Nederlands Instituut Publieke Veiligheid

Fighting fire in a building with sprinkler system

A substantiated action perspective for the fire brigade

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Date	November 9, 2023

The Netherlands Institute for Public Safety is established by law under the name Institute for Physical Safety.

Contents

Introduction

This document contains the information on the basis of which the fire brigade's perspective on action in the event of a fire in a sprinklered building has been drawn up. This introduction discusses the need to achieve one
perspective for action.

Why an action perspective?

More and more buildings are equipped with a sprinkler system. The sprinkler systems play an important role in the fire safety concept of buildings and are often installed as an equivalent solution for, for example, creating large fire compartments or allowing a longer escape route. The purpose of sprinkler systems is to control or extinguish an incipient fire and prevent further fire development. The fire brigade is needed for the so-called 'final
extinguishment' and the follow-up check.

The size of sprinklered buildings is increasing, not only in terms of the size of the fire compartments in m2 , but also in terms of height. This is evident in practice can cause limitations in repressive action and entail risks, for example because the location of the fire is not clear or accessible or safe action is not possible due to items falling from high racks. In addition, risks may arise if (part of the) sprinkler system is not switched off at the right time or in the correct manner.

There is no standard procedure for dealing with an activated sprinkler system and therefore dealing with a sprinkler system is not yet part of the regular training. However, it is necessary for the fire brigade to act correctly in order for the sprinkler system to fulfill its role within the fire safety concept.
And not only when there is actually a fire, but also in situations where the sprinkler system has been activated without there being a fire. Consider the activation of the sprinkler due to a collision with a sprinkler head. Practice has shown that the on-site unit does not always know how to act in different situations when a sprinkler system has been activated. This was the reason for
fire brigade units to develop an action perspective for repressive action in incidents involving a sprinkler system

The purpose of this document

The purpose of this document is to make available the background information used in drawing up the action perspective. Although the information in this document is mainly intended for the operational departments (incident response, professional competence and operational preparation) of the fire brigade, it can also be used in the design process of a

building with a sprinkler system can be used as a resource, both by the risk management department and by consultancy firms and installers. Taking the efforts of the fire brigade into account when designing a building and the sprinkler system can contribute to its success.

Reading Guide

Chapter 1 is about deployment in a sprinklered building based on the basic principles of fire fighting. Chapter 2 covers the possible different scenarios involving sprinklers. Chapter 3 describes the risks involved in firefighting in a sprinklered building. Chapter 4 provides the action perspective for fire brigade action in the event of a fire-activated sprinkler system. Chapter 5 discusses the perspective for action when the sprinkler system is activated while there is no fire. Appendix 1 contains information about the types and operation of the sprinkler system and the buildings in which they are used, and Appendix 2 provides a flowchart for the action protocol

weather.

1 Deployment in a sprinklered building

Introduction

The basic principles of firefighting help firefighters in practice to conduct a safe and effective firefighting effort. The basic principles can also be applied to fires in buildings equipped with a sprinkler system. This chapter discusses in more detail the fire brigade response to a fire in a sprinklered building.

1.1 Deployment in a sprinklered building

In the event of a fire in a building, one or more sprinkler heads are usually activated. If the exact location of the fire is known, the location of the fire within the building can be reached easily and safely and the fire has already been extinguished or can be easily extinguished, this is a standard deployment. If this is not the case,
this is referred to as a non-standard deployment. This is discussed in more detail in the paragraphs below.

Number of sprinklers activated in a fire controlled by the sprinkler system
The number of sprinklers activated in a fire controlled by the sprinkler system in the period 2008 - 2012 as registered by the Certification Body for Security and Safety and the
Association of Inspection Bodies for Safety and Fire Safety is:

> 48% of fires are controlled by 1 sprinkler.
> 29% of fires are controlled by 2-3 sprinklers
> 13% of fires are controlled by 4-7 sprinklers
> 6% of fires are controlled by 8-15 sprinklers
> 4% of fires are controlled by >15 sprinklers.

1.1.1 Standard deployment in a sprinklered building

There is a standard deployment if: > It is
known where the fire is.

It is easy to find out where within the building the sprinkler head(s) have been activated by a fire.

> The fire is easily and safely accessible.

The location within the building where the sprinkler head(s) are activated and the location where it burned can be reached in a normal way, for example via a floor, stairs or ramp and via a limited deployment depth.

> There is sufficient cooling capacity.

The sprinkler system has already extinguished the fire or controlled the fire, so that it does not or hardly increase in size, the fire can be extinguished in a normal manner and a good follow-up inspection can be carried out.

1.1.2 No standard deployment in a sprinklered building

A non-standard deployment occurs if:
> It is not known where the fire is.

It is not known or easy to find out where the fire is within the building. For example, it may be a complex building or a large building (both in surface area and height).

> The fire is not easily and safely accessible.

The location within the building where the sprinkler head(s) are activated or the location where it is burning cannot be reached via a floor, stairs or ramp, there is a large deployment depth, there is limited visibility due to the smoke, there are automatic systems in place that it is not certain whether they have been switched off, objects fall from racks, proper follow-up checks cannot be carried out, etc.

> There is insufficient cooling capacity.

There is no certainty that the sprinkler system actually controls the fire, for example there are RSTV indicators that indicate that this may not be the case, or the source of the fire cannot be extinguished in a normal manner.

1.1.3 Deployment proposal

The standard deployment proposal may differ per region in the event of a sprinkler report or a confirmed fire in or next to a sprinklered building. When writing this document, the starting point was that the first deployment is carried out by a TS 6 or a composite unit, so that at least as many tasks can be carried out simultaneously as by a TS 6.

If there is a non-standard deployment, in most cases there will be more tasks that need to be performed largely simultaneously than a basic unit can handle. In that case, scaling up is necessary. With a non-standard deployment, there are many things to consider and coordination is necessary. The duty officer (OvD) can fulfill this task. During a deployment, the Public Safety Officer has more time to delve into the points of interest in the deployment protocol and can monitor its implementation.

By including an OvD in the deployment proposal for a confirmed fire in a sprinklered building, it can be ensured that the correct procedure is applied and an additional check is carried out on the decision and the giving of the order to close the valve of the activated sprinkler section. to be closed. The Public Safety Officer can have the building owner ensure that the sprinkler system is operational again as quickly as possible and that temporary measures are taken until the sprinkler system is ready for operation again.
Ultimately, the Public Safety Officer hands the building back to the building owner.

It can be determined in advance for each object whether there will be a standard use or not.
The standard deployment proposal for the building can be adjusted accordingly.

1.2 Applying the basic principles of firefighting

This section discusses the application of the basic principles of fire fighting in the event of a fire in a sprinklered building.

1.3 Take more time (stop and think).

As with other building fires, taking more time can lead to a more effective and safer fire brigade deployment with a (possibly) more favorable result. If there is a fire in a building equipped with a sprinkler system, the sprinkler system will in most cases control or even extinguish the fire. This ensures that - unlike a fire in a non-sprinklered building - there is actually time. In most cases, the fire will no longer increase in size. This provides time to think carefully in advance about the commitment and the challenges and risks that may arise. Consider, for example:

> A sprinkler system that no longer controls the fire, for example because someone has already closed the valve.
> A fire at height or in a (process) installation.
> Goods that are transported as a result of the activated sprinkler system and the fire fall down.
> The presence of automatically operating installations in warehouses and parking garages.
> No or limited view within the room.
> Limitation in communication due to the size of the building and the building construction.

Chapter 3 discusses the risks in more detail.

Practical example 1: Turning off the sprinkler
A commander who has been alerted to a sprinkler report in a distribution center is told when the emergency response team arrives that the sprinkler has already extinguished the fire in the warehouse. The emergency response officer asks whether the sprinkler can be turned off to limit water damage. The commander indicates that this is allowed without having seen the fire location.
In this practical example, the 120, who arrived on the scene just after the 110, immediately indicated that the sprinkler system should not be turned off until the fire brigade had carried out its own inspection. executed.

If the fire is not completely extinguished, there is a risk that it will develop again. This can cause rapid fire spread, especially in high warehouses.

1.4 Conduct an (outside) reconnaissance with the aim of finding the fire room and extinguishing the fire from outside

It depends on the type of building whether carrying out an exterior exploration is feasible or not. In the latter case, consider, for example, a very large warehouse or a high residential tower. In the event of a fire in a sprinklered building, the fire will in most cases not spread because it is kept under control by the

sprinkler system. This will ensure that no smoke or fire is visible on the outside of the building. In some types of buildings there are hardly any windows in the facades, so that it is not possible to look inside. The advantage of a sprinkler system is that it can reduce the search area by providing information about the location of the fire. This will be discussed in more detail below.

An important point of attention during the all-round exploration is to determine whether there is a fire that started outside the building or whether part of the building structure is on fire. A fire outside the building or in the building structure, unless controlled by the sprinkler system, poses a direct threat to the building and the sprinkler system. In most cases, a fire on the outside will be visible when driving, because smoke can be seen.

The image below (Figure 1.1) is an example of the outside view of a fire in a large warehouse where the sprinkler system controlled the fire at the top of a rack.

Figure 1.1 The fire location in a warehouse is visible from the outside (Source: TBO VGGM)

1.4.1 Determine which sprinkler section is activated

In buildings equipped with a sprinkler system, the geographical fire brigade panel indicates which section of the installation is activated and where this section is located within the building. Exactly where one or more sprinkler heads have been activated within this section is not shown. If there is no internal organization that can indicate where the fire is, a search will have to be made for the exact location within the activated sprinkler section. Multiple rooms and floors can fall within one sprinkler section. The surface area of a sprinkler section in a distribution center can be several tens of thousands of m2 .

The fire brigade panel usually only indicates the fire brigade entrance and the side entrances through which the building can be entered from the outside. By exploring the outside of the sprinkler section, it can be determined where there are entrances to the section.

1.4.2 Where is the fire located?

In addition to the fact that in the case of an activated sprinkler system, it must be clear where sprinkler heads have been activated, it must also be clear whether it is still burning. Particularly if a fire is kept under control by the sprinkler system, there may be considerable smoke and steam production and lower temperatures are more likely to occur, allowing the smoke to mix. Depending on the size of the room and the materials that are burning, this can cause the entire room to be filled with smoke to a greater or lesser extent. This can ensure the exact location of the fire
is not visible.

If upon arrival it is not known where the fire is located within the sprinkler section, it will be possible to look from a safe area through windows on the outside of the section or through the doors that provide access to it to see whether the location where the sprinkler system can be identified can be identified. is activated. The sound of the activated sprinkler heads or the observation of flowing water on the ground can provide an indication of the location of the fire. A thermal imaging camera can also be used as an aid. However, the water flowing from the sprinkler head(s) may prevent a location with a higher temperature from being identified. The thermal imaging camera may then be able to search for a location with a lower temperature than the rest of the room, caused by the cold water.

If it is not visible from the outside where a sprinkler head has been activated within the sprinkler section, a search can be made inside the section. However, this must be possible safely. Basically, the sprinkler system will control the fire and cool the flue gases. Whether the sprinkler section can be entered safely can only be assessed on site.

If there is an indication that the fire is no longer controlled by the sprinkler system, this can lead to a 'no' answer to the question whether the fire is (safely) accessible.

Smoke development as an indicator of whether a fire is being controlled or has been extinguished
If a fire has already been extinguished by the sprinkler system, not much smoke will be produced anymore. There may be visible smoke in the room, but in most cases there will still be good visibility.
If the fire is controlled by the sprinkler system, smoke will continue to be produced. This can result in much less or no visibility into the room where the fire is. How much visibility there is
depends on the size of the fire, the fuel and the size of the room.

The temperature of the smoke layer is kept under control by the sprinkler system. If the temperature of the smoke layer somewhere in the building becomes so high that the activation temperature of a sprinkler head is reached, for example 68 0C, then that sprinkler head is activated. The water from the sprinkler head will then cool the smoke layer. Flue gas cooling is therefore not necessary, but the smoke remains a potential fuel.

Practical example 2: Smoke development with activated sprinkler system
A fire broke out in a storage hall full of waste paper. The fire is kept under control by the sprinkler system. There is such a large smoke development that a significant scale-up is required. Based on the smoke image, a burn-out scenario is assumed. At a later stage, an exploration determines that the sprinkler system keeps the fire under control and that an interior attack is possible. The paper bales are taken outside and extinguished there.

If it burns in a pile of waste paper or rubbish it may continue to burn inside the pile out of the reach of the water coming out of the sprinkler head(s). The associated smoke development can ensure that there is no longer any visibility in the room.

1.4.3 Is the fire (location) accessible?

Once it is known where sprinkler head(s) have been activated within the sprinkler section, it must be determined whether this location is accessible. The fire brigade panel usually only indicates the fire brigade entrance and the side entrances through which the building can be entered from the outside. As with non-sprinklered buildings, the advice is to take the shortest possible route to the fire. This ensures that the building can be left quickly in the event of an unexpected event.

Is a safe indoor deployment possible?
If entering the building is necessary, it will be necessary to assess whether the conditions are safe enough to actually do so. In a sprinklered building, an offensive interior attack will be possible sooner than in a non-sprinklered building, because the sprinkler system will control the fire in most cases and provide conditions under which entering the building is possible. Chapter 3 discusses in more detail the risks that may be present in a sprinklered building.

Is the fire accessible within the sprinkler section?
Reaching the location can be difficult for certain building types or types of use. Consider, for example, a fire at the top of a high room, for example in a warehouse rack at a height of 12 meters. This can make the location of the fire difficult or impossible to reach. If the location where the fire is burning is not physically accessible via floors or stairs, an answer will have to be given to the question of whether the location can be reached by a radius.

Is the fire accessible to the sprinkler system?
A sprinkler system is designed to control or even extinguish a fire. If all the fire can be reached by the water coming out of the sprinkler head, the fire will have already been extinguished when the fire brigade arrives.

If the fire cannot be reached by the water coming from the sprinkler head(s), then there will be a fire controlled by the sprinkler system. For example, if the fire is in a rack where overhead products prevent water from reaching the seat of the fire, in a tight packaging or in a structural part of the building where water from above cannot easily reach it. The sprinkler system is designed to prevent fire spread in that case.
Fire coming out of the packaging is fought by the water. If one sprinkler head does not have sufficient cooling capacity to absorb the energy of the fire, the increase in temperature will activate one or more sprinkler heads. This continues until there is sufficient cooling capacity to control the fire and keep the temperature in the immediate area low enough. The water also wets the immediate area surrounding the fire, which is...

ensures that the fire cannot quickly spread through adjacent flammable materials
to expand.

Practical example 3: The fire is accessible to the sprinkler system

A fire broke out in Christmas decorations in a catering establishment. The sprinkler head near a artificial Christmas tree was activated by the fire. The water coming out of the sprinkler head can reach the fire and has sufficient cooling capacity to extinguish the fire. See figure 1.2.

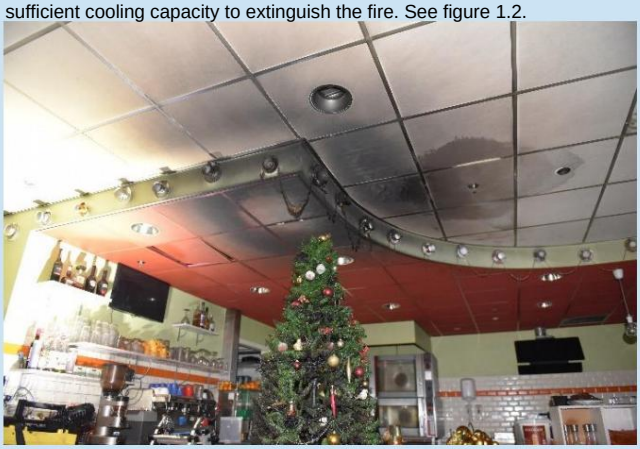

Figure 1.2 Activated sprinkler head near the seat of the fire (Source: TBO VGGM)

Practical example 4: The fire is not accessible to the sprinkler system

The sprinkler system in a parking garage has been activated by a car fire. The water cannot reach the fire in the car, but it does prevent the fire from spreading outside the car.

The flames coming from outside the car are knocked down by the water. Due to the smoke development, a search had to be carried out to find the location of the fire; this could not be determined with a thermal imaging camera. An intervention by the fire brigade was necessary to extinguish the fire.

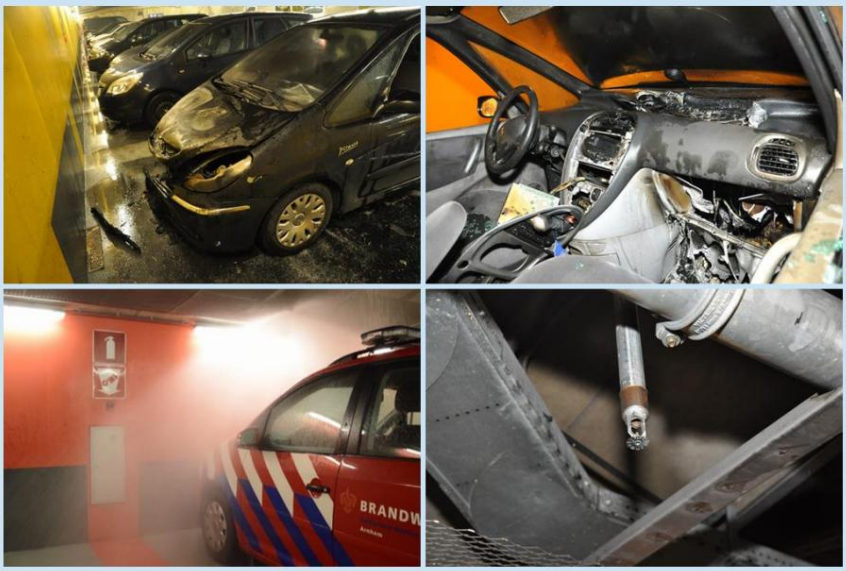

Figure 1.3 Car fire in sprinklered parking garage controlled by one sprinkler head (Source: TBO VGGM)

1.4.4 Is there sufficient cooling capacity?

A sprinkler system is designed to control or extinguish the fire. As long as the valve of the relevant sprinkler section is not closed, the sprinkler system

is not turned off and the pump does not run out of water or fuel, the sprinkler system will continue to control the fire in most cases. In practice, however, it often turns out that the fire brigade is required to definitively extinguish the fire. This obviously requires sufficient cooling capacity. The amount may vary and will have to be determined on site. This partly depends on the size of the area where the fire is burning and what is on fire. The rules of thumb from the basic principles of fire fighting can be used for this. A point of attention is the stacking height in, for example, a warehouse. The rule of thumb per m2 then applies per meter of stack height.

A point of attention when choosing the extinguishing agent is the location where it burns. For example, if there is a fire at a height of 12 meters in a rack, sufficient throw length is required. A high-pressure jet or DLS will be less able to reach a fire at a height than a low-pressure jet or a street water cannon. The action perspective discusses the procedure after extinguishing the fire or if extinguishing it is not possible.

The location of the fire is easily accessible

If the location within the area of the activated sprinkler head(s) is easily accessible, the fire appears to be already out and a complete follow-up inspection can be carried out, then cooling capacity will not always be necessary.

The location of the fire cannot be reached

Cooling capacity is necessary if the location cannot be physically reached, cannot be easily reached with a beam, and if proper follow-up inspection cannot be carried out. Cooling capacity is also needed to extinguish a fire if it turns out not to be completely extinguished and flares up again after the relevant sprinkler section has been closed. How quickly a fire can spread in that case depends on the situation. In a warehouse rack this can sometimes happen very quickly. In addition to having sufficient cooling capacity, it is necessary to have a team at the valve who can open it immediately if fire symptoms are visible again. It may take a while before water comes out of the opened sprinkler heads again. Partly for this reason, it is necessary to have one or more beams ready at the fire location. For warehouse racks it is recommended to always have at least a low pressure jet ready due to the cooling capacity and the throw length. To determine the required cooling capacity, rules of thumb from the basic principles can be used.

2 Scenarios in an object with a sprinkler system

Introduction

Various fire scenarios are possible for sprinklered objects that the fire brigade may have to deal with. This is discussed in more detail in this chapter. Points of interest and perspectives for action are identified for each scenario. First, the influence of the location of the fire on the scenario is discussed, followed by the extent to which the sprinkler system can control the fire and finally the use (design, type of fire load, etc.) and the dimensions of the building.

2.1 Scenarios

The fire brigade can be alerted to various types of incidents involving a sprinkler system. The following scenarios have been identified:

> The sprinkler system has been activated by a fire.
> The sprinkler system has been activated without a fire.
> A sprinkler message has been generated without the sprinkler system actually being installed activated.
> The sprinkler system has been activated due to the (presumed) release of Hazardous Substances.

This report does not discuss the latter scenario in detail. See section 2.4.5.

2.2 Influence of the location of the fire on the scenario

The location of the fire in relation to the sprinkler system partly determines whether the sprinkler system can do its job effectively. Three fire locations can be identified in a sprinklered building:
> in a room
> in a construction part of the building
> on the outside of the building.

The paragraphs below discuss these different locations in more detail.

2.2.1 A fire in a room of the building

A sprinkler system is designed to control or extinguish a fire in a room. This has already been discussed in more detail in section 1.5.

A fire can occur in a normal living space. This space can usually be reached via a normal walking route. Within the room in question, the fire can:
> be easily accessible via a floor, stairs or ramp
> not easy to reach, because it is located, for example, in:
– a (process) installation
– an automatic storage system
– high (and/or deep) warehouse racks
- Etcetera.

However, a fire can also occur in a space that is not intended for human habitation. Consider a technical room, a (pipe) shaft or a suspended ceiling. These spaces can be reached via a (closed) door, a hatch or by lifting a floor hatch or ceiling plate. Sometimes finding and reaching such spaces proves to be very difficult.

Practical example 5: The sprinkler system controls the fire
The fire brigade arrives on the scene after being alerted to a sprinkler alarm in a shopping centre. Only the sprinkler section that has gone into alarm is indicated on the sprinkler panel. It is not clear where within the section the sprinkler came in. While exploring the building, the team sees water flowing under the front door of one of the shops. The team members also see some smoke in the store. After gaining access to the store, the activated sprinkler head is found in the kitchenette. The coffee maker is still burning on the inside and is extinguished with water from the tap.

Figure 2.1 The shop on the left, the coffee machine that burned on the right (Source: TBO VGGM)

2.2.2 A fire in a structural part of the building

As previously indicated, a sprinkler system is designed to control or extinguish a fire in a room. If a fire has started in a floor, wall, ceiling or roof construction, the sprinkler system will only be activated if sufficient energy is released to activate a sprinkler head somewhere in the building. The water from the activated sprinkler head may not reach the fire. In most cases, a sprinkler system is not designed for this scenario. As with non-sprinklered buildings, a fire can spread out of sight and beyond the reach of the sprinkler system in this scenario. This can cause damage to a sprinklered building

a sprinkler head is activated in different locations or, in the worst case, a fire occurs that can no longer be controlled by the sprinkler system.

Practical example 6: The sprinkler system cannot reach the fire
The fire brigade's emergency center receives a 112 call from a clothing store; Shortly afterwards an automatic sprinkler notification comes in from the shopping center. In the store, a fire started in a lighting fixture built into a wooden cove. A sprinkler head located above the suspended ceiling activates. The water does not reach the location of the fire. An intervention by the fire brigade is necessary to extinguish the fire.

Figure 2.2 Photos of the cove in which it burned (Source: TBO VGGM)

2.2.3 A fire on the outside of the building

A fire on the outside of a sprinklered building, for example next to the facade or on the roof, poses a direct threat to the sprinkler system. If there is no fire-resistant separating structure between the fire on the outside of the building and the sprinkler system, heat conduction or heat flow from outside can cause sprinkler heads to be activated in the building. In addition, a fire on the roof can lead to secondary fires starting at various places within the building through roof penetrations or through melted and burning roof covering and insulation material that flow in through cracks and openings. A sprinkler system can limit the spread of fire within the building, but if the fire activates more sprinkler heads than the system was designed for, a problem arises. The available amount of water that the sprinkler pump can supply per minute,

is then distributed over the opened sprinkler heads, causing the water quantity and pressure per head to become too low. In this scenario it is important that the fire on the outside and on the inside is fought as quickly as possible in an attempt to limit the number of sprinkler heads that are activated.

Practical example 7: Fire on the outside of the sprinklered building
A fire breaks out in the plastic shopping carts next to a sprinklered supermarket. The facade of the store is not fire-resistant. The flammable plastic shopping carts are not allowed to be at this location based on the sprinkler rules, but they are there nonetheless. There is a rapid fire spread. The facade of the store begins to collapse and the fire enters the store above the suspended ceiling. In total, more than 130 sprinkler heads in the store are activated by the fire. This means that hardly any water comes out of the sprinkler heads and the sprinkler system no longer functions. The fire brigade extinguishes the fire on the outside and inside the store. The interior of the store has been lost and there has been significant damage to the structure of the building.

Figure 2.3 Images of the fire, the facade and the water yield from an activated sprinkler head (Source: TBO VGGM VRGZ)

Practical example 8: Fire on the roof outside the reach of the sprinkler system
A roof fire occurs during work on a warehouse roof. Presumably due to heat conduction along the steel sheet pile roof panels, the air around the sprinkler heads inside the building has become so warm that they are activated. This causes more sprinkler heads to be activated than the installation was designed for. In this case, fire spread to the inside of the warehouse.

Figure 2.4 Roof on fire on a sprinklered warehouse (Source: TBO VRBZO)

2.3 The role of the sprinkler system in the scenario

The sprinkler system influences the fire scenario. The turnout service may encounter the following scenarios when arriving on site:

> The sprinkler system has not yet been activated by the fire.
> The sprinkler extinguishes the fire.
> The sprinkler system controls the fire.
> The sprinkler system can no longer control the fire.

2.3.1 The sprinkler system is not activated by the fire

If the fire produces insufficient energy to achieve the required temperature at the location of the sprinkler head, a sprinkler head will not be activated. The size of the fire, the distance between the fire and the sprinkler head and the air flows in a building play a role in this. See the box below for a practical example.
The most important task for the fire brigade in this fire scenario is to extinguish the fire, followed by a follow-up check to determine whether the fire is actually completely out and there is no longer a chance of re-ignition.

Practical example 9: Sprinkler system has not yet been activated by the fire
A fire breaks out in a company that processes cardboard. Employees discover the fire and see flames approximately two meters high. 112 is immediately called to report the fire. The fire brigade is alerted to an internal industrial fire. The fire is extinguished by the staff using the available portable fire extinguishers. Due to the height of the room and the short duration of the fire, insufficient energy has yet reached the sprinkler head to activate it. If the fire had been allowed to develop further, the sprinkler head would most likely have been activated.

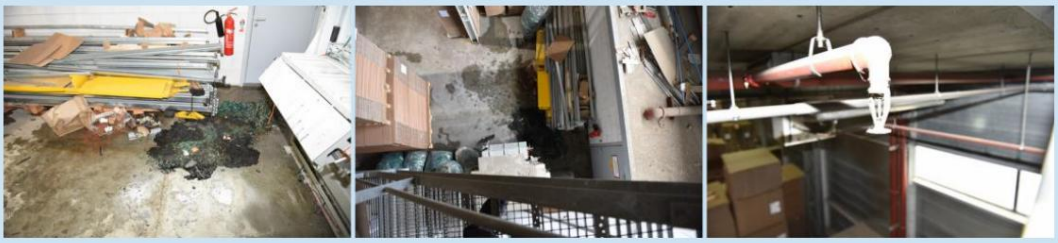

Figure 2.5 Fire of limited size has not produced enough energy to activate the sprinkler head just above the fire (Bon: TBO VGGM)

2.3.2 The sprinkler system extinguishes the fire

In practical example 3 (see section 1.4), the sprinkler system extinguished the fire. The most important task for the fire brigade in this fire scenario is to carry out a follow-up check to determine whether the fire is actually completely out and there is no longer a chance of re-ignition.

2.3.3 The sprinkler system controls the fire

In practical example 2 (see section 1.5.2), the sprinkler system keeps the fire under control. It can only burn in the place(s) where the water coming from the sprinkler head does not reach the fire. The task for the fire brigade is then to extinguish the fire

the fire if the location is sufficiently safely accessible or allow the fuel to burn out in a controlled manner if the fire is not accessible or when action cannot be taken safely.

2.3.4 The sprinkler system can no longer control the fire.

As with other types of installation, it is also possible that the sprinkler system does not function or cannot function properly. This can cause danger during a deployment. The box below lists some reasons why a sprinkler system may not function. If the sprinkler system cannot control the fire, the outcome is predictable. The task for the fire brigade is then to limit the fire spread outside the fire compartment.

Some reasons why a sprinkler system cannot function

> If a valve of the relevant sprinkler section is closed prior to a fire or during a fire, water will not flow from the activated sprinkler head. The fire cannot therefore be controlled by the sprinkler system.

> If a user of a building does not comply with the conditions that apply to the use of the building, this may result in the sprinkler system being unable to control the fire. For example, when a different type or much more flammable goods are stored than the sprinkler system is designed for. The method of storage can also prevent the sprinkler system from functioning properly. For example, because there is insufficient free space between the sprinkler head and the items underneath it, so that the spray pattern that is necessary to keep a fire under control cannot be achieved. This allows more sprinkler heads to be activated. If there are more than the installation is designed for, this can lead to a fire that can no longer be controlled by the sprinkler system.

> If no or insufficient maintenance has been carried out on a sprinkler system, this can lead to (part of) the sprinkler system not functioning properly, for example due to blockages in pipes. This can cause more sprinkler heads to activate. If there are more than the installation is designed for, this can lead to a fire that can no longer be controlled by the sprinkler system. Practical example 6 is an example of sprinkler heads that can no longer function properly.

Certified sprinkler systems are maintained by certified maintenance companies and periodic inspections are carried out by an independent inspection body. The chance that a sprinkler system does not function properly is therefore limited.

Practical example 10: The sprinkler system is not functioning optimally

A fire breaks out in a company that works with hazardous substances. An intervention by the fire brigade is necessary to extinguish the fire. During the fire investigation, it was counted how many sprinkler heads were activated by the fire. This turned out to be more than expected. It was then decided to inspect the sprinkler heads that had been activated. Some sprinkler heads turned out to be completely or partially clogged, meaning that no or insufficient water could come out at all. This is why more sprinkler heads were activated than expected.

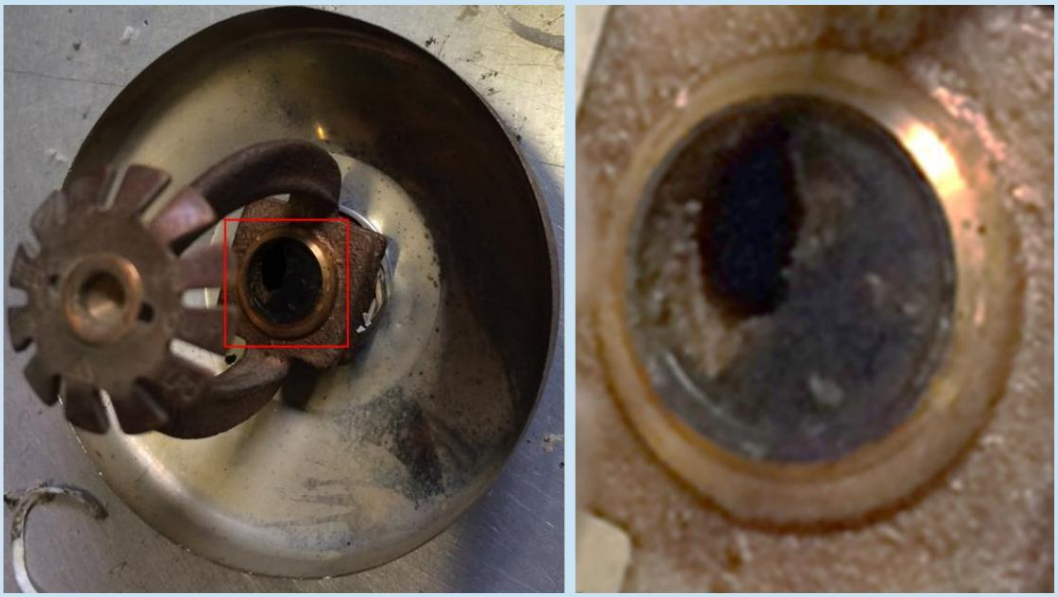

Figure 2.6 Contamination in the pipework leads to ineffective functioning of the sprinkler (Source: TBO VGGM)

2.3.5 Scenario with hazardous substances

If there is an activated sprinkler system in a room or installation with hazardous substances, such as a PGS or fireworks storage, then expert advice from, for example, an AGS is necessary in most cases to determine whether and how safe action can be taken by the fire brigade is possible, and what deployment is necessary.

3 Risks during firefighting

Introduction

Even in the event of a fire in a sprinklered building, there are still risks that the fire brigade must deal with during their response. These risks are discussed in more detail in the sections below.

3.1 The sprinkler system does not control the fire or does not function properly.

If the sprinkler system cannot control the fire, the outcome will often be predictable. In this case, the fire compartment or even the building burns down if the fire brigade cannot control the fire in any other way. If a sprinkler system cannot function properly, this can cause an unexpected fire spread during the fire brigade's response, just like in non-sprinklered buildings. In accordance with the basic principles of fire fighting, it is therefore necessary to always approach the fire within the sprinkler section via the shortest route. The importance of this will be greater if the fire has not yet been extinguished by the sprinkler system than if the internal organization indicates that the fire is already out.

Points of attention

> If the sprinkler system cannot control the fire, the fire will be serious smoke development and dynamics are visible in the smoke layer.
> If the internal organization indicates that part of the installation is under maintenance or that the sprinkler section has already been closed, be extra alert.
> If it is found that hardly any water comes out of a sprinkler head, this is an indication that the installation is no longer functioning properly.

3.2 System failure (during the incident)

Parts of a sprinkler system can also fail during use. The annual maintenance of the installation, the built-in inspection moments and the certification reduce the chance of this, but failure can never be ruled out. Particularly when a fire is controlled by the sprinkler system, failure can lead to an undesirable situation. It is therefore necessary to always know what the shortest (escape) route outside is. It is therefore recommended to approach the fire within the sprinkler section via the shortest route. The importance of this will be greater if the fire has not yet been extinguished by the sprinkler system than if the internal organization indicates that the fire is already out.

Running out of fire extinguishing water is classified as a system failure. There are installations where the sprinkler system, the wet fire extinguishing pipes and/or the hydrants on the site are supplied from the same system. Failure of this system can or will lead to an ineffective sprinkler in combination with an ineffective fire water supply for the fire brigade. These systems are usually double (redundant) to prevent failure.

Points of attention

> Most sprinkler systems are designed to control a fire for at least one hour. This is based on the maximum number of activated sprinkler heads. However, usually far fewer sprinkler heads are activated than the maximum number, which means that the sprinkler time is much longer. However, monitoring the amount of remaining water remains necessary. Depending on the number of activated sprinkler heads and the type of water supply, this may run out. The sprinkler system will then no longer be able to control the fire. With a Rhine water frame or a sprinkler tank, the water can often be replenished. It is preferable to do this with tap water to prevent contamination and possibly even clogging of the pipe network and the sprinkler heads. The sprinkler pump may also run out of fuel.

  By monitoring the water supply and, if applicable, the diesel supply, it is possible to prevent the sprinkler system from failing.

> There are installations where the sprinkler system, the wet fire extinguishing pipes and/or the hydrants are supplied by the same system. The consequences of failure can then be greater, because there is no longer a primary fire-fighting water supply.

> By having a team monitor the pump room, it can be observed when a pump fails or may no longer function properly. Live parts As with non-sprinklered buildings, live parts can pose a risk when extinguishing. A certain distance is then kept. An activated sprinkler on live parts of low-voltage installations1 does not in itself pose an increased risk of electric shock. 2

Point of attention

> Preferably have the (high) voltage switched off within the relevant area, before performing. The water from an activated sprinkler head may come into contact with live installation parts.

1 Building Decree 2012 Article 1.1. Definitions: Low voltage is a nominal alternating voltage up to 1,000 volts and a nominal direct voltage up to 1,500 volts.

2 Netherlands Fire Department (2022). *Knowledge document Fire brigade operations near electricity.*

Practical example 11: Replenishing the water supply
During a fire in a waste paper recycling company, the fire brigade replenished the water supply in the sprinkler tank, partly because it was not yet known how long the sprinkler system would have to remain in operation.

Figure 3.1 Replenishing the water supply via the connections provided for this purpose (Source: TBO VRR/VRZHZ)

3.3 Fire at height and in a (process) installation

In particular, fires high up in a room, institutions or in a process installation can ensure that the location of the fire cannot be reached via floors, stairs or ramps.

Point of attention
> Prevent climbing into scaffolding or onto (process) installations to reach a fire. It is necessary that the deployed personnel can always leave the location quickly and safely, should an unexpected event occur.

3.4 Goods falling from racks

Particularly in warehouses with racks, products may fall as a result of the fire and the activated sprinkler system. The fire can also cause cardboard packaging and foil used to wrap goods to burn away. In addition, the water from the sprinkler or from extinguishing by the fire brigade can cause (bio) films to dissolve or cardboard packaging to become soaked and collapse.

Point of attention
> Goods can fall down, especially in warehouses with racks.
Preferably do not perform within the shadow of the goods.

Practical example 12: Items falling from a warehouse rack
During a fire in a warehouse, the wrapping film surrounding the pallet partly burned away and became loose. As a result, objects have fallen down.

Figure 3.2 As a result of the fire, the wrapping film became loose (Source: TBO VGGM)

3.5 Collapse of (parts) of scaffolding

Particularly if a fire cannot be controlled by the sprinkler system, there is a risk that parts of racks will collapse. Even if products are stored in racks that are not permitted according to the standards because the products collect too much water, there is a risk of possible overloading of the rack.

Point of attention
> In a burn-down scenario, take into account that scaffolding can collapse.

3.6 Automatic systems

If there is an automatic system, such as a (top load) self-storage system or an automatic parking garage, both the automatically moving parts and
danger of falling is a risk for the repressive personnel. Consider moving floor parts or automatically driving vehicles. In addition, there are often live parts in such a system. Whether safe action can be taken within the system at all depends in part on the preparation, the provision of information and the measures that have been taken for the fire brigade to be able to act within the system.3 Early coordination with and provision of information to the fire brigade is essential . necessary.

3 There are already several safety regions that have indicated that, given the difficult accessibility and the above-mentioned risks, they in principle do not carry out indoor use within automatic parking and storage systems.

Point of attention

> It is important that it is absolutely certain that the system is completely switched off and de-energized before any action can be considered within the range of the automated system. For some automatic storage systems there are instructions to dismantle the system in the event of fire to reach a possible source of fire. If partial dismantling of the system is considered, the amount of water falling in the area where work is to be carried out

a point of attention, as well as the sound that is produced, which can make mutual communication difficult. In order to extinguish the fire, it may also be necessary to go meters deep into the system, which entails additional risks, apart from the risks posed by the goods in the automatic system.

3.7 No one present with knowledge of the sprinkler system.

If there are no expert personnel present within the company, unwanted actions may be carried out on the sprinkler system without the fire brigade being aware of this. Think of closing a valve, when
people think that the fire is already out, while this is not the case. A lack of expert staff can also mean that there is insufficient knowledge about how installations within the building may need to be switched off.

Points of attention

> Ask immediately upon arrival whether and, if so, which actions have already been performed sprinkler system.

> Make it immediately clear that, in the event of fire, no actions may be carried out on the sprinkler system without permission from the highest management of the fire brigade.

> Check whether the sprinkler system is still in operation.

> The company's decision-making authority and/or sprinkler expert will be on site have to come. The company will have to take over surveillance of the incident location if the fire brigade leaves the location, see paragraph 4.14.

3.8 No or limited visibility within the sprinkler section

When a sprinkler system controls a fire, smoke will continue to be produced.
This can cause the entire sprinkler section to be covered in smoke. Depending on the type of material on fire, there may also be no image when using a thermal imaging camera.

Smoke production
In a sprinklered fire, there will be incomplete combustion, which will produce more soot and carbon monoxide. On the other hand, the sprinkler system (partly) washes out the soot particles and greatly limits the fire capacity.

The sprinkler system will ensure that the smoke temperature will be much lower than in a non-sprinklered fire. This lower temperature, in combination with the currents caused by the spray pattern of the sprinkler drops, will mean that a smoke layer is no longer stratified. A homogeneous smoke layer may or may not be formed locally that will spread throughout the entire room. The density of this smoke layer depends, among other things, on the size of the fire, the type of materials involved in the fire and the size of the room

A sprinkler system is often used to create larger fire compartments. This can result in large distances that have to be bridged to reach the fire. This could be 60 meters from an access, or even more if an equivalence has been applied. Operating deep within a sprinkler section full of smoke entails risks.

Points of attention

> Try to determine from the entrances to the sprinkler section where the sprinkler system has been activated if the location is not yet known. Turn off the sound of the evacuation alarm system to better hear where the sound of the activated sprinkler head is coming from. The point of attention here is that the internal organization must ensure that no one goes back into the building because the alarm signal can no longer be heard.

> Only enter the sprinkler section if you are sure that the fire is controlled by the sprinkler system. The smoke image (RSTV) can be used as an indicator.
Have a crew in the pump room monitor the functioning of the pump(s), pressure and water supply.

> Preferably approach the location of the activated sprinkler head via the shortest route from an entrance.

> Only enter the sprinkler section if mutual communication is possible.
Activated systems such as the evacuation alarm system or a ventilation system can hinder this.

> Only enter the sprinkler section under cover of a low-pressure jet if it is not yet known that the fire is actually under control. This provides cooling capacity with which the repressive personnel can protect themselves and ensure that they can find their way back. The cooling capacity required depends on the situation.

> Use a thermal imaging camera to determine the location of the activated sprinkler head(s). The water from the sprinkler heads can cause a visible temperature difference.

> Do not simply turn off the sprinkler (section) to create a view. The fire can spread quickly after it has been put out, making it uncontrollable.

> Be aware that goods may fall within the area where the sprinkler is activated.

3.9 Flue gases

In the event of a fire, visible and invisible flue gases are produced, even in the event of a fire that is controlled by a sprinkler. If no smoke is visible, toxic flue gases may still be present.

Point of attention

> Always enter a room in which a fire has burned with breathing air and carry out measurements to determine whether the use of breathing air is still necessary.

3.10 Restrictions in mutual communication

The flowing water from the activated sprinkler heads, the ventilation system and/or the activated evacuation alarm system can produce so much noise that mutual communication, both verbally and via the walkie-talkie C2000 network, is not or hardly possible. In addition, the structural situation with possibly underground building parts or very large and/or very high building parts can contribute to poor range of C2000 and limitations in communication. Finally, the construction of the building, with a lot of steel and/or concrete, can also lead to further limitations in the C2000 network and radio communication. Particularly in the case of fires in sprinklered buildings, good communication between the commander, teams in the fire room(s) and the team that sits at the valve(s) and/or monitors the installation in the sprinkler pump room is necessary.

Points of attention

> Clearly agree on what should be done if communication is no longer possible is.

> Never allow a sprinkler section to be closed until it has been ensured that it is closed quickly enough contact is possible between the persons standing at the fire location and the persons standing at the section valve. If a fire turns out not to have gone out, the sprinkler section must be turned on again as quickly as possible. It may take some time before sufficient water comes out of the sprinkler head(s) again.

3.11 Fire flares up again

It has happened that a fire turned out not to be completely out when a valve in the sprinkler section was closed. The sprinkler section was closed,
because people thought the fire was out or to create better conditions in which to perform. Re-ignition of the fire can cause rapid fire spread, especially in warehouses with (high) storage racks and/or large quantities of flammable materials.

Points of attention

> Always ensure that there is sufficient cooling before a sprinkler section is closed power with sufficient throw length is available for immediate use if the fire flares up again.

> Do not close a sprinkler section until everything indicates that the fire is out. Leave never close the main shut-off valve or turn off the sprinkler pump. The pump may only be turned off by trained persons. If the sprinkler pump is turned off incorrectly, it will not restart when the sprinkler section is turned back on.

> Have the fire location and the sprinkler valve monitored by repressive personnel which allows direct communication from the fire location. Do this until it is assured that the organization can take over responsibility. The monitoring period by the repressive staff is shorter (think 15 minutes) when it can be stated with certainty that the fire is actually out, and longer (think 60 minutes) when it cannot be stated with certainty that the fire is out.
However, this monitoring period is situation dependent and therefore always at the discretion of the operational manager of the fire brigade.

> If the fire appears not to be completely out, immediately reopen the section valve open. Depending on the size of the section, it may take a while before water comes out of the sprinkler heads again. The sprinkler system serves as a backup in case the fire cannot be brought under control with the hand jet.

> Advise the building owner or user to determine the location of the fire and the sprinkler section monitored until the sprinkler section can be put back into use. This way, he or she can immediately call 112 if it lights up again or a new fire starts. Record this by reporting the name of the person to whom this advice was given to the control room in his or her presence. The time required to make the sprinkler section ready for operation again depends on various factors. If the location of the activated sprinkler head is easily accessible, the installation can be operational again within a few hours, but it can also take several days or weeks. If (part of) the sprinkler system is out of use, it can have a major impact on the fire safety level of the building.
It may therefore be necessary to consult with colleagues in the risk management department, for example through a preventionist on duty.

4 Action perspective occur in a fire-activated sprinkler system

Introduction

The actions and tasks to be taken are described for each phase of the incident.
The incident starts with the receipt of the sprinkler report at the fire brigade's alarm center and ends with the transfer of the building to the building owner.

4.1 Reception and alarm after sprinkler or fire alarm at the common fire brigade control room

A fire in a sprinklered building can be received directly as a sprinkler report to the common fire brigade control room (GMK), via a private alarm center or via a 112 call. The alarm center will contact the object to ask whether there is actually a fire, what the location of the fire is and what is on fire. The alarm procedure may differ per control room if an automatic sprinkler report has been received by the GMK.

4.2 Driving

When driving, the commander will be informed about the location, nature and size of the fire based on the information already available in the notepad lines or via the operator. In any case, it will be reported whether there is a sprinkler report or not. If an accessibility map of the object is available, it may contain information about the type of company, the fire brigade entrance(s), the location of the fire brigade panel, the pump room and possibly also the sprinkler sections and the fire separations present.

Points of attention:

> In most cases the sprinkler system will control the fire, which means there is time for proper preparation. Prior to deployment, and if available, view the accessibility map of the object for the location of the sprinkler panel, the pump room and the entrances to the building.

> In the event of a verified fire in a building, scale up immediately if there is an indication that it is not a standard deployment (uncertain whether the sprinkler system is controlling the fire,

complex building, large deployment depth, high racks, fire not directly accessible, etc.). Always alert the Public Safety Officer in the event of a confirmed fire in a sprinklered building.

> Handle the questions of the basic principles of firefighting. The premise of a sprinkler system means that it extinguishes the fire or has sufficient cooling capacity to control the fire. Whether this is actually the case will have to be assessed on site.

> Ask the operator to report immediately if there is a sprinkler alarm received when there is a fire in, next to or on a sprinklered building where the sprinkler system has not yet come into operation. In particular, a fire outside the building can pose a direct threat to the sprinkler system. Such a fire will have to be tackled as quickly as possible to prevent too many sprinkler heads being activated within the building. Since there are more tasks than one fire brigade unit can handle (namely a fire outside the building and probably also within the building), immediate scaling up will be necessary.

> If a sprinkler report was received via a private alarm center, ask at what time the PAC received the sprinkler report. If a security company first went to the location to verify whether there was actually a fire, this may have taken some time (20 minutes or more). The water supply is used from the moment a sprinkler head is activated. In most cases there is a water supply that can supply the required water for at least 60 minutes. This applies to the maximum number of sprinkler heads that are assumed in the design to be activated simultaneously. When one sprinkler head is activated, the water supply will be able to supply water for longer.

> If it is suspected that the sprinkler system has been active for some time Before the fire brigade has been alerted, direct monitoring of the water supply is a point of attention during the deployment. This is an additional task that will have to be performed on site. A consideration may be to scale up to have sufficient staff on site for all tasks that need to be performed.

> If the building is not in operation, ask if a key holder will be on site.

4.3 On site

If the building is in operation, the operator will have asked for the fire brigade to arrive on site. If the building is not in operation, the operator will ask a key holder to go on site. If this is not yet known, it will have to be determined on site which scenario applies: an activated sprinkler system with or without fire. When the building is in operation, the internal organization can in most cases indicate where the sprinkler system has been activated and whether there is actually a fire. She may also be able to answer the question of the shortest route to the location and provide any details about the fire and type of inventory.

If there is no shelter on site, the fire brigade entrance will have to be used. This will be indicated by a red flashing light. Near the fire brigade entrance there is a (geographical) fire brigade panel that provides information4 about the sprinkler section that has been activated, as well as the positions of fire brigade and side entrances. In addition, the sprinkler pump room and the position of the alarm valves (and associated shut-off valves) and possibly the position of dry or wet fire extinguishing pipes will be indicated.

4 NEN-EN 12845:2015 + NEN 1073:2018 chapter 16 Alarms and signaling devices.

When you arrive on site, ask immediately whether the sprinkler system is still active and whether any valves have already been closed. Sometimes the internal organization has already (partially) turned off the sprinkler system because it has extinguished the fire or it is suspected to be a false alarm. If the fire is not actually extinguished, this can have major consequences. Immediately indicate that actions may only be carried out on the sprinkler system after permission has been obtained from the fire brigade manager.

Points of attention:

> In the event of a verified fire in a sprinklered building, immediately scale up to medium fire. There are more tasks that need to be performed almost simultaneously than one basic unit (TS-6) can handle. The first unit initially focuses on the fire. The second unit monitors the sprinkler pump room and can assist the first unit if necessary.

> Scale in a verified fire in a complex sprinklered building (with large deployment depth, high racks, etc.) directly leads to a major fire. There may be more tasks than two basic units can handle.

> Stop and think: a sprinkler system is designed to control or extinguish a fire in the building for a certain period of time (e.g. 60 minutes). This ensures that there is time to think carefully about the deployment.

4.3.1 Fire outside the building

A fire outside the building must be fought as quickly as possible to prevent too many sprinkler heads being activated within the building.

Points of attention:

> Consider scaling up, because deployment outside and inside the building is necessary.

> When facades are protected by facade sprinklers, it will be necessary to monitor whether the risk of fire spreading to the building is sufficiently limited.

4.4 Determining the activated sprinkler section on the fire brigade panel

A sprinklered building can be divided into one or more sprinkler sections. These are displayed on the fire brigade panel. A red light indicates which sprinkler section is activated. The section will have to be searched for the exact location where a sprinkler head has been activated. If there is also fire detection,
then this can provide more information about the location of the fire within the sprinkler section.

Activated sprinkler section on the fire brigade panel
The fire panel shown on the next page shows that there are four sprinkler sections: blue, green, yellow and brown. The red light in the blue sprinkler section indicates that the sprinkler message comes from this section. The (side) entrances are indicated with a white arrow on the panel. These are inputs that can be used to determine the location of the activated sprinkler head. The panel also shows that there is a fault.
The sprinkler alarm center can be used to read which fault is occurring.

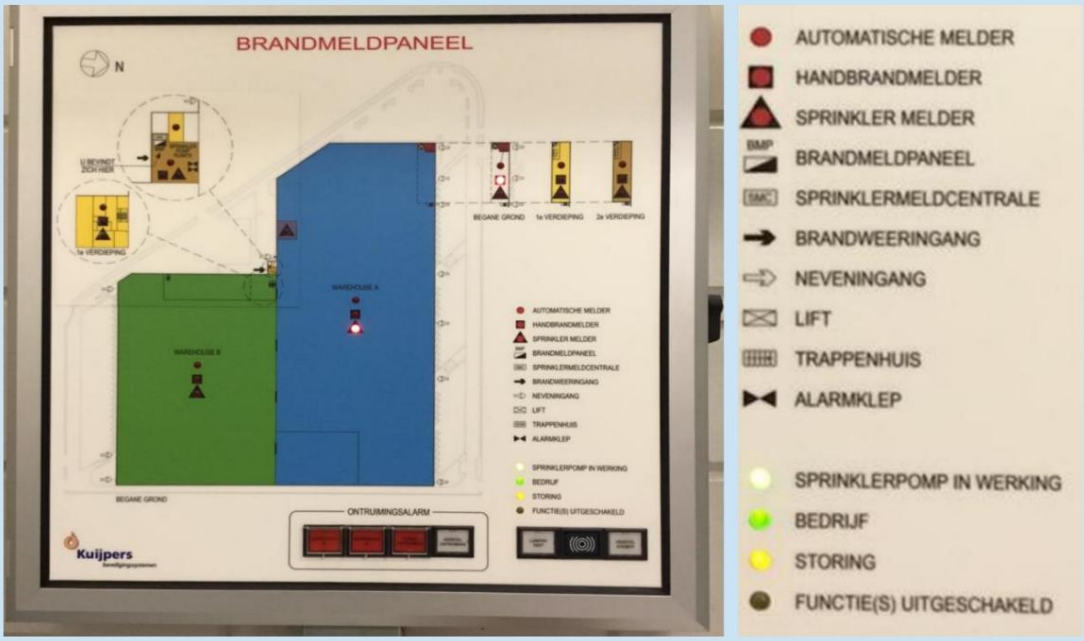

Figure 4.1 Fire alarm panel (Source: TBO VGGM)

Points of attention

> Always check the fire brigade panel yourself to see in which section(s) the sprinkler system has been activated. More than one sprinkler section may have been activated as a result of the fire.

> Determine the shortest route to the fire. The fire brigade panel provides information about the fire brigade access and side entrances. By conducting an exterior survey of the part of the building in which the sprinkler section is activated, other entrances to the section can also be identified.

> Never close a sprinkler section or turn off a sprinkler system before the fire brigade has determined that the fire is actually out, there is sufficient cooling capacity to immediately combat a rekindling fire and there is a team at the section valve to immediately open it again when the fire flares up.

> Ask a person to be on standby at the fire alarm system to switch off the evacuation alarm signal if this is necessary to identify the location of the fire. The point of attention here is that staff and/or visitors must be prevented from re-entering the building because they think the incident is over.

because the evacuation alarm signal has gone out.

4.5 Determining the location of the fire

Within the sprinkler section, a search must be made for the location where the sprinkler system has been activated. A section can be very large; Multiple rooms and even multiple companies (such as in a shopping center) can be located within one sprinkler section. If no information is available about the exact location of the fire, the location will have to be searched for.

If smoke is observed, it is an indicator that there has most likely been a fire. How much smoke is visible depends partly on the materials that burned, whether it is still burning and the size of the fire and the building.

There are various ways to determine the location of the fire and the activated sprinkler heads: > An all-round reconnaissance can
be carried out at the sprinkler section, looking at flame and/or smoke phenomena, the sound of or sight of an activated sprinkler head , or water flowing out.

> Flame and/or can be viewed from the entrances to the sprinkler section smoke, the sound or sight of an activated sprinkler head, or visible water.

> You can search the building, within the sprinkler section, by looking at the same indicators.

Point of attention

> If there is reduced or no visibility and the location of the fire is unknown, try first determine from the entrances to the section or the space within the section where the sprinkler system has been activated. A thermal imaging camera can be used to observe the temperature difference created by the water.

4.6 Determine whether safe operation is possible within the sprinkler section

Before the section in which the sprinkler system is located can be entered, it must be assessed whether the situation is safe enough.

Points of attention

> Does the sprinkler system actually control the fire? If the sprinkler system does not control the fire, this will be visible in the smoke (RSTV) hanging within the sprinkler section or flowing outside. See the box on the next page for this. It is important that the smoke is continuously monitored by someone to quickly identify any deterioration in the smoke image.

> If the location of the fire cannot be reached via floors, stairs or ramps, this may entail additional risks.

> Assess whether there is sufficient visibility in the space for the team to continue to orient themselves. A room equipped with a sprinkler system can be very large. This may involve a large deployment depth of 60 meters or more. Make sure it is always clear what the route outside is.

> Ensure that automatic systems within the sprinkler section are switched off, so that they no longer pose a risk during deployment. This includes automatic parking systems, automatic order picking systems, etc.

> Determine whether there is an additional risk due to the presence of hazardous substances substances within the sprinkler section, for example at a PGS15 storage.

Indicators that indicate that the sprinkler system is not controlling the fire
The most important indicator of whether a fire is controlled are the fire and smoke symptoms. This will have to be looked at carefully upon arrival. In a controlled fire, the fire capacity, and therefore the smoke production, is limited compared to a non-controlled fire. The smoke from a controlled fire will usually be lighter in color. This is partly due to the mixing of smoke and air and partly due to the soot particles being washed out by the water. Finally, in a controlled fire there will only be flow to a limited extent. In an uncontrolled fire, on the other hand, there is significant smoke flow and a darker color. This smoke flow is also more turbulent.

It becomes dangerous if the sprinkler system can no longer control the fire during deployment.
Therefore, continue to monitor the smoke to determine whether there is a deterioration in the smoke image.

Figure 4.2 Example of smoke image outside a sprinklered building and the fire location after ventilation (Source: TBO VRR/VRZHZ)

In the pump room you can look at the pressure gauge located near the shut-off valves on the supply pipe of the activated sprinkler section. This indicates the pressure. Upon arrival in the pump room, have the pressure identified, written down and monitored. A lower pressure or drop in pressure can be an indicator that more sprinkler heads are being activated. However, not all installations function the same, so this indicator does not apply to all installations.
For example, there are installations where the pressure is increased by the pump to maintain pressure in the pipe. No decrease in pressure can then be observed.

4.6.1 Monitoring in the sprinkler pump room

In the pump room, you can read from the sprinkler alarm center which sprinkler section(s) have been activated. As shown in the figure below, each valve indicates which sprinkler section is connected to it. At the valve and pipe of this section you can hear or feel that the water is flowing. The manometer also shows that water is flowing, because the pointer may move slightly. The indicator on the valve shows that the valve is in the open position. The indicator is parallel to the flow direction (see figure 4.3).

Figure 4.3 Firefighting team identifies the activated sprinkler section (Source: TBO VGGM).

Points of attention

> Check whether the shut-off valve of the sprinkler section is open. When the valve is secured with a chain, it will still be there. You can also look at the indicator on the valve.

> Prevent someone from closing a valve without permission.

> Monitor the pressure indicated on the manometer. If the pressure suddenly drops, this may be an indication that part of the sprinkler system is no longer functioning.

> If the pump(s) of the sprinkler system are in the sprinkler room, monitor whether the pump is still functioning properly. If this pump suddenly produces a strange noise or fails, immediate action can be taken to ensure your own safety.

> Monitor the water supply if possible. This will be especially important with a long-term deployment or a fire where it is suspected that many sprinkler heads have been activated.

Figure 4.4 Closed valves of a sprinkler system; chains on the ground, the orange indicator on the valve is horizontal (closed) (Source: TBO VGGM)

4.7 Enter the sprinkler section with or without a jet

In principle, the room where the fire is located cannot be entered without the coverage of a beam. When accessing the sprinkler section and/or the fire room, it can be assessed whether it is responsible to enter the sprinkler section without a jet that is ready for use. It is advisable to only enter the room without a jet if it is certain that there has only been a fire in the room and not on the roof, if there is no or barely visible smoke in the room and if it can immediately be seen that the fire is real. is out. If there is a fire controlled by the sprinkler system, a jet is in most cases necessary to actually extinguish the fire. Particularly in buildings with a large deployment depth or at height, it will take some time before a beam is ready for deployment.
However, because the sprinkler system keeps the fire under control, there is enough time for the spray to build up.

Points of attention

> Preferably take the shortest possible route to the fire. When unexpected event, the building can then be left quickly.
> Always enter the fire room with breathing air.
> Always take a beam with you for your own safety if there is reduced visibility due to smoke development or there is an indication that the fire is not yet out.
> For complex buildings and large deployment depths, the beam can be used for a safe retreat. When a jet is connected to a wet or dry fire extinguishing pipe in the building, the safe return from the connection point to the outside must also be guaranteed.
> Have the evacuation alarm signal of the evacuation alarm system turned off if there is due to limited visibility based on sound, the location of the activated sprinkler head must be sought. The point of attention here is that people must be prevented from returning to the building, because the evacuation alarm signal can no longer be heard. This must be coordinated with the internal organization.
> Act with restraint if there is no or very limited visibility. Naturally, the situation in a small store is different from that in a very large warehouse with considerable insertion depths and the danger of items that can fall from, for example, shelves as a result of the fire and the activated sprinkler system.

4.8 Accessibility of the fire

It will have to be determined whether the location of the fire can be reached physically or by means of a beam from a safe place. In many sprinklered buildings, such as schools, office buildings or shopping centers, the fire will be accessible via floors or stairs. If there is a fire in a (process) installation, in an automatic storage system or high in a warehouse rack, the fire will be less easy to reach.
When the sprinkler system checks the fire, there is some time to see how the fire can be reached and extinguished. It is then important that the sprinkler system in the pump room is monitored.

4.8.1 The fire is accessible

If the location of the fire can be reached safely at close range or via the throw length of a beam, the fire can be controlled.

Points of attention

> In the event of a fire at height, choose a beam that has sufficient throw length to reach the reach fire.

> In the event of a fire controlled by the sprinkler, ensure that there is sufficient cooling on-site capacity to take over the task of the sprinkler system if it unexpectedly fails.

> When extinguishing the fire, take specific account of the surfaces that have been damaged by the fire above goods) are shielded from the sprinkler.

> In warehouses with racks, for example, keep in mind that fire and water can cause goods to fall. Preferably do not operate in the area directly below or next to the fire.

> Ensure that the pump room and water supply are monitored. This is possible be acted upon immediately if there is a system failure.

> A pallet may be able to be removed from a rack to extinguish it if this is not possible with a beam. Ensure that the equipment for this purpose is only operated by qualified personnel. Please note that non-fire personnel should not be exposed to the effects of the fire, such as smoke.

> If aids are used to reach the fire, such as a scissor lift, always ensure that a backup system or escape route is available in case the aid no longer functions.

4.8.2 The fire is not accessible

If the seat of the fire cannot be reached safely, cannot be reached with a jet or cannot be extinguished with an insert, [5] then there are two options.

1. **Allowing the fuel to burn under cover of the sprinkler system.**

If the fire does not reach the fire and cannot be extinguished, you can choose to let the fuel burn under cover of the sprinkler system.

Points of attention

> Most sprinkler systems are designed to control a fire for at least one hour. Depending on the number of sprinkler heads activated and the water supply may run out. This may mean that the sprinkler system no longer has sufficient cooling capacity to extinguish the fire. The water can be replenished in a clean water cellar or a sprinkler tank. It is preferable to do this with tap water. The sprinkler pump can also run out of fuel. It is common for there to be enough fuel to run the sprinkler pump for several hours.

> Continue to monitor the pump room.

> Ensure that sufficient cooling capacity in the form of jets is available near the fire location to take over the task of the sprinkler system if it unexpectedly fails. This cooling capacity can also be used to preventively wet the materials in the area out of reach of the sprinkler. A beam of HD or

[5] For example, if lithium-ion battery packs or a car battery are involved in the fire.

In most cases, a DLS jet will have less throw length in height than a low-pressure jet or a water cannon.

> If it is safely possible, flammable materials in the environment can be used as a preventative measure are removed.

> In warehouses with pallet racks, for example, keep in mind that fire and water can cause goods to fall. Preferably do not operate within the shadow area directly under or next to the fire.

> If it will be a long-term commitment, consultation may be considered to engage a private organization with the insurer(s) to take over the fire brigade task.

2. **Preparing for deployment for a possible burn-down scenario**

If it is not possible or not an option to let the fuel burn out, for example because this causes nuisance in the area for far too long, prepare yourself for a burn-out scenario. Naturally, communication about this with the building owner and the insurer(s) is important.

Points of attention

> Most sprinkler systems are designed to control a fire for at least one hour. Depending on the number of sprinkler heads activated and the water supply may run out.

4.8.3 The fire cannot be extinguished

There are objects that cannot or hardly be extinguished. Consider, for example, battery packs (for example Lithium-ion) or a battery pack of an electric car. A sprinkler system can be used for such objects to control the size of a fire. These may be objects that are not easy for the fire brigade to extinguish. One of the options is to let the fuel burn up. See section 4.9.1 for points of interest.

4.9 Carrying out follow-up inspection

If it is necessary to close a valve of the sprinkler system for the follow-up inspection, this should only be done in consultation with the repressive manager and preferably also a decision-making person from the company in question.

4.9.1 The fire is easily accessible for a follow-up inspection

If the fire is easily accessible, a follow-up inspection can determine whether it is completely out.

Points of attention

> The check is preferably carried out while the sprinkler head(s) are still in operation.

> In some cases, it will only be possible to assess whether there are still fire symptoms such as smoke development after the sprinkler section has been closed.

> Use a thermal imaging camera and a CO meter during the follow-up check.

> Continue to monitor the fire location for some time, for example 15 minutes, when it is 100% certain that the fire is out. If it is not absolutely certain that the fire is out, continue

monitor the fire location, preferably until it is clear that the user or building owner is ready to take over this task. In most cases this task cannot be transferred within 60 minutes.

Tools for the follow-up
A thermal imaging camera can be used to determine whether there is still heat development. A disadvantage is that the water from the sprinkler system will cool the materials,
which means that this does not work or does not work well.

Smoke development from the burned area can be an indicator that the fire is not yet out. A CO meter can be used to determine whether there is still CO production.

A drone team from the fire brigade may be deployed to carry out a follow-up check at height can perform.

4.9.2 The fire is not easily accessible for a follow-up inspection

If the location of the fire cannot be reached in a normal way and cannot be reached there there is a good view of it, then it cannot be properly assessed whether the fire is actually out. This may be the case if the fire is at a height or in a (process) installation. In addition the water coming from the sprinkler head(s) can cause fire indicators to become invisible or less visible.

Points of attention

> In some cases, it will only be possible to assess whether there are still fire symptoms such as smoke development after the sprinkler section has been closed.
> If possible, wet the (flammable) goods around the fire area if this has not already been done by the sprinkler system. Another option is to remove these goods to limit the rate of expansion in the event of a revival.
This 'pre-wetting' is of limited use for plastic surfaces, but will have a major impact on cardboard packaging.
> If there is a pallet rack, extra attention is necessary for the stability of the racks and pallets and the risk of falling of items affected by the fire on the pallets. If it is decided to remove pallets from the racks in order to carry out a follow-up check, the safety of the person operating the device used to do this is of course a point of attention.

4.9.3 Closing a valve

It is basically necessary to establish with absolute certainty that the fire is out. before an order can be given to close a valve of the sprinkler section. However, this absolute certainty will not always be available, especially if the fire is in a location that is not easy to reach.

Points of attention

> Limit as much as possible the size of the part of the sprinkler section from which the water supply is turned off. When the valve of a sprinkler section is closed, the entire section is turned off. Determine whether there are shut-off valves within the sprinkler section that can shut off the water supply to a smaller part of the sprinkler section.

> The order to close a valve must be given by the operational manager of the fire brigade, where possible in consultation with the company's decision-making authority.
> Before the valve is closed, there must be sufficient cooling capacity to immediately combat a rekindled fire.
> Do not close a sprinkler section or local shut-off valve before it has been ensured sufficient rapid contact is possible between the people at the fire location and those standing at the section valve. If a fire turns out not to have gone out, the sprinkler section must be opened again as quickly as possible. Never allow the sprinkler pump to be turned off. This is a task for the business expert.
> The section's shut-off valve must be monitored so that it is closed during the first fire lights can be opened again. The point of attention is the possibility of communicating with each other. Before a valve is closed, it must be ensured that some form of communication is possible.
> Do not close a sprinkler section until everything indicates that the fire is out. Leave never close the main shut-off valve or turn off the sprinkler pump. The pump may only be turned off by trained persons. If the sprinkler pump is turned off incorrectly, it will not restart when the sprinkler section is turned back on.

> Have the fire location and the sprinkler valve monitored by repressive personnel with which direct communication can be made.
> Make sure that there is always sufficient cooling capacity with sufficient throw length for immediate use before the sprinkler section is closed. Ensure that there are sufficient beams available to be able to fight the fire from all sides if necessary.

The sprinkler tongs

A sprinkler shut-off pliers can also be used to stop the flow of water from an activated sprinkler head, if the sprinkler head is accessible. This may be present at the building location, and in some regions the vehicles are equipped with this.
The sprinkler clamp is placed on the sprinkler head and closes the opening through which the water flows. A disadvantage of the sprinkler tongs is that the user will certainly get wet. However, its use prevents (part of the) sprinkler section from no longer being protected by the sprinkler system.

Figure 4.5 Sprinkler clamp on sprinkler head (Source TBO VRR/VRZHZ))

Location of the valves

The section valves are located in the pump room. Each section valve should have a map showing the area that falls within the sprinkler section. There may also be shut-off valves within the section that can shut off the water supply to part of the section. These can also be indicated on the map, but this is not mandatory. The location of the valves can also be asked from the company's sprinkler expert or observed yourself in the sprinkler section. The valves are usually provided with an icon as shown in the example below. In high-rise residential buildings there is usually one shut-off valve per floor.

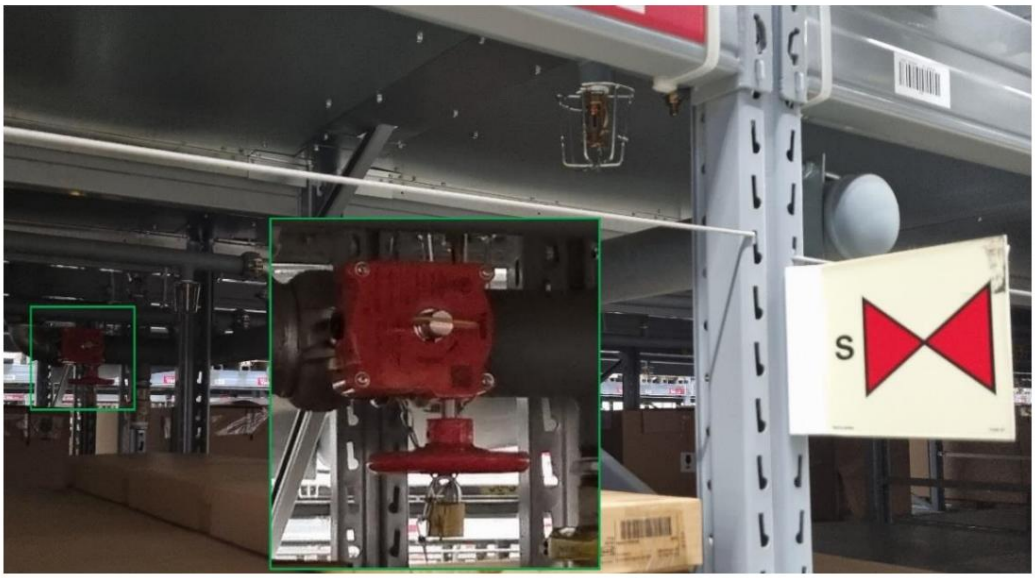

Figure 4.6 Example of a shut-off valve within a sprinkler section (Source: NIPV)

4.10 Follow-up check after closing the sprinkler section

Once the valve of the relevant part of the sprinkler system has been closed and the water has stopped, it can be checked whether the fire is actually out. Carry out a visual check with, for example, a thermal imaging camera. A CO meter can also be used to determine whether there is no longer any smoldering material.

4.10.1 Absolute certainty that the fire is out

The fire is definitely out and an extensive follow-up check is possible.

Points of attention

> A smoldering fire may remain present, for example on the inside of a packaging. It is therefore necessary to carry out an extensive follow-up check.
> Monitor the location for 15 minutes and continuously monitor whether there is any fire symptoms are observed more often.
> Consider whether it is of added value to clear the area around the fire location of flammable materials.

4.10.2 No absolute certainty that the fire is out

It is not possible to carry out an extensive follow-up check and it is not certain that the fire is completely out.

Points of attention

> Monitor the location, preferably until it is clear that the user or building owner is ready to take over this task. In most cases this task cannot be transferred within 60 minutes.
> Keep the required cooling power (rays) available for immediate use during the follow-up phase.
> Have the valve continuously monitored during the follow-up inspection.
> If safely possible, remove fuel from around the area affected by the fire. This reduces the chance that the fire can spread further.
> If possible, disassemble the goods affected by the fire. If safely possible and applicable, have the part of the rack or storage affected by the fire emptied and removed from the building if it is not certain that the fire is out. This may be the case with paper bales or waste.

4.11 Fire flares up again

If fire symptoms are visible again, immediately fight the fire with the rays that have been prepared for this purpose. If the fire is in a location that is not easily accessible, immediately open the closed valve again. Open the valve slowly again to prevent water hammer. It is possible, depending on the size of the sprinkler section, it will take a while before water comes out of the sprinkler heads again. The sprinkler system serves as a backup in case the fire cannot be brought under control with the hand jet. If the valve is not immediately opened again, the rekindling fire may cause too many sprinkler heads to activate. This can prevent the sprinkler system from controlling the fire.

Points of attention

> Immediately open the valve again if there are first signs that the fire is about to flare up. Always open the valve slowly to prevent water hammer.

4.12 Damage Limitation

When a section valve is closed, water may still continue to flow from an open sprinkler head, depending on the position of that head. In the pump room, the sprinkler section can be ensured to empty more quickly to prevent additional damage. In addition, there are sufficient spare heads of the different types of sprinkler heads available in the sprinkler pump room, including suitable tools for replacement. This means that the sprinkler system can be quickly put back into use by an expert in the field (provided that further damage is logically limited).

These repair operations must be carried out by a qualified installer. This is not a task for the fire brigade. If the installer cannot be on site quickly, it could be considered to have these actions carried out by the company expert (en

under his responsibility). However, do not allow this to take place during the follow-up inspection: it will then take too long before the entire sprinkler section is filled again if the valve is opened when the fire appears not to be out yet.

Points of attention

> Do not drain the sprinkler section if it is not yet certain that the fire is complete is out.

> The water that has come out of the sprinkler heads can flow to locations where it can pose a (fire) hazard, for example in a meter cupboard.

> If water enters the lift shaft of the fire brigade lift, the fire brigade lift fall out. A fire brigade lift is resistant to splash water.

> The Salvage Foundation can be called in to repair additional water damage prevent.

4.13 Transfer of the incident

If the incident is transferred to the owner and/or user of the structure, it can:

> be absolutely certain that the fire is completely out

> cannot be sure that the fire is completely out

> such that the fire is certainly not out yet.

4.13.1 Transfer when it is certain that the fire is out

Once the follow-up check has been carried out by the fire brigade and it is certain that the fire is really out, the building can be handed over to the building owner or user.

Point of attention

> Recommend having the sprinkler section monitored as long as this section is not ready for operation.

4.13.2 Transfer if it is not certain that the fire is out

Once the follow-up inspection has been carried out by the fire brigade, the building can be handed over to the building owner or user.

Points of attention

> Recommend having the sprinkler section monitored as long as it is not ready for operation.

> Recommend not draining the sprinkler section until the fuel has been released or it is absolutely certain that the fire is actually out.

> Determine whether the use of a private fire brigade organization can be of added value.

4.13.3 Transfer if the fire is not yet out

If the fire is not extinguished and must burn out under cover of the activated sprinkler system, the incident may be transferred to a private fire brigade organization after consultation with the parties involved.

4.13.4 Repair of the sprinkler system

After sprinkler activation, part of the installation will have to be put out of operation for a long or short period of time. This will affect sprinkler protection and therefore fire safety in general. In consultation with (picket) officials of

Construction & housing supervision and the risk management department will have to determine to what extent conditions can be imposed on the decommissioning of (parts of) the sprinkler system.

As long as the sprinkler system in a part of the building is not ready for operation, additional monitoring may be necessary to guarantee a sufficient level of fire safety. The operational manager of the fire brigade will have to make agreements about this with the various parties involved. The person responsible for the building must be informed about the risks associated with decommissioning (parts of) the sprinkler system. The building owner is responsible for ensuring that the sprinkler system is ready for operation again as quickly as possible after activation. This should be guaranteed via a maintenance contract.

In practice, not all companies appear to have this

Points of attention

> Additional measures may be necessary to achieve a sufficient level of to guarantee fire safety as long as part of the sprinkler system is out of operation.

> Have the building owner notify the GMK when the sprinkler system is ready for operation again.

> An insurer can demand that the affected area is not affected before an investigation into the cause of the fire has been carried out. This can ensure that the sprinkler system is not ready for operation for a longer period of time.

4.13.5 The fire brigade organization

The prevention departments of the municipality and/or fire brigade must be informed via the on-call officers (such as the Public Safety Officer or the prevention inspector on duty) that parts of the sprinkler system are out of use. In consultation with them, it can be determined to what extent conditions can be imposed on decommissioning (parts of) the sprinkler system.

Consult with the Public Safety Officer whether an on-site appointment is necessary when part of the sprinkler system is out of service. Notify the GMK that the sprinkler system is out of service and pass on the on-site appointment stating the deployment requirements if a new fire alarm is received from the object. This could include, for example, a medium-burn procedure.

4.14 Flowchart

The action perspective has been put in a flowchart. Points of interest are shown for each step from the action perspective, if applicable. The flowchart is included in Appendix 2.

5 Action perspective for a sprinkler system that is not activated by fire

Introduction

This chapter describes the action perspectives for each phase of the incident if a sprinkler system is activated without a fire.

5.1 Sprinkler notification, but no sprinkler activation

If there is a sprinkler alarm, but there are no signals of sprinkler activation, the fire alarm center or sprinkler alarm center can be reset by the company expert, after which it can be assessed whether the system goes into alarm again. If the installation continues to go into alarm, the company will have to call a sprinkler installer.

5.2 Sprinkler activation, but no fire

For example, a sprinkler head can be damaged by a collision, causing it to be activated. If it can be stated with certainty that there is sprinkler activation, but there is no fire, then flooding can possibly be limited.

In that case, you can choose to have the valve of the relevant sprinkler section closed in the pump room. The disadvantage of this is that the sprinkler, and therefore effective fire protection, no longer functions over a large area.
It is therefore preferable, if possible, to deactivate a smaller part of the installation. This can be done by means of a local valve. The presence and location of such valves must be known to the manager. A sprinkler shut-off pliers can also be used.

After activation, part of the sprinkler system will be out of action for a long or short period of time until the necessary repair work has been carried out. Decommissioning part of the installation will affect the sprinkler protection and therefore fire safety in general.

Points of attention

> Limit as much as possible the size of the part of the sprinkler section from which the water supply is turned off. If the valve of a sprinkler section is closed, the entire sprinkler section is turned off. Determine whether there are shut-off valves within the sprinkler section that can shut off the water supply to a smaller part of the sprinkler section.

> Recommend having the sprinkler section monitored as long as it is not ready for operation.

> Additional measures may be necessary to achieve a sufficient level of to guarantee fire safety as long as part of the sprinkler system is out of operation.

> Have the building owner inform the GMK when the sprinkler system is ready for operation again.

Practical example 13: Unwanted activation of the sprinkler system

A sprinkler head was hit during work in a warehouse with pallet racks. The head opened, activating the sprinkler system and causing water to flow. After the fire brigade determined that there was no fire, the internal organization closed the relevant section valve. The building has been transferred to the organization with instructions to continue to monitor the area until the sprinkler system has been repaired and to call 112 and activate a manual call point if a fire occurs within the sprinkler section that is out of order.

Figure 5.1 Activated sprinkler head in a warehouse (Source: VGGM)

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Appendix 1 The sprinkler system

Introduction

A sprinkler system is a permanently installed fire extinguishing system that is designed to detect and control or extinguish an incipient fire. This chapter first discusses the components of a sprinkler system and then the most common types of sprinkler systems. This is followed by a brief discussion of the standards on the basis of which a sprinkler system can be designed, and finally an insight into the buildings where sprinkler systems may have been used. For more information about sprinkler installations, please refer to the *Fire Protection Installations Handbook* (Netherlands Fire Department 2012).

The parts of a sprinkler system

This section describes the most important parts of a sprinkler system.

The sprinkler head

A sprinkler head is a sprinkler head that is connected to a pipe through which water can flow. The sprinkler heads usually hang just below the ceiling or roof of a room, but sprinkler heads in hidden spaces such as a suspended ceiling and in racks also occur. The opening of the sprinkler head through which the water can flow is kept closed by a release mechanism. This is actually nothing more than a metal 'stop' in the opening that is held in place by a heat-sensitive element. The heat-sensitive element may consist of a (metal) solder joint, but is usually a glass ampoule with liquid. In the event of a fire, the temperature around the sprinkler head will warm up. This causes the liquid in the ampoule to heat up and expand. This eventually breaks the glass of the ampoule, releasing the release mechanism and allowing the water to flow out through the sprinkler head. The water sprays against the spreading plate, resulting in the desired spray pattern. Water is sprayed over the fire to stop the combustion process, but also to wet the area around the fire (pre-wetting), so that the fire cannot spread more or less easily. The design of the ampoule, the type of liquid and the thickness of the glass determine the temperature at which and the speed at which the ampoule breaks, and the shape of the spreading plate determines the spray pattern and droplet size. See figure B1.1 for an example of a sprinkler head.

If the first activated sprinkler head does not supply enough water to control the fire, the temperature in the area continues to rise. This also activates surrounding sprinkler heads. Ultimately, as many sprinkler heads are activated as necessary to provide sufficient cooling power to keep the fire under control. The design of the sprinkler system determines to what extent the fire can be controlled. 6

6 See the blue box on page. 53: *How is a water supply for sprinkler system designed in broad outline.*

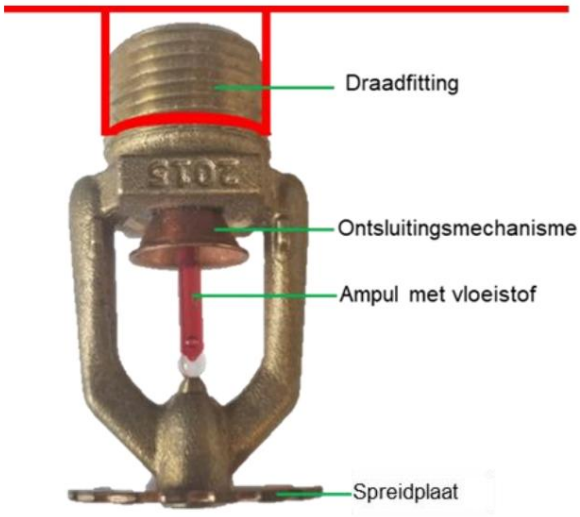


Figure B1.1 A sprinkler head (Source: NIPV)

Sprinkler pipes

The water is transported to the sprinkler head(s) via sprinkler pipes, in most cases made of metal. Just like the fire hoses, the transport pipes have a larger diameter than the pipes to which the sprinkler heads are connected.

Sprinkler section

A part of a building with sprinkler heads connected to the same branch of a (main, distribution and) sprinkler pipe is called a sprinkler section or zone. The surface area of designated sprinkler heads on one sprinkler section can be very large, depending on the standard applied. This may require a large area to be seen through to the location where the sprinkler head(s) are activated. This can result in a large deployment depth. Using (much) smaller sprinkler sections of 1000 m2 or 2000 m2 contributes greatly to locating the seat of the fire. At the start of the branch, there is an alarm valve and shut-off valves in the sprinkler pump room to close the relevant sprinkler section.

The alarm valve

Activating a sprinkler head will result in the flow of water within a sprinkler section. In the pump room at the beginning of the relevant (main, distribution and) sprinkler pipe there is a mechanical valve that opens automatically when flow occurs. When the alarm valve opens, an electrical signal is sent to the sprinkler alarm center, just like a smoke detector does to a fire alarm center.

The ending

In the pump room, each alarm valve has a (section) valve to close the relevant sprinkler section. There must be a clear indication of the relevant section at the location of the valves. It must also be described how the section can be closed. In addition to the section valves, there may also be (partial) valves elsewhere in the building to close off parts of sprinkler sections. There are turning

shutters that can be opened or closed and gate valves that can be slid open or closed.

When a sprinkler system is in operation, all valves should be open. This is indicated on the valve. See figure B1.2 for an example of this. Sometimes these valves are secured in the open position with, for example, a chain to prevent them from being simply closed. In order to close the valve, the chain must first be removed.

Figure B1.2 Left: Monitoring position (yellow button) in open position; valve is open. Right: monitoring position in closed position, valve is closed (Source: NIPV)

The sprinkler alarm center

All signals from (for example) the alarm valves, flow switches and pumps are received at the sprinkler control center (SMC). These signals basically indicate that water is flowing through the system and therefore a sprinkler pump has been activated. So these are actually fire alarms. In addition, fault messages, such as that a valve has been closed, are processed in the SMC. The sprinkler alarm center controls, for example, the evacuation system, the fire brigade panel and the alarm of the emergency services via a private alarm center or the fire brigade control room.

The geographic fire brigade panel

All building parts, including the various sprinkler sections, are graphically displayed on the fire brigade panel. Each sprinkler section has an LED indication for sprinkler messages (ÿ symbol)7 . In addition, a north arrow, the fire brigade and side entrances, as well as the location of the sprinkler pump rooms including alarm valves will be indicated on the fire brigade panel. The position of the other valves in the structure, as well as the replenishment facilities8 and connections for the dry extinguishing pipes, can also be indicated. However, this is not required.

The sprinkler pump

When one or more sprinkler heads open, there is a local pressure drop in the pipe network place. This will cause the water to flow through the pipes, which directly leads to the activation of the sprinkler pump. The sprinkler pump pumps the water into the pipes to maintain the pressure in the pipes. The capacity of the pump used is such that

7 In addition, detection zones of the BMC may also be indicated. In the (BMC) detection zones there is also an LED indication for automatic messages (• symbol) and manual messages (ÿ symbol).
8 Facility with which the water supply of the sprinkler system can be supplemented.

it is capable of supplying sufficient water, at the required pressure, to supply a maximum number of sprinkler heads determined in the design of the installation.
A sprinkler system can be equipped with one or more sprinkler pumps driven by an electric or diesel motor. To reduce the chance of the fire extinguishing water supply failing, many extinguishing water supplies are equipped with two pumps. If one of the pumps fails, the other will automatically take over. These pumps continue to run even when the steam supply in the building has failed and have more than sufficient diesel supply for the first hours. Several buildings and even companies can be connected to a pump room containing one or more sprinkler pumps. In that case we speak of a central fire-fighting water supply.

Water supply

Every sprinkler system is equipped with a water supply from which the sprinkler pump obtains the water that is pumped into the pipes. The water supply is large enough to supply (without the assistance of the fire brigade) the amount of water required during the extinguishing time of the activated sprinkler system. The design principles (the amount of water per m2 , the spray density, the maximum number of sprinkler heads that are activated simultaneously, the maximum spray area and the extinguishing time) determine the size of the required water supply. See also the blue box below. The water supply can (for example) be a connection to the drinking water network, or a private water supply in the form of a sprinkler tank (inside or outside the building) or a clean water cellar. Sprinkler installations are equipped with connections that allow your own water supply to be replenished afterwards (and during a fire). In addition, there are also systems that use two (independent) water supplies.
This is usually the case with objects where failure of the fire extinguishing water supply can have very serious consequences.

Central fire water supply

There are installations where the sprinkler system, the wet extinguishing pipes and/or the hydrants on the site are supplied by one extinguishing water supply, i.e. by one and the same pump and/or water supply. Failure of this extinguishing water supply will lead to an ineffective sprinkler in combination with an ineffective extinguishing water supply for the fire brigade.

How is a water supply for sprinkler designed (in broad outline)?
The design of a sprinkler system is very dependent on what is stored. For example, the requirements for a sprinkler system in an area with little flammable material will be different than for a sprinkler system in an area with a lot of flammable material. But the method of storage, the height of a room and the way in which smoke can spread through a room also largely determine the principles that a sprinkler system must meet. This translates into a so-called hazard class.

This hazard class determines three important design principles for the sprinkler system: > **Spray**
density: This is the number of liters of water that must be supplied per m2 per minute. The spray density typically ranges from 2.5 mm/m2 /min to > 50 mm/m2 /min.
> **Maximum spray area:** This is the minimum number of m2 that must be able to be controlled by the installation. This usually varies from 72 m2 to 325 m2 .

> **Extinguishing time:** The time during which, based on the normative spray density and the maximum spray area, the fire must be able to be controlled. This is usually 60 or 90 minutes.

Practical example for imaging
With a simple (OH1) sprinkler installation, the required spray density is 5 mm/m2 /min and the maximum spray area is 72m2 (minimum 8 sprinkler heads). The required extinguishing time is 60 minutes. This means that at least 72 x 5 x 60 = 21,600 liters of water must be available. In most cases, only a few sprinkler heads are activated and not the maximum number. Er
Less water is then drawn off at the same time, so that there is a supply of water for more than an hour.

Types of sprinkler systems

In addition to the standard (wet) sprinkler installations, there are special versions that are regularly encountered. These are usually not separate installations, but deviations within the (otherwise) regular installations. The paragraphs below provide a brief description of some different types of sprinkler systems.

Wet sprinkler system

In a so-called wet sprinkler system, all pipes are already filled with water. If a sprinkler head is activated by the fire, water immediately comes out of this sprinkler head. No water comes out of the other sprinkler heads. If the fire cannot be controlled by the water from one sprinkler head, the energy from the fire will cause more sprinkler heads to activate. If the activated sprinkler heads supply sufficient water to control the fire and therefore the temperature in the room, no more sprinkler heads will be activated.

Dry sprinkler system

In situations where an area protected by sprinklers may be exposed to low temperatures, measures must be taken to prevent freezing of the sprinkler pipes. This is, for example, the case with (unheated) storage locations, parking garages and canopies. Although freezing is also prevented by adding antifreeze or heating (tracing) the pipes, the most common solution is to dry the relevant sprinkler sections. In this case there is no water, but air or nitrogen in the pipes. The working principle of the sprinkler is basically the same. However, when the sprinkler head is activated, the air or nitrogen must first be pressed from the system before the water (from the alarm valve) is applied to the seat of the fire. Obviously this should not last long.

Preaction sprinkler system

There are situations where, given the vulnerability of the area to be protected, an unwanted sprinkler activation must be prevented. This includes sensitive data centers, document storage and museums. In that case, a pre-action system can be applied. With this system, part of the installation is designed dry and the relevant sprinkler pipes are only filled with water after a fire has been detected, for example by automatic fire detectors. The system is equipped with closed sprinkler heads. This means that the installation only comes into operation when the sprinkler heads are also activated by heat.

Deluge sprinkler system with open sprinkler heads

There are situations where simultaneous activation of many sprinkler heads is desirable. Consider situations where rapid detection is difficult (such as high atria), where protection of an entire area is necessary or in situations where a fire can spread quickly (for example when processing flammable liquids). A deluge sprinkler system consists of sprinkler pipes equipped with 'open' sprinkler heads, through which water can flow freely. The installation is controlled by the SMC when smoke and flames are detected. In this case, a large number of sprinkler heads are activated simultaneously. This type of installation has a large water supply because many sprinkler heads open simultaneously.

(Exposure protection) facade sprinklers

The purpose of the facade sprinklers is to prevent fire from spreading from outside the building to the building. The system, which is installed on the outside of a building, is similar to a deluge sprinkler system with dry pipes with open heads which activate simultaneously in the event of fire. These installations also often have a large water supply.

Sprinkler systems for fireworks storage areas

These are often deluge systems with a limited size. They consist of a water supply, a system with open sprinkler heads for the entrance door(s) and in the (buffer) storage areas and a wet system in the sales area. The deluge system can be controlled via deluge valves or mother sprinkler(s).

Storage and non-storage storage (with ESFR heads)

An ESFR sprinkler head delivers on average five times as much water as a regular sprinkler head and the droplets are larger. The ESFR sprinkler heads are used in areas with high fire risks, such as distribution centers and high-pile warehouses. ESFR sprinkler heads are mainly used to extinguish (and not just control) a fire. With ESFR sprinklers it is possible to only install sprinkler heads near the roof (roof net) without it being necessary to also install sprinkler heads in the racks.

Residential sprinkler installation

Sprinkler installations for the residential environment have various designs. For example, there are 'simple' residential sprinkler installations type 19 for individual homes and 'more complex' residential sprinkler installations type 2 and 3 9 for higher residential buildings, (residential) care functions and accommodation functions. The residential sprinkler systems usually have many similarities with regular sprinkler systems. They have a limited spray density (2.05 mm/m2 /min) and a maximum spray area of two to four10 sprinkler heads. The home sprinkler, whether or not equipped with a sprinkler pump, is often connected to the drinking water network and does not have a separate pump room. Although residential sprinklers are generally able to control a fire, they have a different purpose, namely to create a situation that increases the chances of survival and escape. This is reflected in the intended sprinkler duration of only 10 to 30 minutes.

9 NEN – EN 16925:2018 +NB 2020.

[10] Depending on the type 1,2 or 3 residential sprinkler.

Sprinkler installation standards

To ensure its quality, a sprinkler system is often installed in accordance with one of the European or American sprinkler standards. The installation is installed by a qualified sprinkler installer and then provided with an inspection certificate.11 This means that an independent inspection body assesses the installation12. Maintenance also takes place during the use phase and is assessed annually by the inspection body. The most common sprinkler standards are listed in the table below.

Table B1.1 Sprinkler standards

Sprinkler standard	Title	Origin
FM data sheet 2.0	Installation Guidelines for Automatic Sprinklers	American
FM Datasheet 2.81	Fire Protection System Inspection, Testing, and Maintenance	American
NEN-EN 12845 + NEN 1073	Fixed fire extinguishing systems – Automatic sprinkler systems – Design, installation and maintenance	European / Dutch
NFPA 13	Standard for the Installation of Sprinkler Systems	American
NFPA 25	Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems	American
TB 85	Management and maintenance of water-based extinguishing systems	Dutch

Different standards apply to specific residential sprinklers. The most common residential sprinkler standards are shown in the table below.

Table B1.2 Residential sprinkler standards

Residential sprinkler standard	Title	Origin
NFPA 13D	Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes	American
NFPA 13R	Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies	American
NEN-EN 16925 +NB	Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies	European / Dutch

11 Building Decree 2012 art. 6.32 paragraph 1.

12 Including the associated construction and usage aspects.

Buildings with a sprinkler system

The Dutch built environment is becoming increasingly complex. Consider, for example, increasing urban densification, where the design of public spaces sometimes involves multiple, conflicting interests. By using a sprinkler system, there is more design freedom and building regulations can still be met on the basis of equivalence. This installation detects and controls a fire at an early stage and thus limits the consequences of fire for the building and the immediate surroundings. Some applications of the sprinkler system are discussed in more detail below.

Large fire compartments

The requirements in Dutch regulations impose conditions on the area to which a fire may spread unhindered. These expansion areas, also called fire compartments, are - depending on the type of use - limited to 1000 m2 - 2500m2 . In practice, it may be desirable for buildings to have spaces openly connected to each other without the presence of dividing structures, to have a large space or to have more freedom of layout during use. An equivalent form of fire safety can be achieved by using a sprinkler system, which means that larger fire compartments in particular can be used.

High buildings

Dutch (building) regulations apply to structures with a use area (from 8 meters below) to 70 meters above measuring level. The same degree of fire safety must be demonstrated for taller buildings. This is usually done by applying the *SBRCURnet Guide – Fire Safety in High Buildings.* This document includes a sprinkler system (also within homes) as a requirement.
In addition to the sprinkler system, such buildings contain a large number of other facilities, including overpressure systems in the stairwell. There are usually people present in these buildings and the evacuation has not been completed when the fire brigade arrives.

Homes and residential buildings

Home sprinklers can be used to control a fire, with the aim of improving the conditions under which escape is required. This allows the regulations regarding safe flights to be implemented on the basis of equivalence. This includes excessively long walking distances inside and outside the home or the need for multiple homes to be on a single escape route. The home sprinkler can also be used to achieve a higher fire safety level in addition to the regulations.

Storage of hazardous substances (PGS15)

The requirements in Dutch regulations impose conditions on the storage of hazardous substances. When storing hazardous substances with the highest protection level (protection level 1), the presence of an extinguishing system may be required. The extinguishing system is different in the sense that its purpose is not to control the fire, but to extinguish it. This basically means extinguishing the fire

no longer a task for the fire brigade. Of course, a check to see whether the fire is actually out still needs to be done.

Storage fireworks

The requirements in Dutch regulations impose conditions on fireworks storage areas and points of sale for consumer fireworks. Both the sales location and the buffer storage area are equipped with a sprinkler system.

Healthcare institutions

The requirements in Dutch regulations do not impose any direct conditions regarding the presence of a sprinkler system. They do state that there are “sufficient designated persons to ensure that evacuation in the event of fire occurs sufficiently quickly”.13 In many healthcare institutions, even when the structure meets all architectural and installation requirements, this proves to be a major burden for the staff present. There are often not enough people present, especially at night. Sprinkler installations In combination with good smoke-resistant partition constructions, limit the development of fire and spread of smoke, and thus increase the chance of an effective evacuation with the available personnel.

Museums and ICT data centers

The requirements in Dutch regulations impose conditions on the area to which a fire can spread unhindered. However, this does not prevent the fire compartment itself can and may burn out completely, which could lead to major damage or major disruption of vital infrastructure. Sprinkler installations prevent the development of fire at an early stage, and thus the negative effects outlined.

Church buildings

The roof of many church buildings is made of wooden truss structures. The chance of fire originating and developing in these roof structures is considerable. Moreover, fire fighting in the roof structures proves to be difficult and risky. To protect the hood, a sprinkler system can be used. A common alternative to a sprinkler system is a dry extinguishing line to which sprinkler lines with open sprinkler heads are connected. However, this is not an automatic sprinkler system; the installation will have to be supplied by the fire brigade. Given the time it takes for the fire brigade to arrive and the limitations in pump capacity, the chance of controlling the fire is much more limited than with regular sprinkler systems.

Waste processing (damage reduction)

The processing of waste is a risky activity. The risk of fire starting and developing is considerable, for example due to the presence of lithium-ion batteries in the waste stream, or due to the risk of heating in the waste stream. Moreover, firefighting the waste stream proves to be a difficult and lengthy process, which ultimately requires (part of) the waste stream to be excavated. Sprinkler systems can be used to prevent damage and long-term disruption of the processing process. These are often deluge sprinkler installations, whether or not in combination with controlled fire monitors are controlled by fire detection using (thermal imaging) cameras.

13 Building Decree art. Article 7.11a.

Tunnel-like structures (WARVW)

When constructing (road) tunnels, (longitudinal) ventilation in the tunnel is often chosen to enable safe escape to adjacent (middle) tunnel channels.
Sprinkler installations in road tunnels do not yet occur in the Netherlands14 , but they do occur in the railway tunnels of the Betuwe Route. The sprinkler systems have different purposes:
> checking and, if possible, extinguishing fire
> preventing a BLEVE by cooling wagons
> checking a pool fire
> protecting the structure by cooling
> washing out of toxic particles.

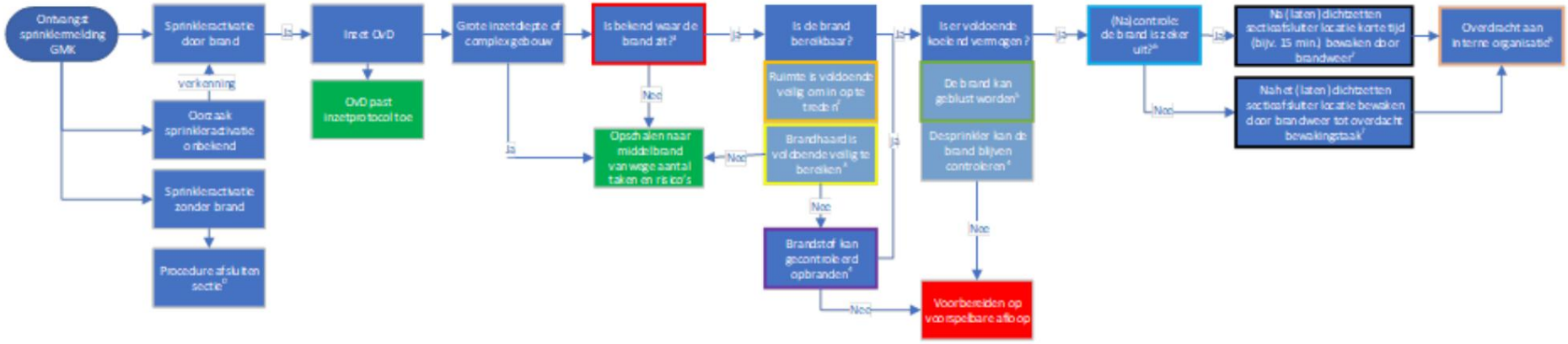
Automatic storage systems and automatic parking systems

The number of automatic storage systems and automatic parking systems has increased in recent years. Both systems are in principle 'closed': products are offered on the outside and the entire logistics process takes place automatically within the system. The internal part is not accessible to persons. A sprinkler system can be used to control and preferably extinguish a fire at an early stage, but other extinguishing systems such as water mist and gas extinguishing systems are also used. In the event of fire, these systems have very limited access. Moreover, it cannot be ruled out that goods and parts may move during a deployment.

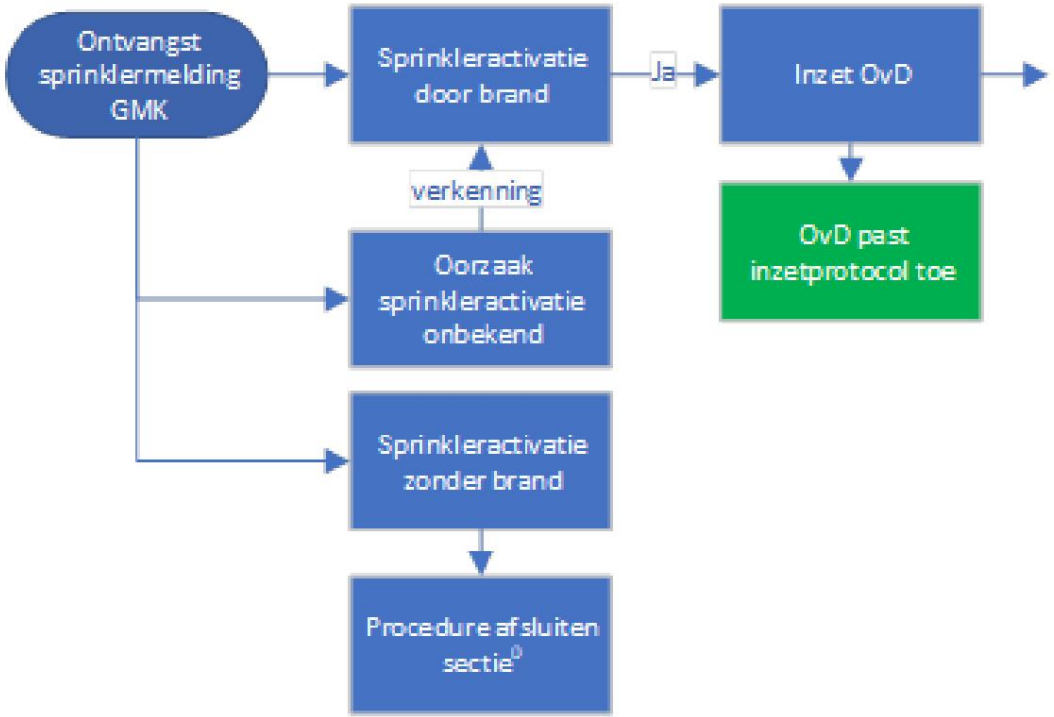
14 There are plans to use water mist installations in tunnels to control a fire.

Appendix 2 Flowchart of action protocol

This appendix contains the flowchart that accompanies the action protocol. Due to the size of the diagram, which does not improve readability here, the entire diagram is shown first and then the successive parts.

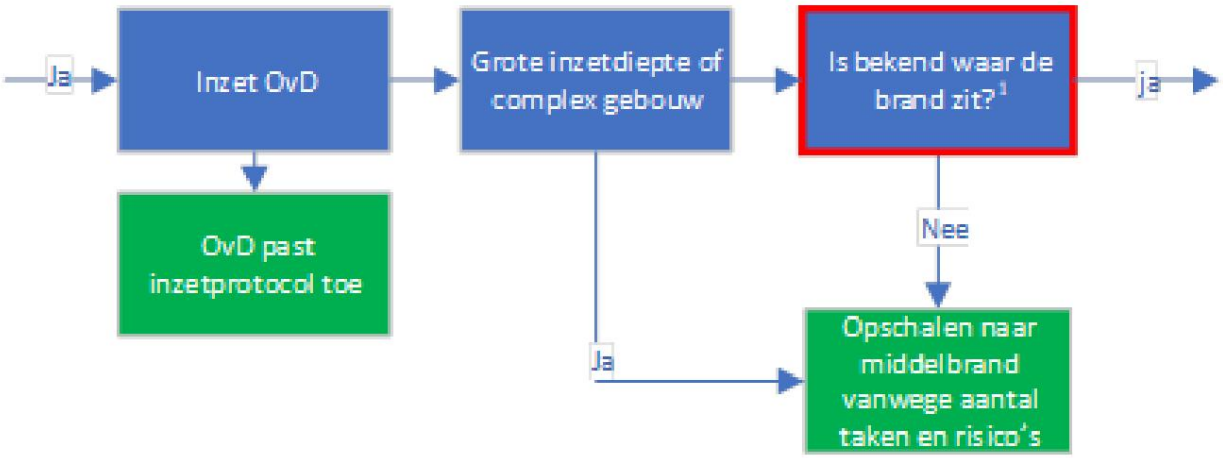


First part of the schedule



Additional information to the first part of the schedule

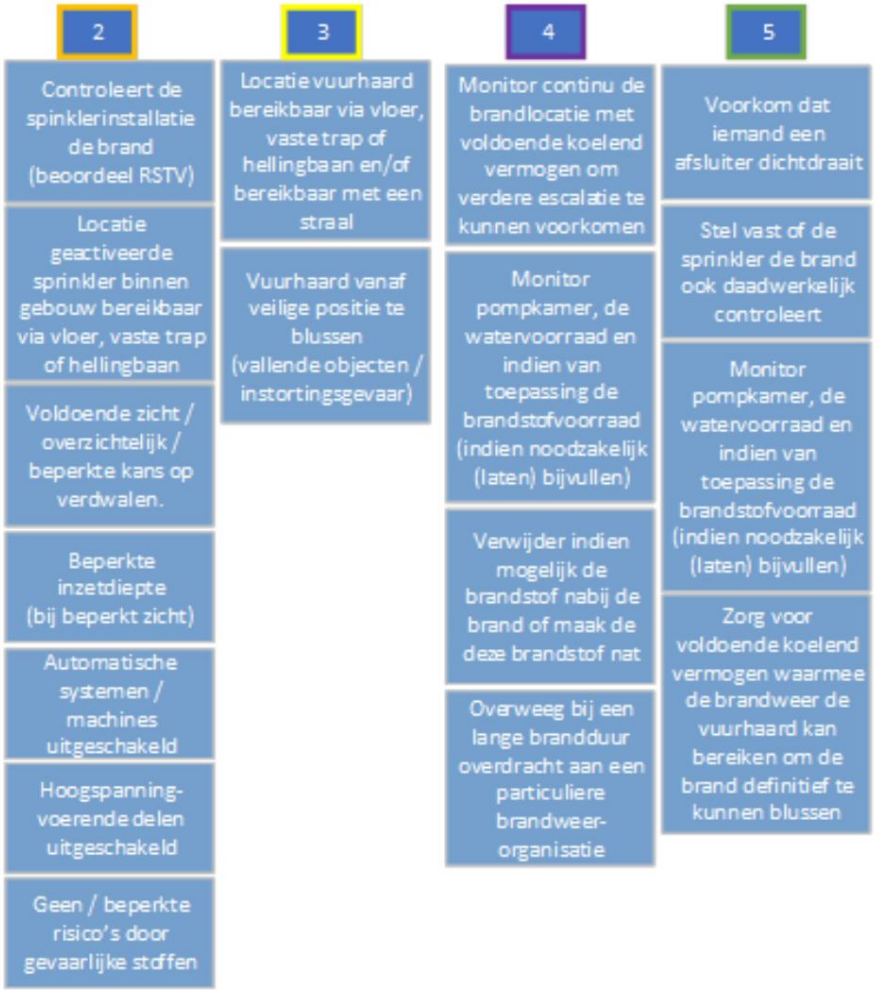
Second part of the diagram



Additional information to the second part of the diagram

Third part of the diagram

Additional information for the third part of the diagram



Fourth part of the schedule

Additional information to the fourth part of the diagram