

XXL fire engine on rails in Rotterdam

It is without doubt the biggest fire engine in the world, with a length of 67m, weight of 330 tons, water storage of 150,000 litres and 8,000 litres foam concentrate. This remarkable firefighting machine has been operational since 1 April 2021 in Rotterdam harbour. And it is rail-based! A unique approach to fire safety on one of the biggest shunting yards in the Rotterdam industrial area. Meet the Rotterdam 'firefighting train', which has no international precedents.



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Dick van Roosmalen (Kappetijn Safety Specialists) and Jochem van de Graaff (H2K) are industrial safety consultants. Both were involved from the start of the project in the development, build, test and training for the fire train. Dick fulfilled the role of supervisor on behalf of ProRail; Jochem fulfilled the role of chief testing for ProRail.

Main port Rotterdam has a typical hands-on mindset: if you can imagine it, it can be done! Proof of that problem-solving pragmatism is the engineering and construction of a unique firefighting train from draft to working concept within a three-month timeframe. The urgency behind the project was caused by the fact that all handling of toxic and flammable hazardous materials was shut down last year, pending optimisation of firefighting capacities on the Waalhaven Zuid shunting yard.

Fire risk and company fire-service designation

Although usually railroad infrastructures including shunting yards don't meet the requirements of the Seveso/COMAH regulations, safety risks for people and the environment can be of equal to those on

industrial sites. Given the large quantities of hazardous materials transported by rail from Rotterdam harbour, the local authorities (Rotterdam-Rijnmond Safety Region) designated all six shunting yards in the area for the obligation to establish a company fire brigade. This designation, based upon paragraph 31 in the Dutch Safety Regions Act, took place in 2003/2004.

Quick response by a dedicated industrial fire team should minimise the impact of chemical spills, emissions of toxic clouds and pool/rail tanker fires. The six shunting yards in the harbour rail system are managed and operated by ProRail. The

▼ Automatic monitors, remote controlled, at both ends of the train.



emergency response in case of accidents and fires on the yards takes place under jurisdiction of ProRail Incident Response by the 'Gezamenlijke Brandweer', a public-private specialised industrial fire service in the Rotterdam harbour and industrial area.

However, the Waalhaven Zuid shunting yard south of Rotterdam ProRail had a safety challenge. Local geography and the scale of the yard, with some 30 rail tracks stretching over 1,500m by 150m, do not allow firefighting equipment to reach all parts of the yard properly from the emergency road along the northern border of the yard. In November 2020 ProRail contacted KSS for consultancy on this matter. In short, the request of the railroad operating company was to create a solution for a safe and effective emergency response covering the south side of the rail yard.

Firefighting capacity should be capable of quickly controlling and extinguishing a rail car – or pool fire – as well as cover chemical leakage with foam. Scenario analysis and calculations taught that the normative scenario of a 160m² pool fire requires the application of foam at a minimum rate of 1,120 l/min (based on the Dutch guideline of an application of 7 litres/m²/minute in ballast), for at least 15 minutes' extinguishing time. To provide the required throwing length a monitor with a capacity of 4,000 litres water/foam per minute was selected. In order to build a robust and resilient system the water and foam supply are doubled so the water supply is sufficient to extinguish for at least 30 minutes. These calculations resulted in the need of a guaranteed water supply of up to 150,000 litres, available on the site directly at the start of the operation. Also 5,000 litres of foam concentrate are required for the given scenario. Given the facts that water provision is usually a bottleneck in the railroad environment, and shunting yards are not easily accessible for fire engines, a smart firefighting concept was needed to meet the fire-safety requirements for the yard.

The solution: XXL fire engine on rails

KSS joined with partner H2K to develop a concept for ProRail that could solve the fire-safety issue on the yard. Various options for fixed, semi-fixed and mobile firefighting systems were explored. After analysing the normative scenarios, geographical situation and characteristics of the site,

For design and use of the train, the following 5 issues were set as starting points:

1. **No new SOPs:** Alarm, response and use of the train during an incident must be executed 100% within Standard Operating Procedures for incident management, set by the safety authorities Rotterdam-Rijnmond and Unified Industrial Fire Service (Gezamenlijke Brandweer);
2. **No extra education:** Use of the train during an incident must fall 100% within regular education and training programmes of both train operator and firefighters and commanding team leaders and fire officers;
3. **Improving labour safety:** Maximum labour-safety conditions for both train operators and firefighters by using remote controls for both driving the train as well as starting the pump, mixing water/foam and using monitors;
4. **Modular and proven techniques:** Only proven techniques and modular use of rail units/carriages as well as fifi-appliances, no special certifications for (combination of) separate units;
5. **20 minutes response time:** 24/7 operational readiness on the site, with a target of max 20 minutes between first alarm and water-on-fire at the scene.

a solution equally simple as smart unfolded for the consultants: why not use the infrastructure and mobility options that are already there? Road vehicles have difficult access to most of the shunting yard, but the rail infrastructure could very well be used to bring a rail-based firefighting vehicle to the incident location. The same advantage of a rail environment could be used to solve the issue of the required 150,000 litres water supply. What modality could better be used to transport large amounts of fluids than rail tanker cars? If they can transport flammable liquids, they can also be filled with water! This approach inspired the consultancy team to develop the idea of a 'firefighting train'. A mobile firefighting concept, consisting of a traction vehicle, pump- and foam-unit, rail tanker units and two monitors.

KSS and H2K engaged firefighting equipment manufacturer Kenbri Fire Fighting in the project and together the partners started the engineering phase of a unique project. A study for international examples of similar solutions resulted in several mobile fire and emergency trains. In Switzerland and Austria, for example, rail-based mobile firefighting utilities are in use for incident response in railway tunnels. In other countries, such as Russia, fire train concepts are used to reach wildfires in distant areas and protect rail infrastructure. None of the examples found, however, were dedicated to operate in incident

▼ Instruction on layout of the shunting yard and primary use of the fire train.



situations of industrial dimensions, such as (petro)chemical pool fires and emissions. The project team of ProRail, KSS, H2K and Kenbri boldly went where no fire experts had gone before. After six drafts for a possible firefighting train concept, the seventh concept got a 'go' from the project team and ProRail management.

Constructing the XXL rail fire engine

The remarkable Rotterdam firefighting train project required intensive cooperation between the parties involved in realisation. Various companies had to blend into one well-oiled machine in order to bring all elements of the rail fire engine together and finish the project in time. The main goal was to have the fire train constructed, tested and operationalised with a trained crew by 1 April 2021.

Construction works took place at two locations. On 12 February 2021 at the Kenbri manufacturing site in Numansdorp a team started building the 'heart' on the fire train.

Five large industrial scenarios taking place at shunting yards:

1. Maschen, 1988 Germany. Spill of Sodium cyanide
2. Osnabruck, 2002 Germany. Derailment and fire with Acrylonitrile
3. Woippy, 2010 France. Implosion of tank trailer with Butadiene
4. Kijfhoek, 2011 Netherlands. Tank trailer on fire with Ethanol
5. Bailey Yard, 2012 Nebraska, US. Tankfire on diesel fuel station at the yard

A 40ft container-unit containing the motor, pump, FireDos proportioner, 8,000-litre foam concentrate tank (providing a very broad safety margin from the required 5,000 litres) and control technology. Because of the tight schedule the construction team of Kenbri, extended with subcontractors, worked 24/7 on the project.

Meanwhile the assembly of the train-combination started in the maintenance workshop of Shunter Traction in Rotterdam. The contribution of this company proved to be a key asset in the project. The Shunter maintenance site is located right on the border to the south of the Waalhaven

Zuid shunting yard. Involvement of the Shunter company included construction of the train, supplying the locomotive and driver and a rail track for stationing the fire train in the operational phase as well as accommodation for the three crew members (one train driver and two firefighters).

For all partners, including Kenbri Fire Fighting, the realisation of the firefighting train concept was a once-in-a-lifetime project, although the components used for the firefighting part were familiar. The industrial branch of Kenbri delivers several fixed firefighting container concepts for application on industrial sites and offshore platforms annually. Never before, however, has such a container application been used in a mobile concept on rails. On 20 February 2021 the firefighting container was transported by truck to the Shunter construction site in Rotterdam, where the 67-long train combination materialised step by step, day after day. The locomotive was connected with three large flat rail cars on which, one by one, five tank containers and the firefighting container were mounted. The location of the locomotive in the middle is for distance in regard to heat contours. The tank containers, one of them containing 26,000 litres and four of them 31,000 litres of water, were connected with the firefighting unit by a 250mm pipeline system with flexible joints between the three rail cars and the locomotive. Hardly two months after the engineering phase a 'hell of a firefighting machine' materialised.



◀ Water system on wagons is connected with flexible hoses for track switches.

▼ FireDos proportioner fully automatic mixing foam and water.



Performance of the fire train

Compared to the dimensions of the Rotterdam fire train the operational performance seems to be quite 'modest'. The train is provided with two monitors, one on each end of the combination. Pump and monitor capacity are calculated on the use of just one monitor at a time, with a capacity of 4,000 litres water/foam per minute. This capacity should be sufficient to effectively control and extinguish the normative scenario of a 160m² pool fire. The



porous gravel bed forming the base for the rail tracks prevents pool fires from reaching a larger scale. The monitors are designed to throw water or a water-foam mix up to 80m distance at a pressure of 5.5 bar. With this performance each spot on the Waalhaven Zuid shunting yard is well within monitor reach for an effective fire attack via either the emergency road on the north side or the emergency rail track on the south side of the yard. Apart from the fixed monitors, mounted on platforms of the tanker units on either end, there are also connections for feeding hand lines or mobile ground monitors. To refill the water tanks during a firefighting operation or after action both sides of the train contain a rack with 300m of 4in water transport hose.

Location on the yard

This is how the fire train is planned to operate in practice. As mentioned before, the combination will be parked on an emergency track on the Shunter maintenance site south of the shunting yard, while a crew of three has its accommodation in the company's administration building. The train is standardly connected to electricity to keep all systems operational. In wintertime, water in the tanks is warmed slightly to prevent freezing.

The crew, one train driver and two trained firefighters, are stationed on the site 24/7, following a three-shift system. Every eight hours a new shift is deployed. On detection of a fire or spill in the shunting yard, the firefighting train crew is alerted together with a response unit of the ProRail company fire brigade (Gezamenlijke Brandweer Rotterdam). The company

▲ **Testing monitor:**
4.000 liters per minute,
throw 80 meters plus...

► **Fire train, remotely
controlled by train
operator.**



fire brigade is responsible for assessment of the situation and the operational incident management. The fire train is deployed under their command structure, while overall responsibility for incident preparedness on the rail infrastructure and shunting yards is dedicated to ProRail Incident Response.

Remote control for personal safety

Introduction of the firefighting train at the Waalhaven Zuid shunting yard is not only a solution to improve the firefighting capacities in the specific area; it also ensures safe firefighting operations in case of a pool or tanker car fire or chemical spill. Key to this safe operation is the fact that both the locomotive and the firefighting part of the train are completely remote controlled. ProRail and the project team took the risks into account for fire personnel being exposed to heat radiation and toxic fumes. One of the main principles in the procedures behind the fire train's operation is to prevent dangerous situations for train operators, fire crews and

other emergency personnel. Therefore the range of the monitors is defined at 80m. Still the train has to be manoeuvred towards the incident spot in order to bring it in the best position to reach the fire. Both the train driver and the train fire crew use a remote-control terminal to operate their specific part of the fire-train combination. The only requirement for effective monitor operation is that they have a clear line of sight from the firefighting train to the incident, in order to monitor the effect of the operation and adjust monitor angle and capacity if necessary, all from a safe distance. As a matter of fact, this remote-control function makes the firefighting train on Waalhaven Zuid an unmanned operated vehicle of respectable dimensions.

Briefly: it is the biggest fire robot in the world! An extraordinary firefighting machine in an extraordinary industrial transport environment.

► **For more information, go to**
www.kappetijn.eu or
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