6 Passive fire protection

Inside building there are two types of fire protection systems: Active fire protection and passive fire protection. Both systems should actively work together in the event of a fire.

Active fire protection
Active fire protection is a group of systems that require action in the event of a fire. This action can be manual, like a fire extinguisher. or automatic like a sprinkler system. When fire and/or smoke is detected these systems put out or, slow the growth of the fire until firefighters arrive.

Passive fire protection
Passive fire protection is a group of systems that compartmentalize a building through the use of fire-resistance rated walls and floors, keeping the fire from spreading quickly and providing time to escape for people in the building.

This chapter on fire protection in relation to Akatherm HDPE will address passive fire protection.

6.1 Fire compartmentation

Passive fire protection via compartmentation is important for life safety and property protection by dividing a building into smaller blocks. Vertical fire resistant walls and horizontal fire resistant floors aim to limit the fire spread and gain time. Compartmentation plays an important role in a building when the active system of the fire area is no longer able to control the fire.

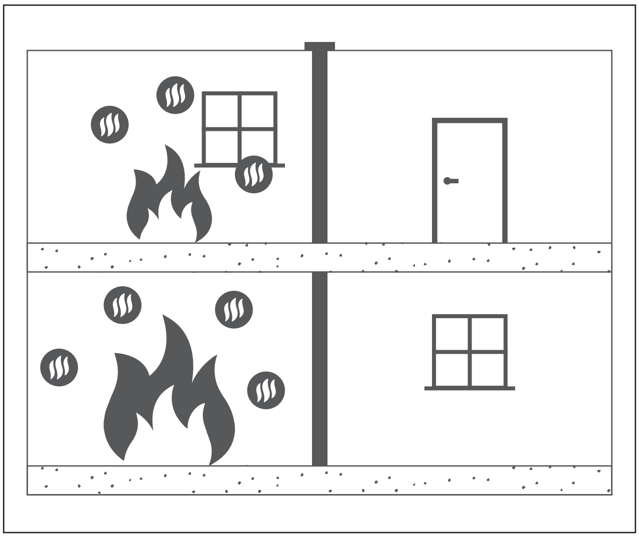

Illustration 6.1 Fire compartmentation

6.1.1 The four stages of fire development

Fire in a building evolves in four stages

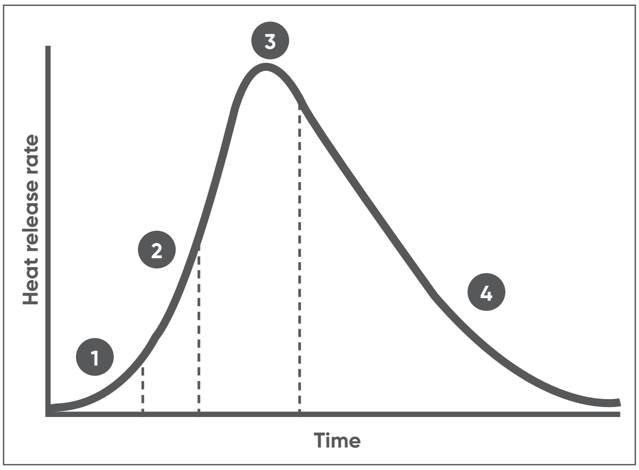

Illustration 6.2

1. Incipient stage
The incipient stage begins when heat, oxygen and a fuel source combine and have a chemical reaction resulting in fire. This is also known as “ignition” and is usually represented by a very small fire which often goes out on its own. Recognizing a fire in this stage provides the best chance at suppression or escape.

2. Growth stage
The growth stage is where the structures fire load and oxygen are used as fuel for the fire. There are numerous factors affecting the growth stage including where the fire started, what combustible are near it and ceiling height. It is during this shortest of four stages when a deadly “flashover” can occur; potentially trapping, injuring or killing firefighters.

> Flashover: the sudden complete involvement of a room in flames caused by thermal radiation feedback. Thermal radiation feedback will cause all combustible materials in the room to reach their ignition temperature.

3. Fully developed stage
When the growth stage has reached its max and all combustible materials have been ignited, a fire is considered fully developed This is the hottest phase of a fire and the most dangerous for anybody trapped within.

4. Decay stage
Usually the longest stage of a fire, the decay stage is characterized by a significant decrease in oxygen or fuel, putting an end to the fire. Two common dangers during this stage are first - the existence of non-flaming combustibles, which can potentially start a new fire if not fully extinguished. Second, there is the danger of a “backdraft” (a smoke explosion) when oxygen is reintroduced to a volatile confided space.

6.1.2 Compartmentation during growth stage

A fire out of control occurs when the fire is at the flashover stage where everything that is combustible in a room is inevitably lost and one can only try to save the neighboring rooms or buildings.

Burnable hot gases are concentrated below the ceiling and are heated up due to the fire in the room. When this mixture of gases is hot enough, the flashover happens and a “wave” of fire rolls along the ceiling. A flashover does not occur in every fire compartment. The fuel must have sufficient heat energy to develop flashover conditions and the fire must have sufficient oxygen.

6.2 Fire behaviour of Akatherm HDPE

The behaviour of Akatherm HDPE in a fire, corresponds to material class B2 (normally inflammable) in accordance with DIN 4102, Part 1.

Standard	Classification
DIN 4102	B2
EN13501	E

Table 6.1

European standard EN 13501-1
This standard defines a class system for material behaviour at fire for building products and building constructions. The fire behaviour of the end product as applied needs to be described by its contribution to the development and spread of fire and smoke in an area or environment. All building products can be exposed to fire developing in an area that can grow (develop) and eventually flashover. This scenario contains three phases according the development of a fire:

- Phase 1: flammability
- Phase 2: smoke generation
- Phase 3: flaming drops/parts

Fire classification

Phase 1: flammability

Class	Fire tests	Flashover	Contribution	Practice
F	Not tested, or does not comply to class E	Not classified	Not determined	Extremely flammable
E	EN-ISO 11925-2 (15 sec-Fs<150 mm-20 sec)	Flashover 100 kW <2 min	Very high contribution	Very flammable
D	EN 13823, Figra <750 W/s EN-ISO 11925-2 (30 sec-Fs<150 mm- 60 sec)	Flashover 100 kW >2 min	High contribution	Good flammable
C	EN 13823, Figra <120 W/s + Thr <15 MJ EN-ISO 11925-2 (30 sec-Fs<150 mm-60 sec)	Flashover 100 kW >10 min	Great contribution	Flammable
B	EN 13823, Figra <120 W/s +Thr <7,5 MJ EN-ISO 11925-2 (30 sec-Fs<150 mm-60 sec)	No flashover	Very limited contribution	Very difficult flammable
A2	EN ISO 1182 of EN-ISO 1716 plus EN 13823, Figra <120 W/s + Thr <7,5 MJ	No flashover	Hardly contribution	Practically not flammable
A1	EN ISO 1182 = Not flammable EN-ISO 1716 = Calorific value	No flashover	No contribution	Not flammable

Table 6.2

Fire safety level of buildings
The level of fire safety of a building is not equal in every European country. Each member state may determine in its regulations which products may be used and which fire class is found suitable.

German industry standard DIN 4102
In the past the official fire rating has been ruled according to DIN 4102 (still valid today).

Materials are tested for the degree of flammability and combustibility. DIN 4102 include for testing of passive fire protection systems, as well as some of its constituent materials. The following are the categories in order of degree of combustibility as well as flammability:

Rating	Degree of flammability
A1	100% non-combustible
A2	~98% non-combustible
B1	Difficult to ignite
B2	Normal combustibility
B3	Easily ignited

Table 6.3

6.3 Fire collar protection

The fire behavior of Akatherm HDPE is rated as normally inflammable, class B2 according to DIN 4102. When Akatherm HDPE passes through fire-rated building elements, it is mandatory to install fire protection collars that will not reduce the fire-rating of these building elements and prevent a flashover. The Akatherm HDPE system can be installed with Promat fire collars as an effective passive fire safety solution.

Certification
Promat fire collars are tested with Akatherm HDPE according to EN1366-3:2009 and hold a fire resistance classification certificate according to EN13501-2:2016.

Measuring passive fire stopping
Passive fire stopping by means of fire collars is measured in terms of integrity and insulation. Stability or structural adequacy is not recorded for service penetrations like pipes, except when those which are required to be load bearing. Integrity failure occurs when cracks, holes or openings occurs through which flames or hot gases can pass.

Insulation failure occurs when the temperature on the unexposed surface of the pipe system exceed a set temperature (~180°C). To prevent failure in interlinked concealed cavities, where pipe systems generally run, it is vital to ensure compartmentation by sealing any and all gaps, including gaps left for structural movement and gaps left due to poor workmanship.

EU standard EN1366-3:2009 is accepted for fire testing in many parts of the world. For more information related to fire safety testing regulation in conformity with international standards please contact your Aliaxis export office.

> ! Applicable national regulations, standards, codes and building practice on fire protection must be observed.

6.3.1 Wall penetrations with Akatherm HDPE

Penetrations of fire rated walls require two fire collars on both sides of wall. The origin of the fire is unknown and can come from both sides.

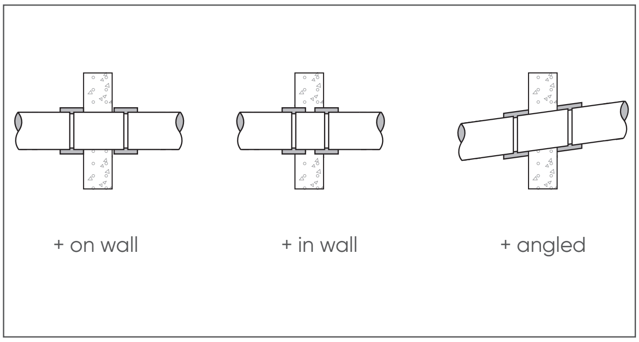

Illustration 6.3

Akatherm HDPE is tested in a variety of ceiling constructions, please refer to the fire resistance rating chapter.

6.3.2 Ceiling penetrations with Akatherm HDPE

Penetrations of fire rated ceilings require one fire collar installed on the bottom of the ceiling. The heat of the fire and the flashover come only from below.

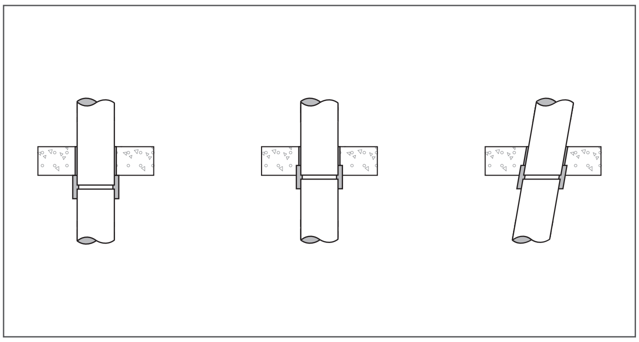

Illustration 6.4

Akatherm HDPE is tested in a variety of ceiling constructions, please refer to the fire resistance rating chapter.

6.4 Promat fire resistance rating for HDPE

Promat fire collars are tested with Akatherm HDPE according to EN1366-3:2009 and hold a fire resistance classification certificate according to EN13501-2:2016.

Wall penetrations of Akatherm HDPE pipes

Akatherm pipe outer diameter (mm)						40	50	56	63	75	90	110	125	160	200	250	315
Type	Thickness	Specification	Promat fire collar	Penetration angle	Installation	Load bearing/Integrity/Insulation											
Concrete wall	> 100 mm	> 450 kg/m³	Promastop-FC3	90°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-
			Promastop-FC6	90°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-
			Promastop-FC6	45°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-	-
	> 150 mm	> 450 kg/m³	Promastop-FC3	90°	In wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	
			Promastop-FC6	90°	In wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-
			Promastop-FC6	90°	On wall	-/240/240	-/240/240	-/240/240	-/240/240	-/240/240	-/240/240	-/240/240	-/240/240	-/240/240	-	-	-
Multiboard (wood) wall	> 140 mm		Promastop-FC3	90°	On wall	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-	-
			Promastop-FC6	90°	On wall	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-
Sandwich panel wall	> 80 mm		Promastop-FC3	90°	On wall	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-	-
			Promastop-FC6	90°	On wall	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-
Light partition wall	> 100 mm		Promastop-FC3	90°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-	-
			Promastop-FC6	90°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-
			Promastop-FC6	45°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-	-
Shaft wall	> 2 x 15 mm		Promastop-FC6	90°	On wall	-/60/60	-/60/60	-/60/60	-/60/60	-/60/60	-/60/60	-/60/60	-/60/60	-	-	-	-
	> 2 x 20 mm		Promastop-FC6	90°	On wall	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-	-	-
	> 2 x 25 mm		Promastop-FC6	90°	On wall	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-	-

Table 6.4

Ceiling penetrations of Akatherm HDPE pipes

Akatherm pipe outer diameter (mm)						40	50	56	63	75	90	110	125	160	200	250	315
Type	Thickness	Specification	Promat fire collar	Penetration angle	Installation	Load bearing/Integrity/Insulation											
Concrete ceiling	> 150 mm	> 650 kg/m³	Promastop-FC3	90°	On ceiling	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-
			Promastop-FC6	90°	On ceiling	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-
			Promastop-FC6	45°	On ceiling	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-/120/120	-	-	-
Suspended ceiling	> 40 mm	2 layers	Promastop-FC3	90°	On ceiling	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-	-	-	-	-
			Promastop-FC6	90°	On ceiling	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-/90/90	-	-

Table 6.5

6.5 Plastics and fire safety

Although most metal pipes are classified as non-combustible, and plastic pipes as combustible, one needs to have a closer look at which drain, waste and vent (DWV) pipe material may be advantageous for life safety in a building fire.

It is important to note that in most fire safety codes, the objectives are not on prevention of fire, but rather on the spread of fire. In other words, construction practices are specified with regard to fire safety that if a fire should breaks out for some reason, that the building construction practices should be such that this fire is compartmentalized to remain in the compartment of origin, thus allowing sufficient time for fire suppression activities to occur such as fire sprinklers or fire department response.

It is generally conceded that most combustible pipes will be consumed fairly quickly in a fire but does that create a large fire safety risk for the remainder of the building? The answer is no.

The reason it does not is through very effective fire stopping. Fire stopping is the process of applying tested materials and systems to the underside of floors or on both sides of walls whereby the penetration for the pipe will not allow passage of heat or flame to adjacent compartments. It can be argued that fire stopping devices such as collars actually work more effectively with combustible pipe than they would for metal pipe. This is because these devices tend to sever off a combustible pipe very early in a fire as the intumescent material rapidly expands and fills the hole left by the consumed pipe. The end result is a collar fastened to the floor or wall surface that contains a large amount of charred material which is resistant to the passage of flame or significant heat. They are effectively like a lump of coal protecting the hole during the fire and will typically offer sufficient protection.

Fire stopping metal pipe is also somewhat common but works much differently. Since the metal pipe will not be consumed during the fire, the focus of fire stopping is simply to seal off the annular space between the pipe's outside diameter and the hole interior. Mineral wool and firestop caulking can achieve this but there are two concerns with these systems.

One is that the mineral wool plus caulking will not prevent a high level of heat transfer from one compartment to the next through the very conductive metal pipe. Temperature increases on the unexposed side of a pipe penetration can easily exceed 180°C with uninsulated metal pipe. Having this hot stove pipe effect can actually inadvertently ignite combustible materials on the unexposed side of a fire and thus allow continuity of the fire beyond the separation.

Secondly, the most common manner of joining cast iron pipes today is through the use of a rubber, steel mesh sleeved mechanical joint couplings. During a fire, the rubber component of these couplings can be consumed which will potentially create openings in a cast iron stack (vertical pipe) and thus allow fire to enter the pipe interior and breach the separation by spreading to the unexposed side.