

# SKYLINE OF ROTTERDAM


## FIRE SAFETY IN HIGH-RISE BUILDINGS

**R**otterdam, a city that is increasingly known for its skyline of towering buildings, has developed over the past decades into a global city. With more than 650,000 inhabitants and a growing need for housing, the city is confronted with a

housing shortage, limited space, and the challenge of using the available space efficiently. Building high-rise buildings is therefore an obvious solution. Rotterdam has 50 buildings higher than 70 metres, of which 27 are higher than 100 metres and eight are higher than 135 metres, with 215 metres as the current peak. In the coming years, buildings exceeding 250 metres will be added. This modern high-rise development gives the city a contemporary appearance but also brings new and complex fire risks. The fire brigade of Rotterdam has responded to this by developing a unique procedure: the RRICEC protocol.

### HIGHER BUILDINGS, GREATER RISKS

The rise of tall buildings in Rotterdam is no coincidence. The city is dealing with a growing population, an ageing society, shrinking household sizes, and increasing density in the city centre. Whereas Rotterdam was once mainly known for its port and industrial character, in recent years it has positioned itself as a cosmopolitan metropolis with an impressive skyline. Rotterdam has a clear direction for housing, offices, shops, and leisure: high-rise buildings of unlimited height and multi-layer parking garages, as the only city in the Netherlands. However, this spatial choice has its downside.

An aerial photograph of Rotterdam, Netherlands, showing a dense urban landscape with numerous high-rise buildings. The Erasmus Bridge, a prominent cable-stayed bridge, spans across the water in the middle ground. The foreground is dominated by lush green trees, and the sky is clear and blue.

Panorama of Rotterdam city  
and the Erasmus bridge  
Erasmusbrug over Nieuwe Maas.

The taller the buildings, the greater the challenge and risks for the fire brigade. Building safely in compartments, using non-combustible materials and fire prevention systems, makes the chance of fire development extremely low, but that chance remains, and the fire brigade is then called into action. Firefighting in these modern skyscrapers requires specialised approaches and technologies. Firefighters cannot simply use the usual tools and techniques they are accustomed to in low-rise fires. The challenge of quickly and effectively reaching and combating a fire in a building higher than 70 metres is significant. The fire brigade becomes increasingly dependent on the facilities within a building, both in terms of logistics and planning, and complexity continues to increase as height increases.

### **THE RRICEC PROTOCOL: A BREAKTHROUGH IN FIREFIGHTING**

The Rotterdam Fire Brigade has not only focused on improving their deployment concepts and strategies but has also developed a unique procedure specifically aimed at high-rise incidents. This procedure, the RRICEC protocol, was developed by a project group led by chief officer and project leader Rogier Piek and provides a structured approach to ►



**RRICEC-protocol by Rotterdam fire service: no specialities in basic fire-education and no specialities in fire-trucks.**



firefighting in buildings higher than 70 metres. Rotterdam-Rijnmond is the first region in the Netherlands to specifically focus on combating fires in very tall high-rise buildings (up to 250 metres). The RRICEC protocol consists of six phases: Reconnaissance, Rescue, Intervention, Containment, Evacuation, and Command, and is inspired by the RICE procedure developed by Paul Grimwood.

## FIRE SAFETY AT HEIGHT: PRINCIPLES

The RRICEC protocol forms the basis for the operational response of the fire brigade. The building permit sets requirements for the building that make the likelihood of fire extremely low. Nevertheless, the use of a building can still lead to fire. For the realisation of special high-rise buildings, the fire brigade sets the following preconditions:

1. Compartmentation is structurally implemented and secured in such a way that any fire remains limited to a single compartment.
2. Fire control at height should, in principle, be achievable by a permanently installed water system/sprinkler.
3. For fire brigade deployment to all floors, lift capacity is available that can only be operated by the fire brigade.
4. Upon alarm for a fire in a high-rise building, multiple vehicles with fire brigade teams with predefined roles are immediately deployed for a full response.
5. The fire brigade does not need to establish special deployment locations within the 'spread' of its fire stations that

are specifically aimed at the planned high-rise developments.

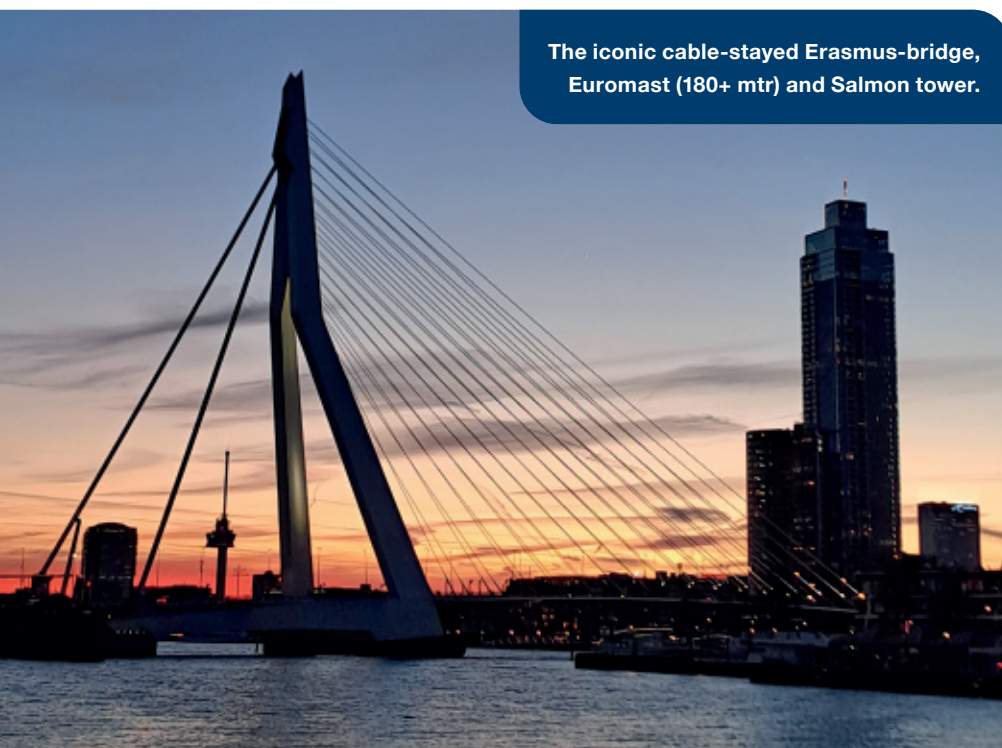
6. Vehicles used for deployment do not require technical or functional modifications for firefighting at height.
7. No changes are required in the educational programme of the Dutch firefighter for firefighting at height in high-rise buildings.
8. For firefighting at height, the fire brigade does not need to have specific personal protective equipment that differs from standard equipment for interior firefighting.
9. From every floor, evacuation and escape are possible via two sides, (spiral) stairwells remain smoke-free through overpressure.
10. The availability of sufficient extinguishing water (1,200 l/min) on all floors is ensured via pumps, with pump capacity redundantly secured in case of power failure for up to 2 hours.

An important success factor is the substantial response capacity that can be deployed to the location immediately upon alarm. To determine the appropriate response capacity upon alarm, four (increasing in severity) scenarios have been predefined, each elaborated based on RRICEC aspects:

1. Fire scenario limited to a space with an activated sprinkler (controlled fire)
2. Fire scenario without sprinkler but contained by fire and smoke compartments (developed fire)
3. Fire scenario without sprinkler, where spread beyond the compartment affects escape routes



**Hotel New York (built 1901), with office buildings. Port of Rotterdam and Safety Region Rotterdam and Montevideo tower (152 mtr).**



**The iconic cable-stayed Erasmus-bridge, Euromast (180+ mtr) and Salmon tower.**

4. Fire scenario that develops from an internal or external fire into a façade fire

When a (potential) fire is reported via the fire alarm system or an active sprinkler, control is assumed (scenario 1) and two fire brigade units are dispatched. When a fire is reported directly to the emergency control room (112), failure or non-activation of the fire alarm system or sprinkler is assumed (scenario 2, 3 or 4), and a fire brigade platoon (four units with extended operational command) is immediately dispatched.

Roles, positions, and command of fire brigade teams are predefined and are immediately assumed. Depending on the scenario classification after reconnaissance, the required response capacity is deployed without delay.



## 1 RECONNAISSANCE (ASSESSMENT)

The model begins with a crucial phase: Reconnaissance. This phase aims to quickly obtain a complete picture of the situation. Upon arrival, the (predefined) command room is immediately put into use, and the fire brigade lift is immediately assigned a 'lift operator'. The fire brigade gathers information about the floor and location of the fire, the severity of the situation, and the specific characteristics of the building. A full external reconnaissance in the traditional way is not possible due to the height of the fire within the building. The initial internal reconnaissance is carried out using a small extinguishing agent – no hoses, no direct interior attack. Information is also obtained through the

use of drones (outside and/or inside). The deployment of drones goes beyond reconnaissance alone. They provide eyes where they are needed most – at height, behind glass, in smoke. In Rotterdam, they are now standard equipment at major high-rise incidents. When every second counts, technology makes the difference. The reconnaissance phase must conclude with a decision on the operational approach to be taken by the fire brigade.

## 2 RESCUE

When lives are at risk, Rescue becomes the central focus. The aim of this phase is to evacuate residents from hazardous zones, such as in the event of smoke or fire development. Rescuing people must be carried out quickly

and purposefully, especially because evacuations in high-rise buildings can take a considerable amount of time. The time factor is crucial. In the Rotterdam approach, rescue is centred on self-reliance and the use of available escape routes and fire brigade lifts: people must have time to bring themselves to safety, while for any casualties, the fire brigade uses the same facilities. To gain time, advanced technologies such as drones are used, which can assist in locating people and potential victims on floors at great heights. Rescue can only take place in the case of a controlled fire (sprinkler activated); in other cases, intervention measures (scenario 2) and/or compartmentation measures (scenario 3) must first be implemented. ▶

### 3 INTERVENTION

During the Intervention phase, the fire brigade actively proceeds to combat the fire. Extinguishing the fire and preventing further spread is essential to stabilise the situation. Because the water supply in a high-rise building is often more complex than in low-rise structures, specific techniques are applied. Internal fire pumps and wet risers are essential to deliver sufficient water to the fire floor.

The principle in firefighting is control through sprinklers: systems must ensure that a fire remains small and

is extinguished. The actions of the fire brigade are complementary to what sprinklers achieve. An important point of attention is the amount of extinguishing water: water finds its way downward through open connections between floors, stairwells, and elevator shafts. This creates a risk of contact with electrical systems, and thus their failure. In practice, this means that the fire brigade must, where possible, limit the use of water and remain aware of the threat that extinguishing water poses to fire brigade lifts.

### 4 CONTAINMENT

Containment plays a crucial role in firefighting in high-rise buildings. Limiting the spread of both fire and smoke is essential. The goal is to keep the fire within designated compartments so that it cannot spread to other parts of the building. This is achieved through the strategic protection of stairwells and other escape routes, and by maintaining sufficient overpressure to keep them free from smoke and fire.

During operations, the fire brigade has access to flexible smoke stoppers to seal open spaces or doors that need to be opened and closed frequently, in order to prevent smoke spread.

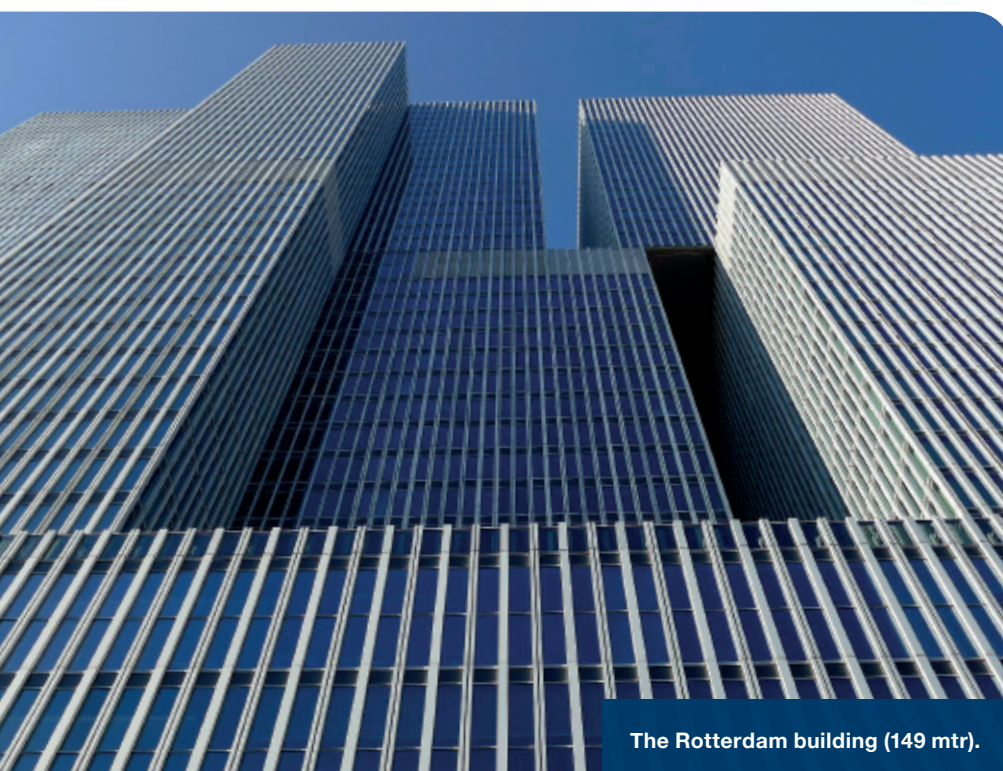
### 5 EVACUATION

When the fire cannot or can only with difficulty be controlled, Evacuation is the next step. The building must be evacuated in a timely manner and as quickly as possible, depending on the severity of the situation. The fire brigade ensures that stairwells are safe for evacuation. Coordination in this phase is essential to prevent panic and to ensure an orderly evacuation. Therefore, a phased evacuation is initially applied: only the directly threatened zone – the fire floor, two floors above, and one below – is automatically alerted via the fire alarm system. This keeps escape routes accessible and allows the fire brigade to carry out its work.

A broader evacuation only takes place if the situation requires it and is then deliberately initiated by the fire brigade. Control is essential to maintain overview and command during high-rise incidents. Therefore, the MOI (Mobile Operational Information system) includes a function that automatically displays how long the incident has been ongoing every 15 minutes. These time markers help monitor progress, decision-making, and safety. The control room actively maintains command and ensures that command and control (particularly the TOA) remains sharp – even when time seems to pass more slowly than it actually does. Furthermore, depending on the preventive concept, a timeline applies for decision-making regarding timely full evacuation, ensuring the building is cleared before systems begin to fail.

### 6 COMMAND (LOGISTICS)

Finally, Command is an indispensable pillar in the RRICEC approach. The greatest challenge for Command and logistics in a high-rise fire often does not



The Rotterdam building (149 mtr).



Salmon Tower (215 mtr).

begin on the street, but ... at the front door. How do you get equipment, hoses, personnel, and resources dozens of floors upward – quickly, safely, and in a coordinated manner? That requires more than physical strength alone. It requires proper role allocation, tight coordination, and clear command. Therefore, in such incidents, two duty officers and a platoon commander are deployed as standard, each with their own focus – including Command and Logistics. Without a well-organised supply chain, operations at height come to a standstill.

## INTERNATIONAL FIRE IN HIGH-RISE BUILDINGS: A GLOBAL PROBLEM

The approach to high-rise incidents adopted by the Rotterdam Fire Brigade has not emerged in isolation. It has been shaped in part by hard and costly lessons learned abroad. Incidents such as the Baku Residential Tower (Azerbaijan, 2015), Grenfell (UK, 2017), Marina Torch (Dubai, 2015/2017/2019), Trump Tower (New York, 2018), and Kaohsiung (Taiwan, 2021), as well as incidents in Valencia and Hong Kong, have been extensively analysed and translated into regulatory requirements for both the permitting processes and operational principles for the fire services.

The RRICEC protocol anticipates risks that have manifested elsewhere – often at the cost of human lives.

## WHAT MAKES THE ROTTERDAM RESPONSE PROCEDURE DIFFERENT?

Rotterdam has positioned itself as a pioneer in the approach to firefighting in high-rise buildings. The RRICEC protocol, inspired by international best practices, provides a unique, structured, and cooperative approach that closely collaborates with the municipality (as permitting authority), building managers (as operators), and residents (as users). The main difference compared to earlier procedures in the region is the emphasis on prevention and building provisions in combination with suppression. In previous procedures, the focus was on combating the fire itself, whereas now maintaining smoke-free escape routes and proactive preparation are also crucial. By implementing predefined measures such as compartmentation, adequate water supply systems, accessibility to and from height, and maintenance of fire safety systems by the building operator, incidents can be better controlled.




Rotterdam has positioned itself as a pioneer in the approach to firefighting in high-rise buildings.

In addition, rapid and broad alarm response and cooperation between all involved parties play a major role in the Rotterdam approach. This goes beyond merely preparing for a potential fire brigade deployment. Building managers, architects, and residents are actively involved in planning and maintaining fire safety. The shared goal is to ensure optimal safety for both residents and emergency responders. The fact that Rotterdam specifically focuses on high-rise buildings above 70 and even 250 metres, with its own tailored protocol, makes this approach unique and distinguishes Rotterdam from other regions.

## CONCLUSION: ROTTERDAM UNIQUE IN HIGH-RISE FIREFIGHTING

Rotterdam is therefore unique in its approach to firefighting in high-rise buildings. With the development of the RRICEC protocol, the city has created a structured, coordinated, and highly efficient procedure that optimises both resident safety and the effectiveness of emergency services. While many fire brigades struggle with the challenges of taller buildings, Rotterdam has found a way to mitigate and manage these risks. The combination of preventive measures, alignment with fundamental safety concepts, logistical support,

and collaboration between various stakeholders makes Rotterdam an example for other cities facing high-rise challenges. High-rise development here is not only a visual characteristic of the city, but also an example of how innovatively and proactively the fire brigade and the region address the challenges of modern times.

The guiding principle remains: the fire brigade must be able to operate professionally and effectively at great heights, without the need for additional training, complex techniques, or specialised equipment. Structurally safe, using existing resources, and supported by a tailored procedure: RRICEC. 



For more information, go to [www.kappetijn.eu](http://www.kappetijn.eu)



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