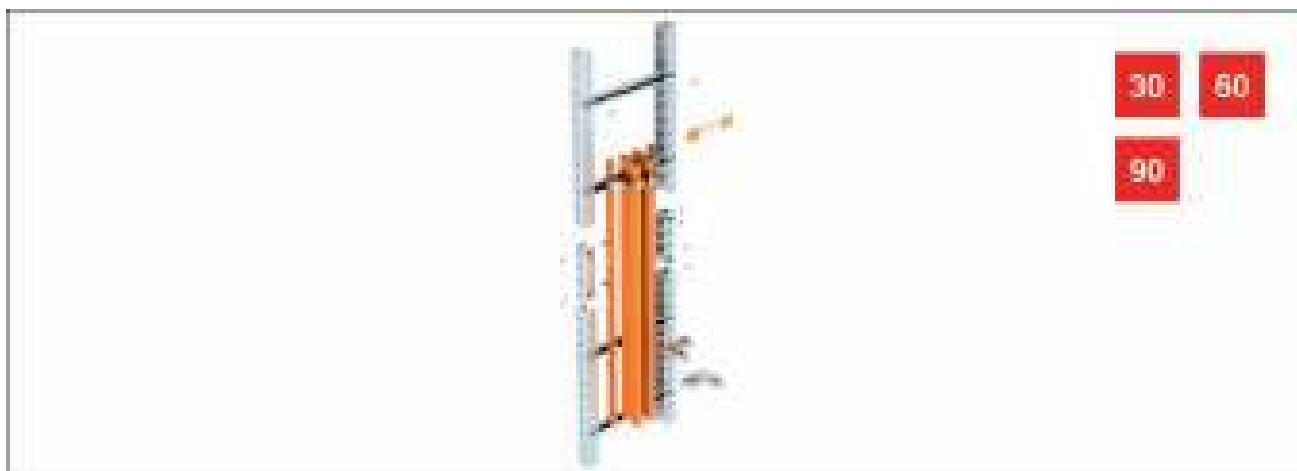


4.6.1 Rising sections

Light-duty vertical ladder

Vertical ladders of type LG fulfil all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30, E 60 and E 90. The vertical ladders are fastened directly to the wall through the lower flange of the ladder rails at a spacing of maximum 1.2 m. Alternatively, the vertical ladders can also be mounted with additional fastening brackets, attached to the rail from the outside. Mounting of screwed-on connectors is

approved and they can be positioned freely. The rung distance is 30 cm and the cables are fastened using clamp clips, type 2056 M (clamp clips with metal pressure trough). Light-duty vertical ladders are available in widths of 200 to 400 mm. Mounting of the strain relief ZSE90 is approved for storey heights of more than 3.5 m. The vertical ladder need not be interrupted as the strain relief is mounted via the continuous vertical ladder.



Heavy-duty vertical ladder

Vertical ladders of type SLM fulfil all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30, E 60 and E 90. They are made of U profiles with screwed-on rungs. The vertical ladders are fastened directly to the wall through the ladder rails at a spacing of maximum 1.2 m. Individual lengths can be screwed on with connectors. They can be positioned freely. The cables must be fastened on each rung with clamp clips of type 2056 UM with a riveted metal

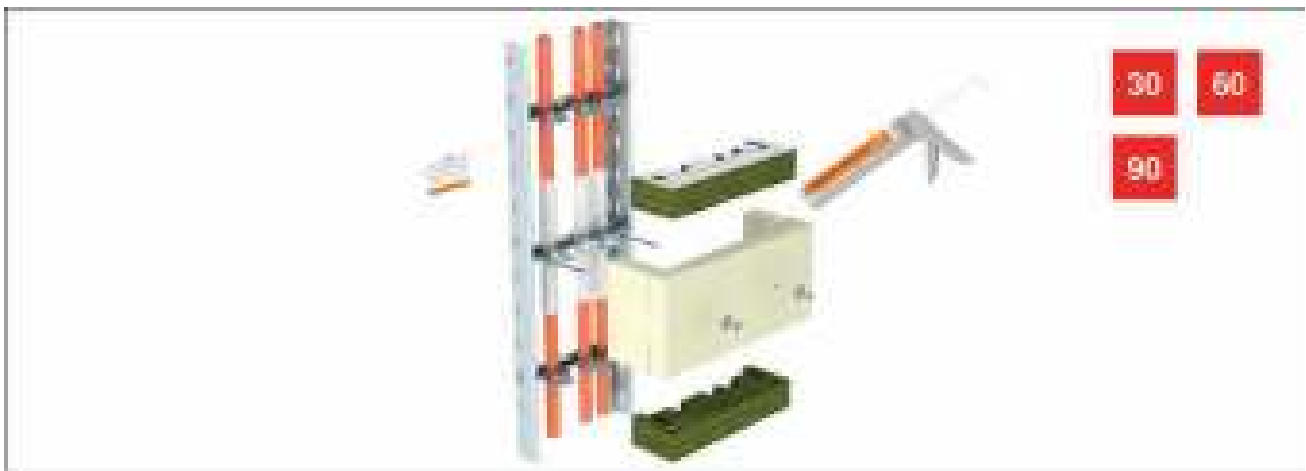
pressure sleeve with a spacing of 30 cm. There is no limit to the diameter of installed individual cables with clamp clips. Bundling of up to three cables is possible with this standard support structure. Heavy-duty vertical ladders are available in widths of 400 to 600 mm. Mounting of the strain relief ZSE90 is approved for storey heights of more than 3.5 m. The vertical ladder need not be interrupted as the strain relief is mounted via the continuous vertical ladder.



Industrial vertical ladders

Industrial vertical ladders of type SLS fulfil all the requirements of DIN 4102 Part 12 as a standard support structure for the maintenance of electrical functionality classes E 30, E 60 and E 90. They are made of I profiles with screwed-on rungs. The vertical ladders are fastened at a spacing of maximum 1.2 m using fastening brackets, which are screwed to the ladder rails. When mounting rungs, maintain a spacing of maximum 30 cm. The cables must be fastened on

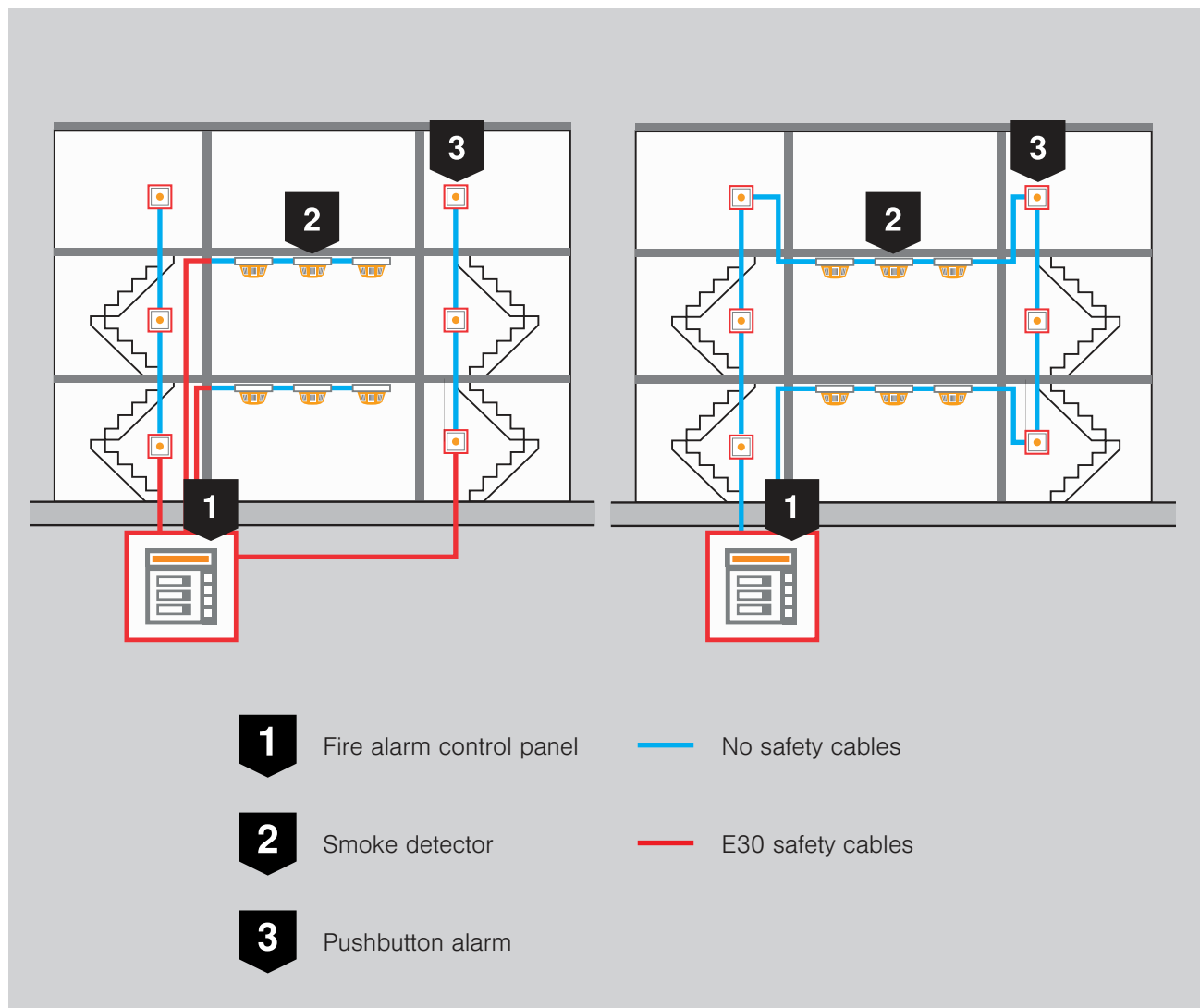
each rung with clamp clips of type 2056 UM with a riveted metal pressure sleeve. There is no limit on the external diameter of individual cables. Up to three cables can be bundled together under a clamp clip. The industrial vertical ladders are available in widths of 400 to 600 mm. For storey heights of more than 3.5 m, the strain relief ZSE90 may be mounted over the vertical ladder. The vertical ladder need not be interrupted for it.



4.6.2 Effective support Strain relief ZSE90

In the case of continuous, vertical routing of cables that maintain electrical functionality cables according to DIN 4102 Part 12, the standard requires effective cable support at a maximum spacing of 3.5 m. This requirement can be fulfilled with the OBO ZSE90 strain relief. The ZSE90 is approved for all maintenance of electrical functionality classes E 30 to E 90 in combination with standard support structures. It can be used for all rising section widths and also for vertical single-clip installations. The ZSE90 strain relief

covers the fastening point of the cables on profile rails, rungs or with single clips. In case of fire, it prevents direct fire loads on the clips, meaning that they stay "relatively" cold. The weight of the cable is dissipated safely. There is no risk of the cables tearing through their intrinsic weight if there is a fire. This guarantees secure maintenance of electrical functionality. The strain relief can be fastened using slide nuts on profile rails, on the rungs of vertical ladders or on the wall next to installed cables.

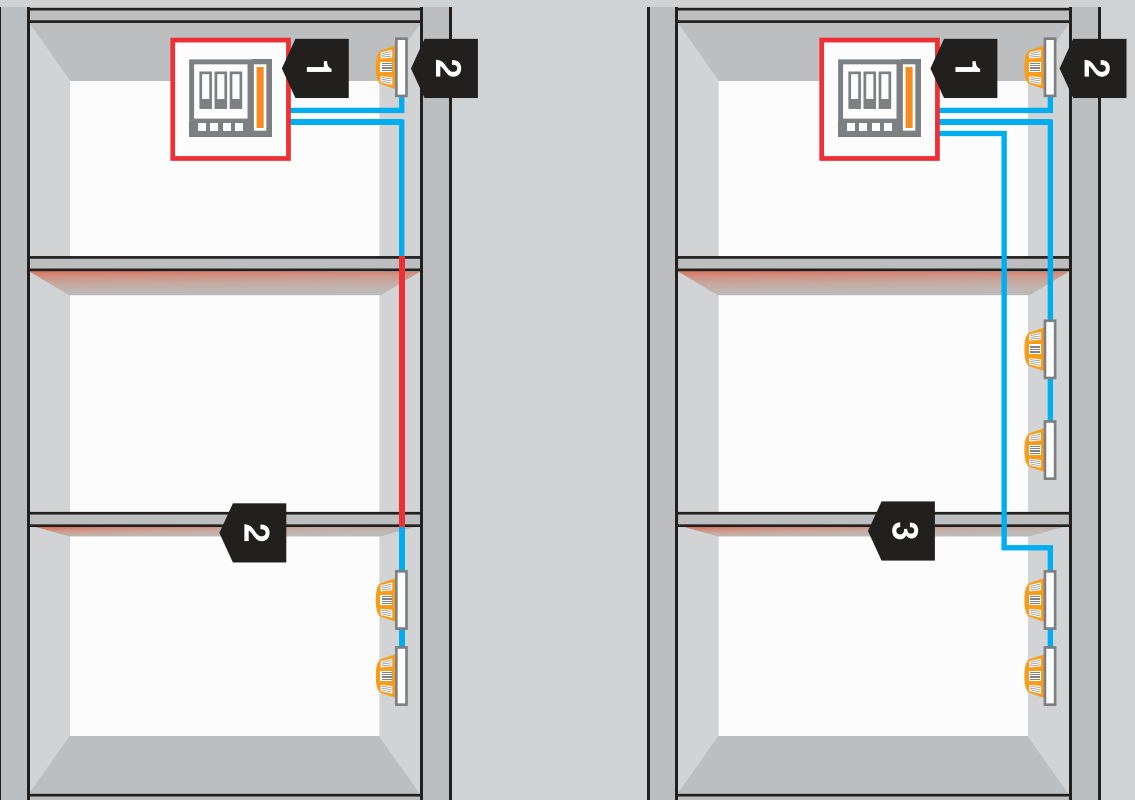


4.7 Exceptions to the maintenance of electrical functionality

If fire alarm systems are installed in the building, it is possible to waive cabling with maintenance of electrical functionality class E 30 in certain areas. These include, for example, branch cables to fire alarms located in a fire section. Here, routing of E 30 cables to the first fire alarm is sufficient. If the fire alarm system was created with loop technology, then no E 30 safety cables at all are required. The system detects interruptions if cables fail during a fire and automatically switches the signal paths.

If cables of the fire alarm system are run through monitored areas into a final fire section, then there is no need for E 30 cabling. If the bridged fire sections are not monitored, then safety cables with maintenance of electrical functionality class E 30 must be installed.

The exceptions described above have no influence on the supply of safety-relevant electrical systems with the maintenance of electrical functionality classes E 60 and E 90. The higher-level classes must be given the appropriate safety cables.



- 1** Fire alarm control panel
 - 2** Smoke detector
 - 3** Firewall
- No safety cables
- E30 safety cables

Branch cables



Heat build-up under the ceiling in the event of a fire

4.8 Limits of maintaining electrical functionality

Not only surrounding installations can have a negative impact on the maintenance of electrical functionality, but also insufficient knowledge of local factors or even incorrect planning can quickly limit implementation in accordance with the approval. All too often, there is poor matching of the networks, which are managed by different planners and installation engineers. It is rare to find a technical building manager for fire protection on construction sites. The responsibility for this primarily lies with the architects and construction engineers. If they do not employ a technical building manager, then they automatically fill this position. But planners of technical building equipment will, in future, have to expand their knowledge of construction and system fire protection.

4.8.1 Unsuitable components

In many cases, the building structure often does not permit the routing of an electrical functionality maintenance system which is conformant with the approval. Separating components, such as walls and ceilings, which do not have a supporting function in the event of fire, are unsuitable for fastening cable systems with integrated maintenance of electrical functionality 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 sub-construction. 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 as a fastening substrate for the maintenance of electrical functionality.

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 duration. 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 to steel is not possible. Steel fire protection is implemented, for example, in the form of plate panelling or coatings. However, these measures should primarily protect the building structure against early failure during a fire. If something is to be fastened to these protected steel girders, then the panelling or coatings must ultimately be destroyed. Reworking is thus necessary and is usually very complex.

Even worse than steel girders are roofs made of trapezoidal plates. In the event of a fire, the hot fire gases rise. The upward movement draws a lot of oxygen from the environment into the fire. A so-called "ceiling jet" is created, which distributes the fire smoke throughout the whole building at great speed. Thermals cause the fire to be fanned further through the draught and the smoke fills the entire building. This causes 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.



Routing in the earth



Routing under the screed

4.8.2 Solution options

The simplest solution for approved mounting of systems that maintain electrical functionality is the arrangement of the systems above the other building technology. Fastening on the raw ceiling or the highest point on the wall means that, if there is a fire, nothing can fall on this safety-relevant equipment. This means that there can be no influence from surrounding components.

If other fire protection problems of a building are known, then system safety for people and the environment can still be achieved using compensation measures. Firstly, the protection aims to be achieved must be considered. The higher the aim, the more comprehensive the necessary fire protection measures will be. Simple measures with regard to the implementation of fire maintenance are, for example, cable routing through non-dangerous areas: If no cable tray that maintains electrical functionality can be fastened to a steel girder, then a different route to the installation must be found. This could be, for example, routing in the earth outside the building or routing under the screed.

Under certain circumstances, in agreement with all the offices involved in construction, fastening on steel girders or other components may be the only option. 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. If technical measures are implemented, then it is also 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 achievement of the protection aims for the building is guaranteed, even if there are deviations from construction and system requirements.

As with all fire protection installations, it is dependent on suitable and approved fastening agents. The following chapter is dedicated to this.



Chapter 5: Anchorings

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5 Anchorings

Of equal importance to the selection of the cable 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 maintenance of electrical functionality according to DIN 4102 Part 12 require metal anchors with a general construction approval or a European Technical Approval/Evaluation. 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. With these solutions, the necessary setting depths according to the load are listed in the approval documents or in the appropriate fire protection reports. It must also be noted for which substrates and resistance classes the anchors are approved.

The most important solutions for anchoring small to very large loads in most substrates are:

- 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
- Wood screws with a large setting depth



5.1 Fastening principles

There are three types of force transmission from the anchor to the substrate:

- Form fit
- Adhesive bond
- Friction bond

Anchors with form-fitting tap the substrate and support themselves on it. The anchor fits "tightly" into the component. Examples are back cut internal thread anchors or cavity ceiling ties. The threads of the bolt ties also work according to this principle.

Firmly bonded anchors join chemically to the substrate, e.g. through sticking with special mortar. Adhesive cartridges or injection systems, in which a threaded rod is mounted, are included in these fastenings. Cleaning the drill holes is very important for these systems, in order to prevent slipping out due to dust in the drill hole.

When a frictional connection is made, a spreading element set on the anchor body ensures locking in the drill hole. When mounted with the planned torque, the friction ensures the high load values.



5.2 Fastening substrates

The main differences are in the 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 the 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 and injection systems can be placed very close to the edge, as they do not create any lateral forces.

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. All too frequently, so-called extraction experiments are often required, in order to determine the resistance and load capacity of the construction.

Materials

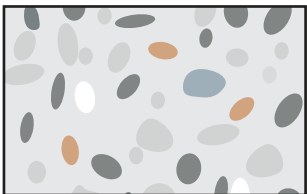
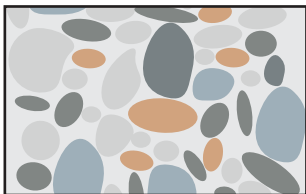
Concrete

Normal concrete,
e.g. C 20/25

Lightweight concrete,
e.g. LC 20/22

Light construction materials

Plates and panels,
e.g. plasterboard



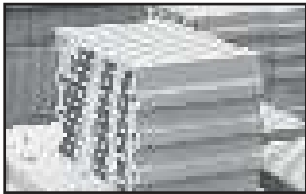
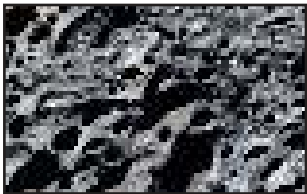
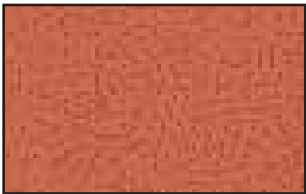
Wall materials

Full brick with dense structure,
e.g. brick

Hollow blocks with dense structure,
e.g. hollow brick

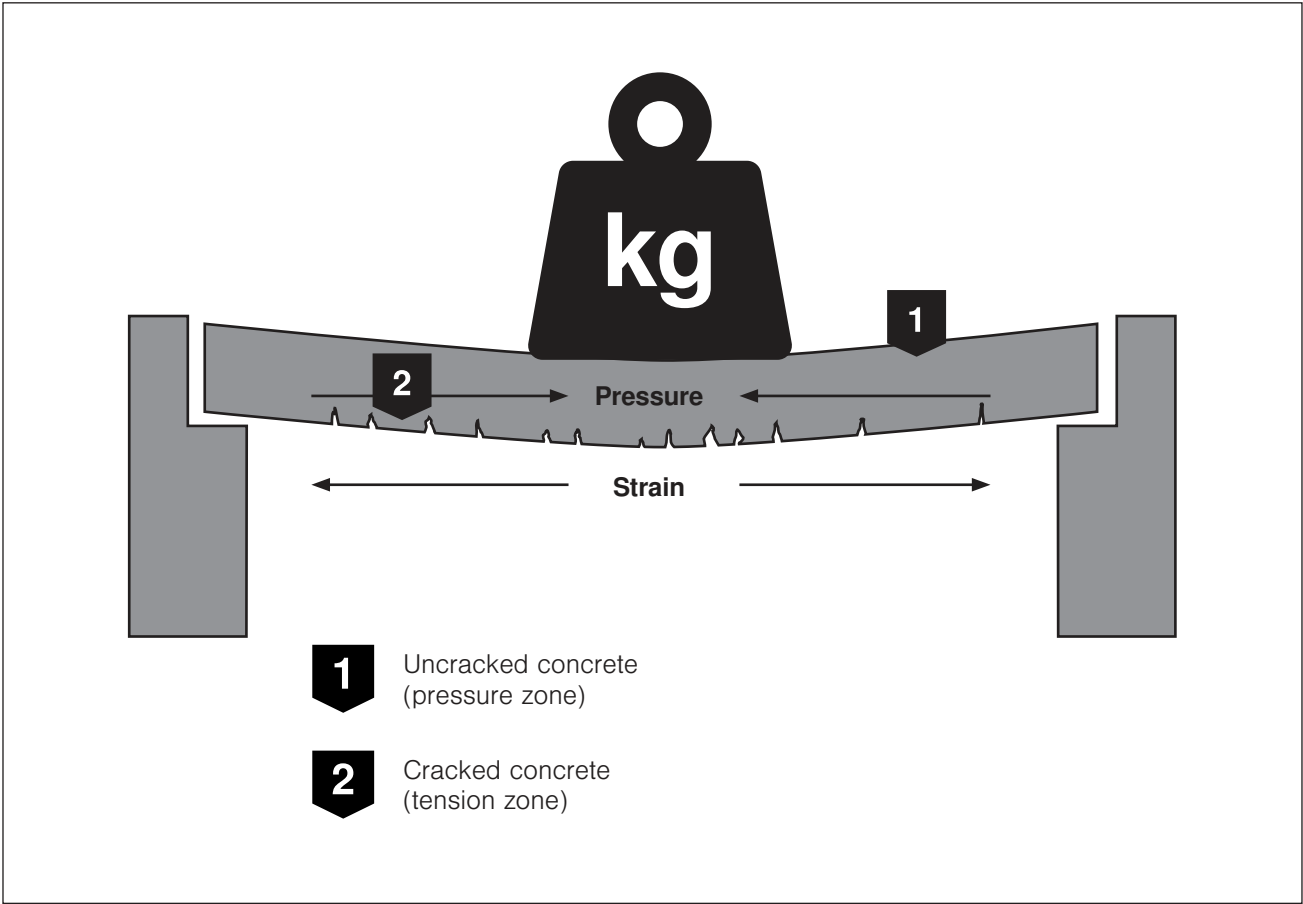
Full bricks with a porous structure,
e.g. lightweight concrete, expanded clay,
pumice

Plates with a porous structure,
e.g. hollow blocks made of lightweight concrete



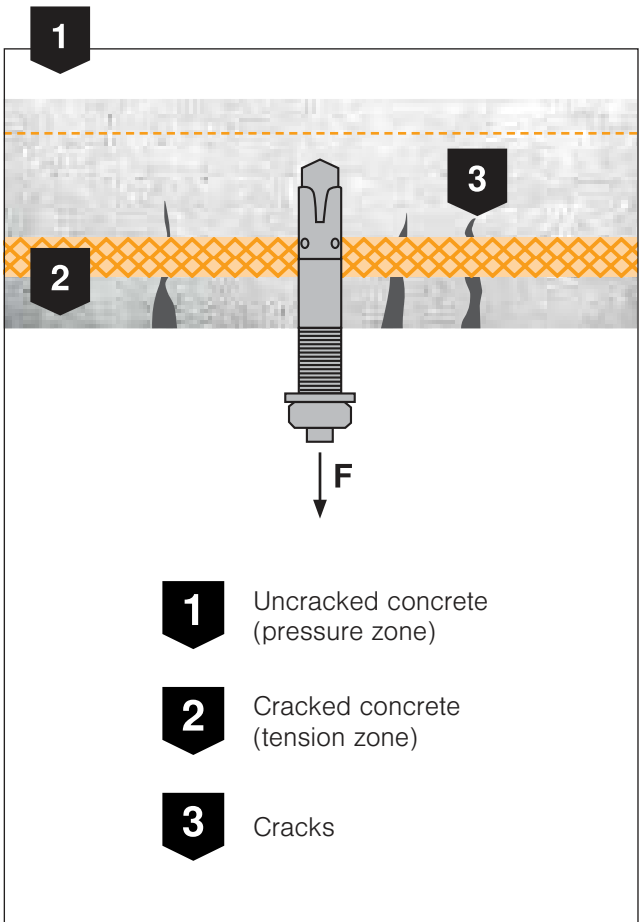
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5.2.1 Concrete

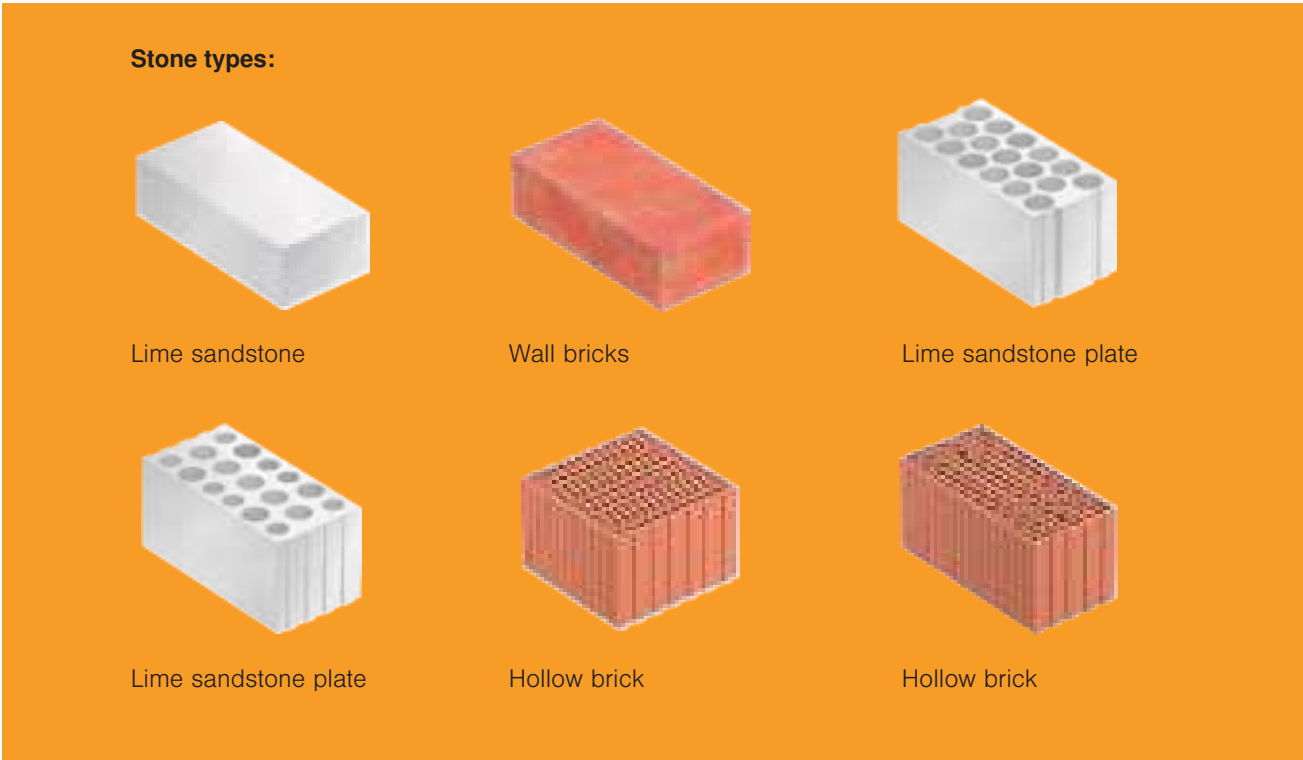
One of the most frequently used construction materials is concrete. The load capacities are very high and thus ideally suited for the fastening of the technical building equipment. However, it is important to remember that ceilings experience so-called tension and pressure zones. Cracks can occur in the tension zone, which reduce the load capacity. With an unsuitable anchor, the fastened component can fall out of the drill hole. It must also be ensured that the anchors are suitable for cracked concrete and are approved.

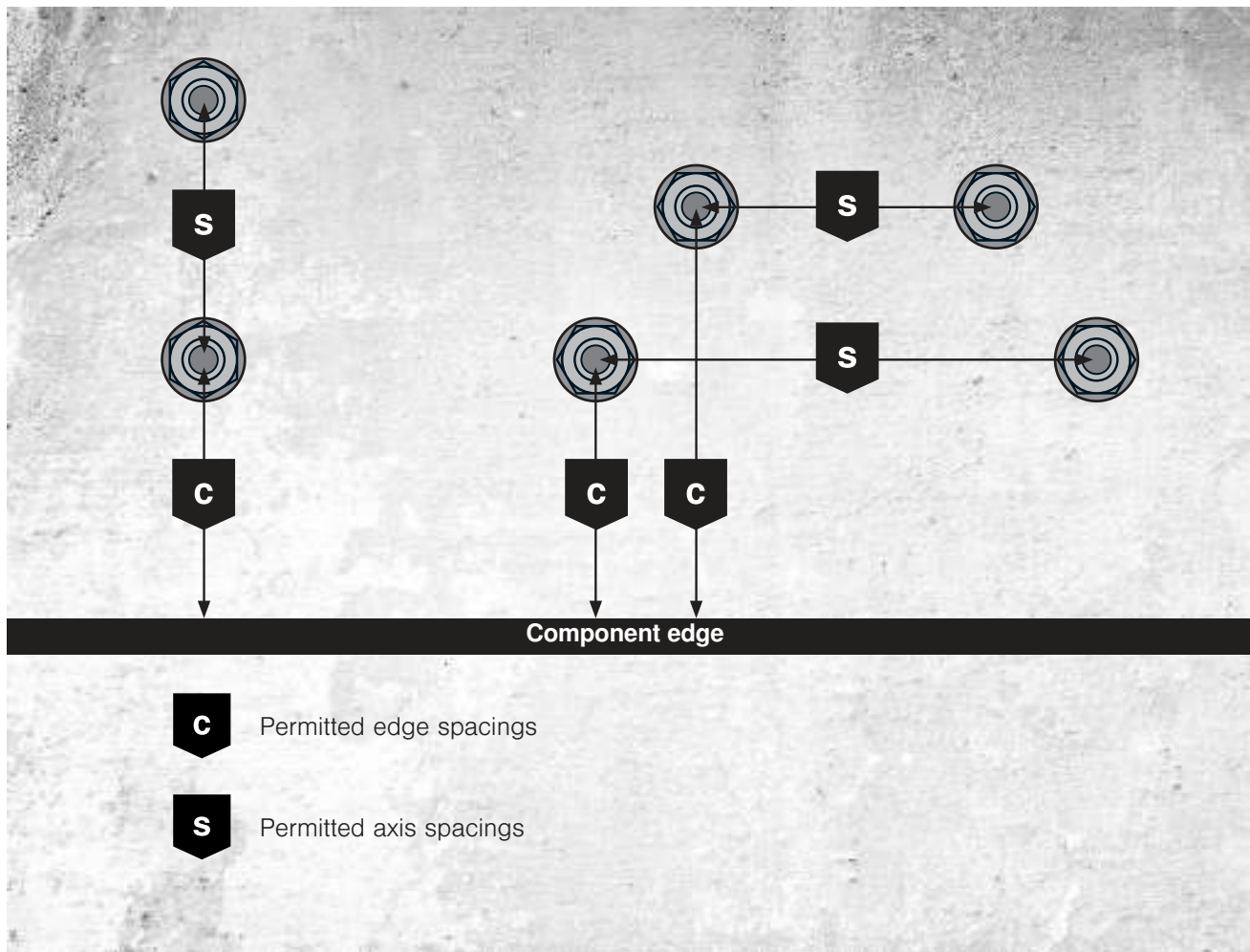




5.2.2 Masonry

Besides concrete, various masonry types of different stones play a special role in buildings. In order to fasten support systems or other loads on these walls, the stone types must have a minimum raw density and a minimum pressure resistance. If this data is not available, then withdrawal experiments may need to be performed, in order to determine the load capacity of the wall.

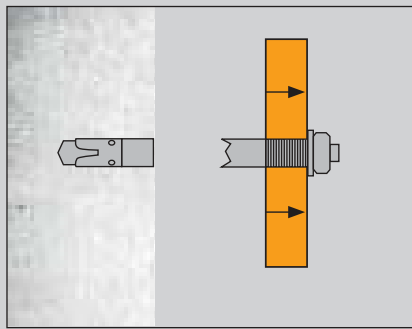




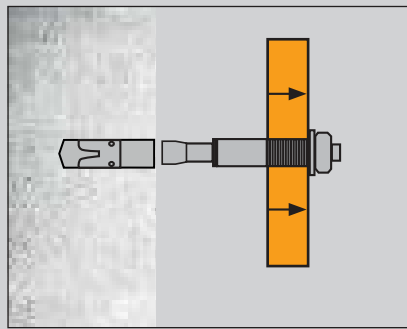
5.2.3 Distances and setting depth

Edge and axis distances play a major role when setting anchors. This means the distances to component edges and distances from anchor to anchor. If these are not maintained, then the load values are reduced and failure of the fastening is more likely. Of course, the setting depth is the main criterion for the maximum load values. The deeper an anchor can be anchored in the substrate, the greater the load to be fastened to it can be.

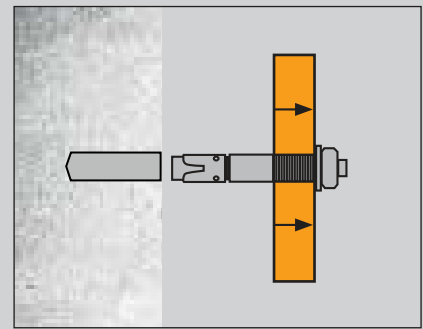
Deeper anchoring
=
Greater concrete load capacity



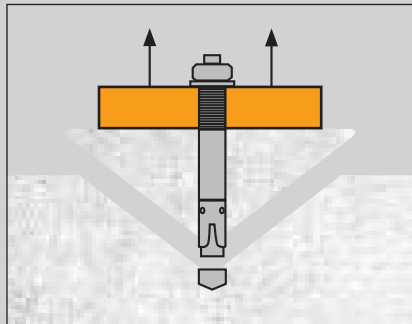
Steel break



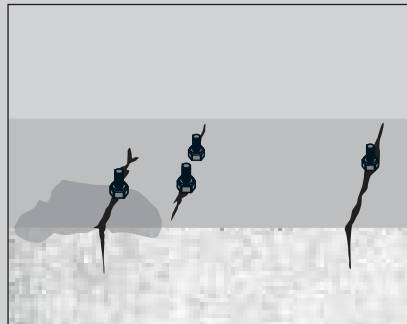
Pull-through



Pulling out



Concrete break-out



Columns

5.2.4 Failure criteria

Different failure criteria occur depending on the mounting arrangement and load of the anchors. Under a tensile load, these are:

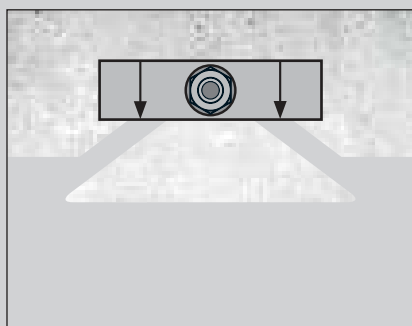
- Steel break
- Pulling out
- Pull-through
- Concrete break-out
- Columns

The anchors for mounting cable support systems under the ceiling must thus be designed exactly for the tensile loads.

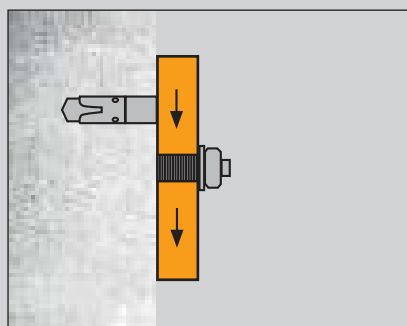
The following reasons for failure occur with transverse loads:

- Steel break through shearing
- Concrete edge break
- Concrete break-out on the side away from the load

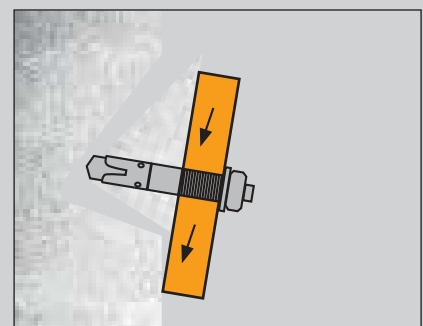
Wall mounting of cable trays on brackets causes high torques and bending moments. The above-mentioned failure causes will occur if the anchors are not dimensioned sufficiently.



Concrete edge break



Steel break



Concrete break-out on the side away from the load

5.2.5 Selection aid

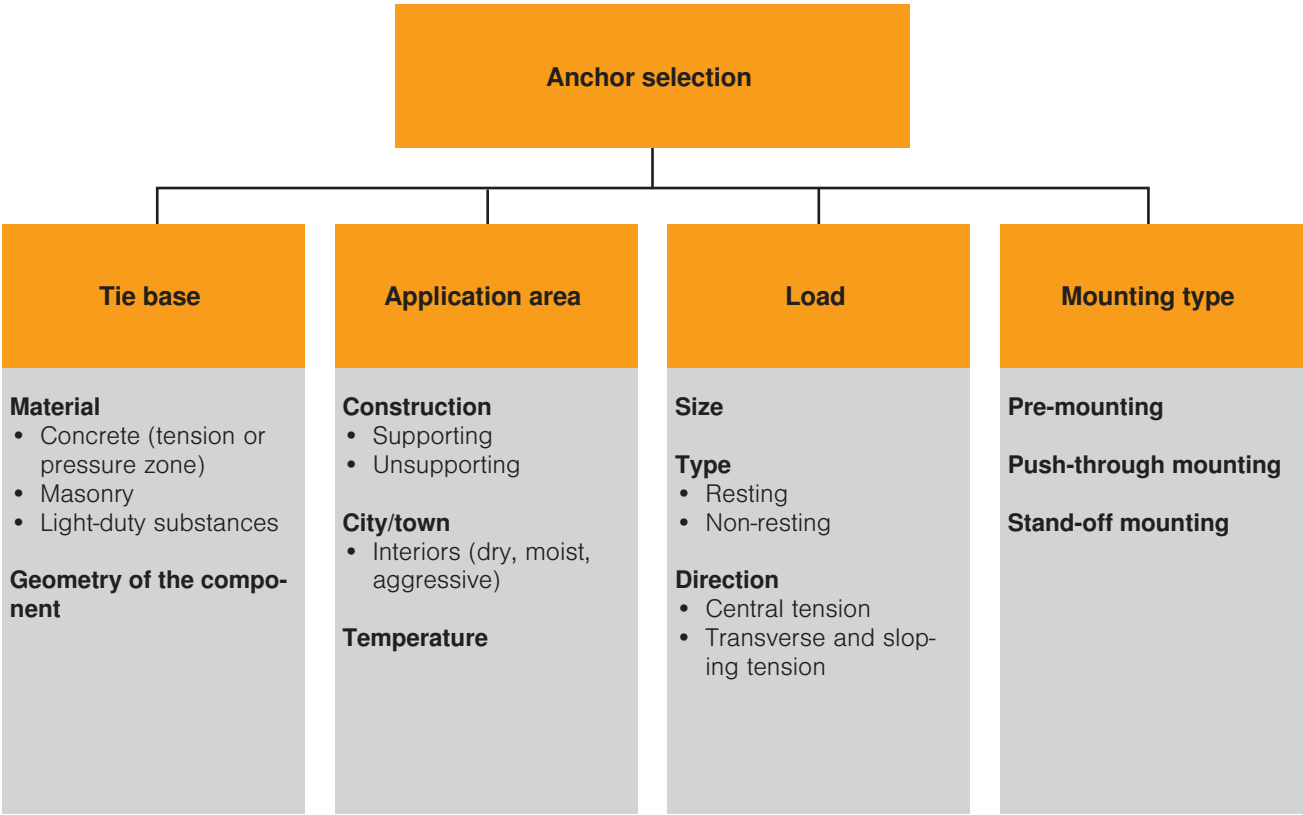
To determine suitable anchors, basic parameters must first be queried:

- Fastening substrate
- Application area
- Load
- Mounting type

All the data relevant to the mounting of anchors and bolt ties for the fastening of fireproof installations must be contained in the approval documents.

5.3 Types of anchors

Besides all the already described parameters, the means of fastening must also be suitable for the ambient atmosphere in which they are used. Many materials and surfaces are available, from electrogalvanised anchors and bolt ties up to highly corrosion-resistant steels.





5.3.1 Metal spreading anchors

OBO Bettermann's metal spreading anchors for mounting on concrete were tested for fire protection. Appropriate proofs are available for the tests carried out. Depending on the fire resistance length (up to 120 minutes), a maximum load capacity was determined when anchored in concrete. This load data is contained in the appropriate European technical ap-

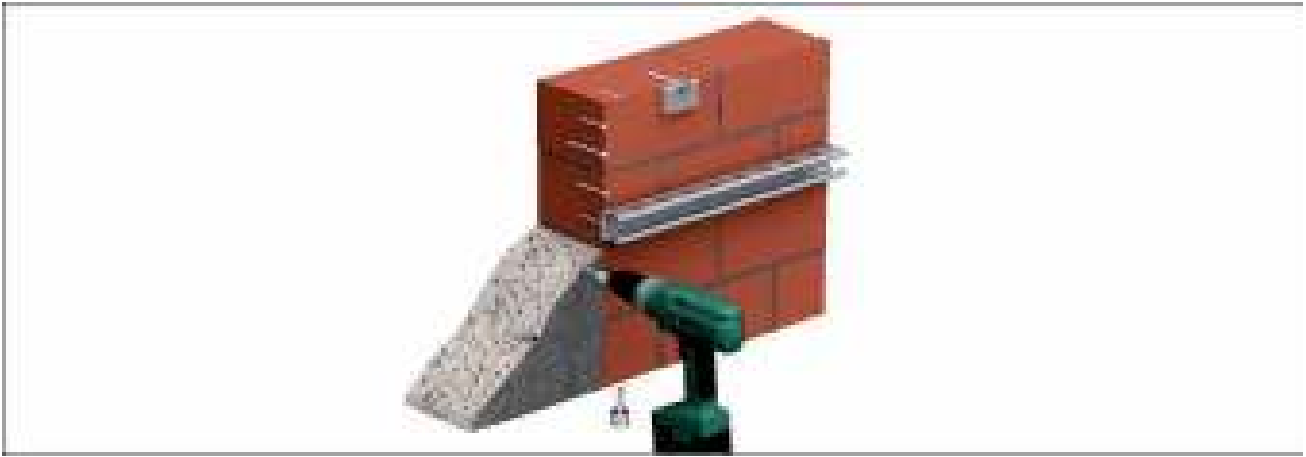
provals and appropriate test documentation. Although the load capacity of the anchors during a fire is below the load capacity when cold, this load capacity is completely sufficient for fireproof fastening of the different routing types. Special metal spreading anchors are offered for false ceilings.



5.3.2 Injection mortar

The VMS Plus injection mortar system is particularly suitable for fire protection fastening in hollow brick, concrete and porous concrete, calcareous limestone, sand-lime brick and masonry. The connection is free from spreading pressure and it is created through the form-fitting of the injection mortar with the substrate and a tie rod; the components are tested and approved for a fire resistance period of 90 minutes. The

maximum load capacity depending on the fire resistance period and the fastening substrate is documented accordingly in the available fire protection certificate. Although the load capacity of the injection mortar system is below the load capacity when cold, this load capacity is completely sufficient for fireproof fastening of the different routing types.



5.3.3 Bolt tie

OBO Bettermann's fire protection bolt ties were fire-tested according to ETAG 001 Part 3 [34]. The maximum load capacity, depending on fire resistance periods of up to 120 minutes, was determined for different types of solid masonry. These values are documented in the appropriate test certificates. Taking the occurring loads for the maintenance of electrical functionality applications and for false ceiling mounting in-

to account, the determined load capacities for the different masonry types are absolutely sufficient. The fire protection bolt ties are screwed directly into the drill hole. There is no need for an additional anchor. No spreading forces develop and mounting near masonry edges is not required. The bolt tie is equally suitable for cracked concrete in ceilings.



5.4 Fastening on steel structures

In industrial construction, steel constructions are frequently used for the building structures. Steel girders and supports can also be found in power stations. However, at approx. 500 °C, steel loses half of its resistance, so that, if there is a fire, the building structures are exposed to a high risk. Thus, unprotected steel does not possess fire resistance, meaning that special measures are necessary, such as treatment with fire protection coatings or lining with non-combustible plates.

At first, fastening of support systems to steel girders seems barely possible. However, if the supporting steel elements of the building are unprotected, other technical equipment, e.g. smoke extraction or automatic extinguishing systems, can compensate for the bad properties of the steel in case of fire by limiting the critical temperatures.

As steel girders may usually not be drilled through, the only other option is fastening with clamping components. Thus, profiles can be used to mount a clamping unit, which neither destroys a fire protection coating nor plate panelling.

A further fastening type is the mounting of light-duty suspension systems with steel girder clamps. The fixed points on the steel girder may need to be re-worked with fire protection paints. It is not wise to use steel girder clamps on supports lined with plates.



5.5 Fastening on wooden components

In future, ever more buildings will be erected with wooden support structures. With suitable fire protection measures, these buildings do not present a greater risk during a fire than buildings erected conventionally. In addition, hall structures with large span widths using glue binders are possible. And wood is also becoming ever more popular as a sustainable resource and, for environmental reasons, is increasingly used in construction (structural engineering).

Wood is a combustible material and, as with steel constructions, wooden components are firstly only suitable under certain conditions for the fastening of

fire-tested electrical installations. Coatings and panelling are also used in the constructions, in order to achieve a fire resistance class at all. However, if there is a fire, wood has a very good property: When burning, an insulated layer is created which delays further combustion. The wooden component must be dimensioned in such a way that failure of the carrying capacity cannot occur at an early stage. The combustion rates are a standard means for calculating the required wooden cross-section, depending on the desired fire resistance class. The combustion rates depend on the type of wood and the moisture content of the wood.



Taking the combustion rates into account, various cable support systems for electrical safety systems with the maintenance of electrical functionality classes E 30 and E 60 can be fastened to wooden components. Wood screws with a suitable steel cross-section and sufficient embedment depth are used for fastening. The long screws drill deep into the cross-section of the wooden beam, ensuring a secure hold of the mounted support systems, despite burning. Various mounting variants are documented in a fire protection survey.

Wood type	Structure	Characteristic density [kg/m3]	Burn rate [mm/min]
Pine and beech	Laminated timber	≥ 290	0.70
	Solid wood	≥ 290	0.80
Hardwood	Solid wood or laminated timber	≥ 290	0.70
		≥ 450	0.55
Veneer timber		≥ 480	0.70
Plates (min. 20 mm)	Wood panelling	≥ 450	0.90
	Plywood	≥ 450	1.00
	Wooden panels made of plywood	≥ 450	0.90

Table 15: Burn rates of various wooden components according to EN 1995-1-2 [35]





Chapter 6: Fire protection from OBO Bettermann

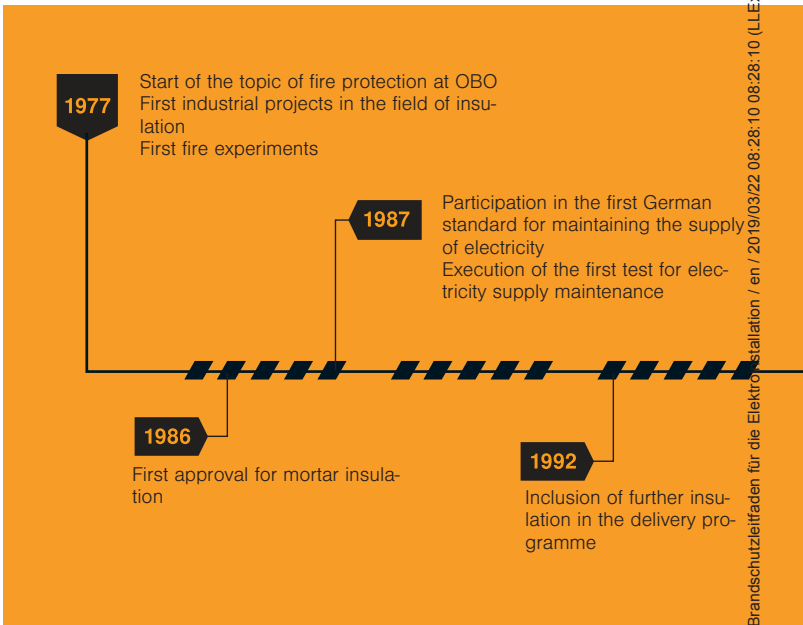
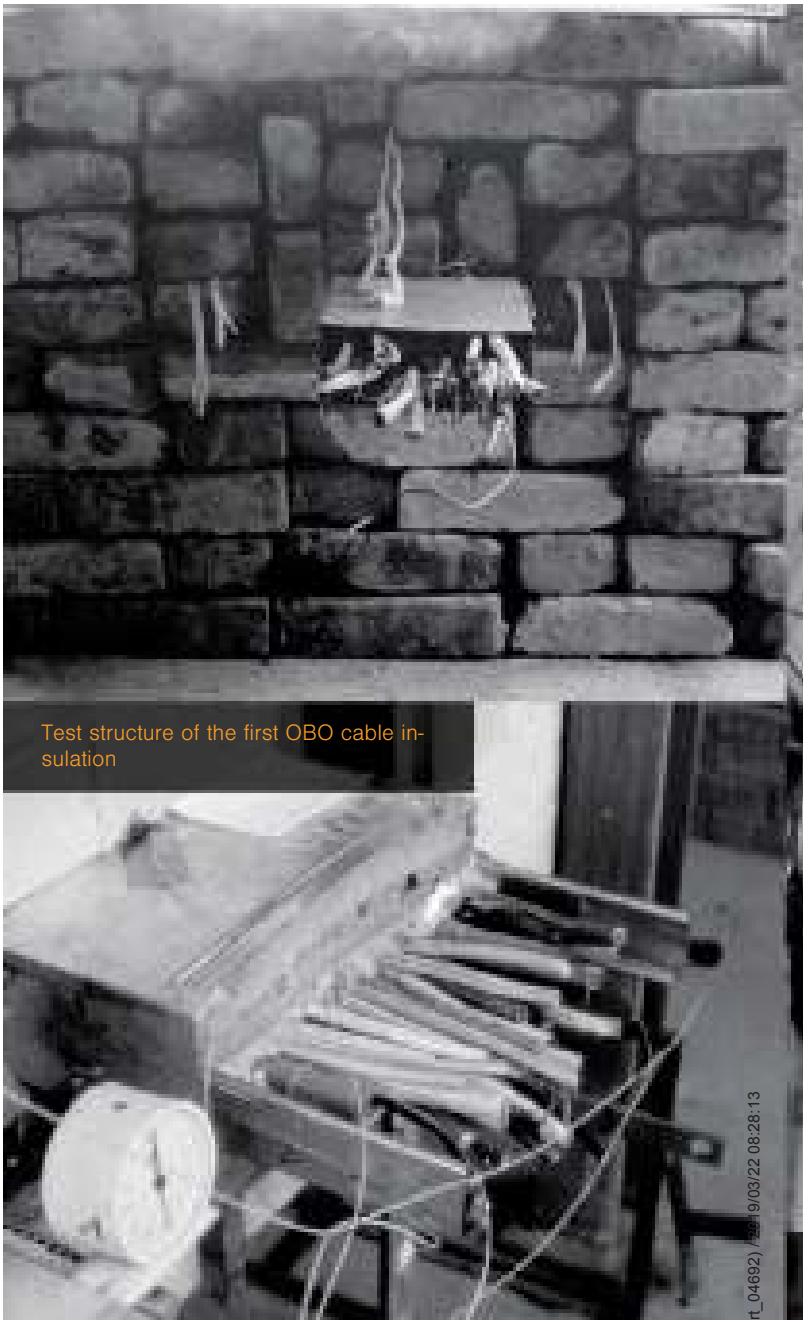
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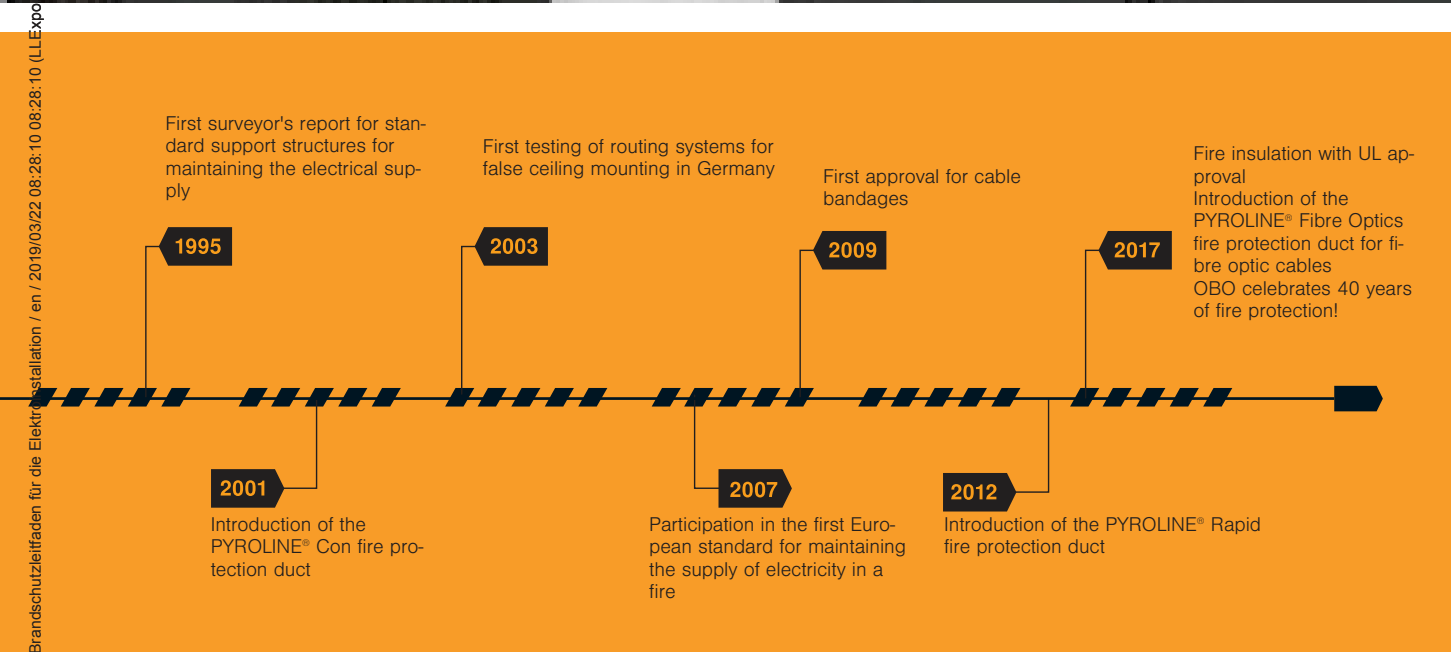
6 Fire protection from OBO Bettermann
6.1 A short trip through the history of "BSS"

OBO Bettermann has been working on the development of fire protection systems for more than 40 years. In the 1970s, with its first proprietary insulation system "NEUWA/BAK", it entered new territory for safe electrical installations. The tests at the materials testing office in Dortmund and the approval by the then Institut für Bautechnik, now Deutsches Institut für Bautechnik DIBt in Berlin, led to the market launch in the early 1980s and represent a first step for OBO's "safety systems". This period also saw the first basic fire tests on cable support systems for the supply of safety-relevant electrical systems. The experiments and experience gained were considered pioneering work and led to the involvement in the creation of a testing standard on the part of the OBO Bettermann experts. The testing standard DIN 4102 Part 12, published in 1998, retains validity even today.

OBO Bettermann continuously expanded the product range of the fire protection systems. Insulation systems were added and lightweight concrete fire protection ducts for installation in escape and rescue routes and for the maintenance of electrical functionality in the event of a fire supplemented the portfolio. After the catastrophic fire at Düsseldorf Airport in 1996, with 17 dead and 88 seriously injured, the construction regulations for cable systems in false ceilings were increased. OBO Bettermann took this opportunity to check and document the cable support systems for their mechanical stability and the deformation behaviour in a fire when used above suspended false fire protection ceilings. These proven safe routing systems again set a new standard in the field of electrical installations.

For years, OBO Bettermann has focused on internationally proven fire protection solutions. Some of the systems currently in the portfolio not only possess the proof of suitability for national use on the German market but are also suitable for global use, on account of European and other international documents.





OBO fire protection history by numbers



Customer Service

Tel.: +49 23 73 89 - 17 00

Monday to Thursday 7.30 a.m.–5.00 p.m.
Friday 7.30 a.m.–3.00 p.m.

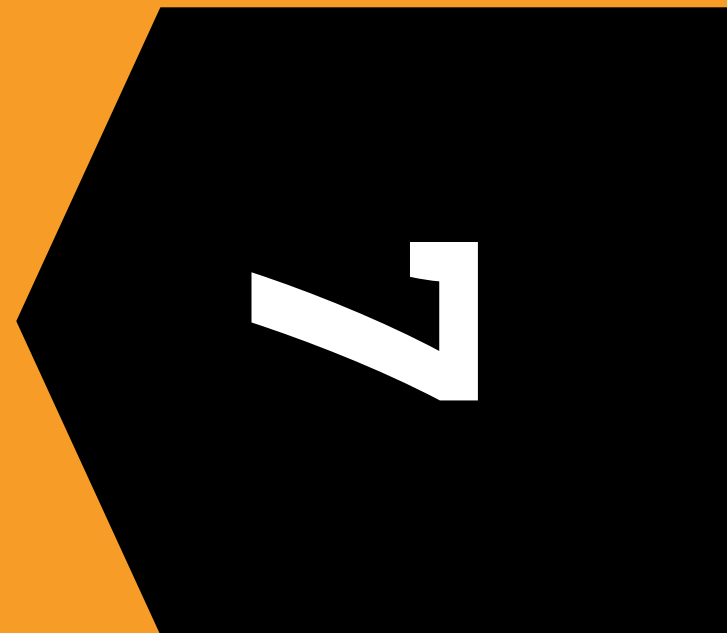
6.2 Engineering and support

The fire protection experts at OBO Bettermann can also 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. They will support you in working out the problem and offer the first solution options. If the requirements become more difficult, fire protection product management at the head office in Menden comes into play. 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.



6.3 Seminars

Through a comprehensive range of seminars and workshops on the subject of fire protection in electrical engineering, OBO Bettermann supports 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. As well as the theoretical principles, this concerns implementation in everyday situations. Specific customer or project seminar content is also possible.



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"We fire protection experts are also responsible for safe electrical installations."

Dipl.-Ing. (FH) Stefan Ring
Head of the Fire Protection Systems Business Unit
BSS at OBO Bettermann

7.1 About the author

After his studies as an electronics engineer for energy devices, Stefan Ring, who was born in 1968, studied electrical engineering at Fachhochschule Dortmund, with special emphasis on electrical energy technology, and was awarded the title of Diplom-Ingenieur (FH) in October 1994. He has worked as the fire protection expert at OBO Bettermann GmbH & Co. KG in Menden, Sauerland, since 2005. He was first active in the field of product management, but changed to the strategic marketing division in 2014, in order to provide help and assistance to OBO's sales companies. On 1 January 2016, Stefan Ring also took over the leadership of the Fire Protection Systems Business Unit (BU BSS) at OBO Bettermann.

As an expert in structural fire protection in electrical installation technology, Mr Ring receives invitations to training courses, seminars and trade fairs in Germany and abroad. He thus supports the marketing activities of the company.

During his activities, Stefan Ring successfully completed training as a specialist planner and surveyor 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 30 years, as the Chief Fire Officer with the Weddinghofen fire engine. In addition, he has run the BSB surveyor's office since 2013, also in Bergkamen-Weddinghofen.





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Exclusion of liability

§ 10 Liability exclusion and limitation, exclusion of a contractual penalty

(10.1) An explicit exception shall be made for the liability exclusions and limitations below, the injury to life and health which is the result of an intentional (§ 276 III of the German Civil Code) or negligent (§ 276 II of the German Civil Code) infringement of obligations by a legal representative or assistants (§ 278 of the German Civil Code) of the Seller and other damage caused by a grossly negligent infringement of obligations by the Seller or an intentional or grossly negligent infringement of obligations by a legal representative or assistants of the Seller in the sense of §§ 309 Nos. 7 a) and b) of the German Civil Code. In addition, the liability exclusions and limitations below shall not apply to the acceptance of a guarantee for the structure or lifespan of the item in the sense of § 444 of the German Civil Code and in the case of fraudulent suppression of a fault, in the case of forced liability according to the product liability act and in the infringement of an obligation, whose fulfilment enables the correct execution of the contract and compliance with which the contractual partner has expected and expects (key obligation / cardinal obligation). Thus, only the liability restrictions according to § 10.3 and 10.4 shall apply.

(10.2) If non-essential contractual obligations are infringed, the Seller, their leading employees and simple assistants shall only be liable in cases of intent and gross negligence.

(10.3) In the case of damage caused by negligence, the Seller, their legal representatives and assistants shall only be liable in cases of the infringement of an obligation, the fulfilment of which permits the correct execution of the contract and compliance with which the contractual partner has expected and expects (key contractual obligation / cardinal obligation), although the level shall be limited to the damage which was foreseeable at the time of contract completion and which is typical for the contract.

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