Retrofit of sprinklers in existing industrial buildings

Many existing industrial buildings are not equipped with sprinkler protection, or the sprinkler protection is not sufficient because of a change in fire risks due to changes in the use of the building. Retrofitting these structures with fire sprinklers mitigates fire hazards and reduces potential damage from fire to the building, equipment and environment. This process involves the careful integration of new sprinkler systems into existing building frameworks, often in situations where disruption of the process is not allowed or has severe limitations. Here Ing. J.C. Hoogeweg – Fire Safety consultant – DGMR bouw b.v. takes a look at some of the challenges and possible solutions encountered in projects.

Challenges

During the development of a new building, the sprinkler system can often be optimally integrated so that there is a symbiosis between the sprinkler and the building. In existing buildings this is not possible anymore, so a lot of 'creativity' is required to achieve an effective sprinkler protection.

This requires an excellent knowledge of codes and standards, and an understanding of how certain rules have made it into them. It is also necessary to consider the existing processes that need to continue (e.g. production cannot stop to fit a sprinkler), or the brief moments when production stops.

The use of codes and standards

When retrofitting fire sprinkler systems in unsprinklered buildings, the same guidelines and standards apply as those for new construction. There is (in general) no design standard for existing buildings. This ensures that retrofitted systems provide the same level of fire protection and reliability as those installed during the building's initial construction.

Certainties you will run into

When retrofitting fire sprinkler systems in existing buildings, several certainties must be anticipated. First, the cost of installation can be 1.5-2.5 times higher than in new construction due to the added complexities of working within an existing structure. Additionally, the process often takes longer because the installation must be coordinated with the building's ongoing active use, minimising disruption to operations. Structural modifications can be necessary, such as reinforcing the building to support the added weight of the pipes (especially when the roof is also afterwards fitted with PV panels). Finally, finding an appropriate location for a water reservoir can be a significant challenge, particularly in densely constructed buildings with limited available space inside or outside the building.

Some recommendations

Every building is unique, with its own structural features, usage patterns, and safety requirements. As a result, customised solutions are essential when designing and implementing fire protection systems. In the remainder of this article, we will explore various approaches and lines of thought for addressing the specific challenges that arise in both existing buildings and new construction. These solutions will focus on optimising fire safety while balancing practical constraints such as water supply, space limitations, and structural concerns, ensuring that each building receives the tailored protection it needs.

Sprinkler piping

In locations where process equipment occupies ground-level space, working from the ground can be particularly challenging. Traditional access methods, such as rolling scaffolds or scissor lifts, are often impractical because they cannot navigate around equipment such as storage racks and production lines. In many cases, costly fixed scaffolding is constructed to provide access, adding time and expense to the project. However, an alternative solution is to employ alpine technicians (or industrial rope access specialists). These professionals can work safely at height using ropes, making it possible to reach difficult areas without the need for bulky scaffolding.

Water supply

Often, a direct connection to the drinking water supply is not feasible because the required capacity for fire sprinkler systems is not available, requiring the use of a private water reservoir instead. The size and location of this tank can present challenges, but there are several strategies to help overcome these obstacles:

- **Indoor Placement**: A sprinkler tank does not always have to be placed outside. It can be installed inside the building if space allows, offering more flexibility in finding a suitable location.
- **Alternative Shapes**: Tanks do not have to be round. Rectangular steel or concrete tanks can be used, allowing them to be integrated into available spaces more efficiently, such as basements or unused sections of the building.
- **Optimising Tank Size**: By selecting the appropriate sprinkler system design, the required capacity of the water tank can be reduced, potentially minimising the tank's footprint and simplifying installation.

The drinking water or industrial process water supply can also sometimes serve as a supplementary source for the sprinkler system. However, it is important to remember that the capacity is often limited, which may restrict the amount of water available for the sprinklers. Additionally, connections to the drinking water supply can incur high fixed costs from water companies, which can impact the financial feasibility of this solution.

In situations involving rack storage, traditional sprinkler protection systems often include a combination of roof sprinklers and in-rack sprinklers. Because both systems are assumed to operate simultaneously in the event of a fire the water demand can be substantial – a requirement for as much as 1,200 m^3 of water is not uncommon.

The EN 12845 sprinkler standard is often used for design. Sometimes this standard is used because we always use it or it has been prescribed by the parties involved. However, by carefully selecting the appropriate sprinkler concept and design standard, a more efficient balance can be achieved. For instance, FM data sheets offer design options that do not require concurrent operation of both the roof and in-rack sprinklers when calculating the necessary water capacity. This can significantly reduce the amount of water required, making the system more practical and cost-effective while still ensuring robust fire protection. An example for this is worked out below.

Example of selecting the optimal protection concept

In this example, we assume the following storage configuration: plastic goods (unexpanded plastics in cardboard boxes). These goods are stored on wooden pallets in open-frame double-row racks (<2.7 m, aisle > 2,4 m).

In the example below, we compare two different fire protection concepts. In Situation 1, traditional protection is implemented according to the NEN-EN 12845 [1] standard. Due to the height of the space (15 metres), ceiling level sprinklers and in-rack sprinklers are required. To calculate the required volume of water the system must assume the simultaneous activation of both the ceiling sprinklers and the sprinklers within the racks. This results in a water demand of 268 m^3.

Situation 1: EN 12845 protection concept:

	# of sprinklers/ design area	Flow / sprinkler	Duration	Water supply[1]
In-rack	3 * 3 = 9	K80 * √2.0 bar = 113 l/min	90 minutes	92 m^3
Ceiling level	260 m^2	7.5 mm/min	90 minutes	176 m^3
			Total	**268 m^3**

1 excluding possible hose stream demands and hydraulic imbalance

In Situation 2, the protection is based on the FM Datasheet 8-9 (2.3.6.6) [2]. In this case, it is not necessary to assume the simultaneous activation of both the ceiling sprinklers and the in-rack sprinklers. Instead, the system is designed in such a way that either the ceiling level sprinklers or the in-rack sprinklers can be activated independently, depending on where the fire starts, reducing the demand on water supply and system capacity.

Situation 2: FM protection concept:

	# of sprinklers/ design area	Flow / sprinkler	Duration	Water supply[1]
In-rack	6	250 l/min	60 minutes	90 m^3
Ceiling level	10	K240 * √0.9 bar = 228 l/min	60 minutes	137 m^3
			Total	**227 m^3**

1 excluding possible hose stream demands and hydraulic imbalance

3D is the future?

In existing buildings no situation is the same, so making a well-designed plan is essential for effective fire protection. Errors in the design or prefabrication process not only lead to additional costs for the installer (or client) but also cause delays and disruptions for the building's occupants. A highly effective method to avoid these issues is to scan the building to make a 3D model of the building. This model can then be used to create a precise design for the sprinkler system and fabricate the prefabricated pipe sections, ensuring a more accurate fit and minimising mistakes during prefabricating and installation.

Conclusion

In conclusion, retrofitting fire sprinkler systems in existing buildings presents unique challenges, from structural limitations to water supply considerations. However, with careful planning, innovative solutions, the use of the right design standards and the use of modern technologies like 3D scanning, it is possible to design and implement effective fire protection systems that enhance safety while minimising disruption and cost.

In many situations, customised solutions will also be necessary because certain circumstances may not fully align with standard regulations. By having a deep understanding of the codes, standards, and their underlying principles, it is often possible to develop tailored solutions that still achieve effective fire protection. This approach allows safety objectives to be met, even when strict compliance with guidelines is not feasible due to the unique conditions of a building or its operations.

[1] EN 12845 'Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance', 2015
[2] FM Global (Now FM) 'Property Loss Prevention Data Sheets 8-9' March 2010, Interim Revision January 2022