

# ACCIDENT SCENARIOS FOR MARSHALLING YARDS IN THE NETHERLANDS: PRIVATE OR PUBLIC FIRE FIGHTING

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## Abstract

In the Netherlands, based on the Dutch company fire brigade decree certain companies can be compelled to have a private fire brigade [BZK, 1990]. The criteria for having a private fire brigade relate to the term 'an extraordinary danger'. The municipality assigns companies to this end reckoning for the hazardous materials that are processed and the possible response of the public fire brigade in that area.

ProRail is the organization in the Netherlands that manages the railway infrastructure. ProRail operates over more than 80 marshalling yards. Hazardous materials are processed at about 40 marshalling yards and therefore for about 40 marshalling yards a company fire brigade might be compulsory. In the Rotterdam harbor area, for several years, a (juridical) discussion has been going on between the Rotterdam municipality and ProRail concerning the marshalling yards in this area. In August 2007, this dispute was brought to the highest court for such affairs in the Netherlands, the Administrative Jurisdiction Division of the Council of State.

The design scenarios for marshalling yards in the Rotterdam harbor area are quite similar to the scenarios that might occur at highway A15 and the freight railway line in the same region. Both the highway and the railway line are in close proximity of the marshalling yards. In addition, there are no particular or deviating consequences related to the marshalling yards. Local public fire brigades are not able to handle the accident consequences for marshalling yards. This applies for as well highway A15 as the railway. The Council of State however concluded that not the design scenarios but the credible scenarios should be the basis for determining the need for a company fire brigade.

The Council of State relates the fire brigade capacity to the credible scenarios and not to the design scenarios. The result is that ProRail might be responsible for organizing and financing private fire brigades at about 40 marshalling yards.

Despite the fact that ProRail has lost this court case, the added value of the juridical process is amongst others that for the first time a case concerning the company fire brigade decree was presented to the highest court. The fact that the Council of State has interpreted the decree as described still seems very strange and not in line with the decree in which design scenarios are based upon credible scenarios.

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## **Introduction**

In the Netherlands, based on the Dutch company fire brigade decree certain companies can be compelled to have a private fire brigade. The criteria for having a private fire brigade relate to the term 'an extraordinary danger'. The municipality assigns companies to this end reckoning for the hazardous materials that are processed and the possible response of the public fire brigade in that area.

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To this end, ProRail requested TNO to perform a study regarding the accident scenarios on their marshalling yards in the Rotterdam area. This paper is based upon TNO [2007]. In this paper, we present the results of this study and outcome of the Administrative Jurisdiction Division of the Council of State. In section 2, the research approach is presented. Section three presents the accident scenario analysis and its results. In section 4, the juridical outcome is presented. Several points of discussion related to the outcome are addressed in section 5.

## **Research approach**

The most prominent research steps are based upon the requirements as described in the company fire brigade decree. Based on this decree a company can be compelled to organize private fire fighting activities in case:

its activities cause an 'an extraordinary danger' (article 13): this concept of extraordinary danger is related to the accidents that might occur on the company's site and to the extent public fire fighting is prepared to such scenarios.

Regarding the accident scenarios the decree uses the concept of credible accidents, being the scenarios (article 1):

- that are realistic and typical for the companies activities
- that may cause danger in the companies direct surroundings
- for which prevention and suppression activities decrease the consequences in a way escalation is prevented.

Subsequently, the same decree mentions the concept of design scenarios: those credible scenarios that should be leading for determining the quantity and quality of the private fire brigade.

The accident scenarios cause certain damage. In the decree the fire damage is calculated the heat intention based upon the 3kW/m effect distance. For toxic substances, the damage is based upon the Dutch alarm value (comparable to the acute exposure guidelines): the value above which a concentration may cause irreversible or life threatening health effects for a person that is exposed to this concentration for 1 hour [VROM, 2006].

In the end (article 3), the major is allowed to assign a company to organize its private fire fighting in case its credible accident scenario's cause damage in its direct surroundings which is significantly larger than accidents in the surrounding itself and for which the public fire fighting is prepared.

It is the duty of the municipality to clarify the need for a company fire brigade. The municipality of Rotterdam hardly executed this duty; hence ProRail itself provided the analysis.

To summarize, we have to develop credible accident scenarios, design scenarios, the damage in the surrounding of the marshalling yards and the capacity of the public fire brigade.

Regarding the credible scenarios, we make use of the specific reports that were already prepared by SAVE, a consultancy firm that made for each marshalling yard a scenario analysis requested by ProRail.

For these scenarios, we assessed the damage. For the dangers in the marshalling yards surroundings, we assessed the damage too.

For the necessary fire fighting capacity (both for the marshalling yard scenario's and for the scenario's in the immediate surroundings) we made use of the SAVE reports and several Dutch suppression guidelines. In the direct marshalling yards surroundings, highway 15 and the freight railway Betuweline run parallel to the marshalling yards, both accommodating substantial hazardous materials transport. The type of hazardous materials is similar to those processed on the marshalling yards.

### Accident scenario analysis

Table 1 presents the credible accident on each of the marshalling yards.

*Table 1: Credible accidents.*

Substance category		Credible accident scenario	Europoort	Waalhaven Zuid	IJsselmonde	Permis	Botlek	Maasvlakte (Oosten West)
Flammable (propane)	gas	Leakage→evaporation→ Ignition →torch→ heat radiation	Yes	Yes	Yes	Yes	Yes	Yes
Toxic (ammoniac)	gas	Leakage→dispersion	Yes	Yes	Yes	No	No	No
Flammable liquid		Leakage→ignition→ pool fire (100m <sup>2</sup> )→ Heat radiation	Yes	Yes	Yes	Yes	Yes	Yes
Toxic (acrylnitril)	liquid	Leakage→pool→ evaporation→ dispersion	Yes	Yes	Yes	Yes	Yes	Yes

In table 2, the credible accident scenarios are elaborated. For one of the marshalling yards Europoort [SAVE, 2005]. The type of effects (damage) and its development in time are specified. The most right column presents the effect distances. Rotterdam municipality and ProRail already agreed that the BLEVE scenario is not realistic, neither typical for marshalling yards, hence this scenario is not analyzed here.

Table 2: Credible accident scenarios marshalling yards.

Substance category	Credible accident scenario	Damage development	Effect distance
Flammable gas (propane)	Leakage→evaporation→ Ignition →torch→ heat radiation	Heat radiation immediate after release, possibility with 15-20 minutes	Torch: 3 meters
Toxic gas (ammoniac)	Leakage→dispersion	Intoxication, immediate after release	AGW: 2.000 meters
Flammable liquid	Leakage→ignition→ pool fire (100m <sup>2</sup> )→ Heat radiation	Heat radiation immediate after release,	3kW/m <sup>2</sup> :30 meters from pool edge
Toxic liquid (acrylnitril)	Leakage→pool→ Evaporation→ dispersion	Intoxication, immediate after release	AGW:160 meters

As to the scenarios, the necessary fire fighting capacity was determined. This assessment indicates that maximum capacity is caused by a pool fire [SAVE, 2005]. Both ProRail and Rotterdam municipality marked the pool fire as the design scenario for marshalling yards [VRR, 2005].

The same activities were conducted for highway 15 and freight railway Betuweline. Table 3 summarizes the effect distances of the three infrastructures per scenario.

Table 3: Scenario's compared<sup>2</sup>.

Scenario	marshalling yards	Betuweline	Highway15
Leakage→evaporation→ Ignition →torch→ heat radiation	torch: 3 meters	AGW: 25 meters	torch: 9 meters AGW: 30 meters
Leakage→dispersion	AGW: 2000 meters	AGW: 1.500 meters	AGW: 1.500 meters
Leakage→ignition→ pool fire (100m <sup>2</sup> )→ Heat radiation	3kW/m <sup>2</sup> : 35 meter	3kW/m <sup>2</sup> : 30 meters	3 kW/m <sup>2</sup> : 30 meters
Leakage→pool→ Evaporation→ dispersion	AGW: 160 meters	AGW: 130 meters	AGW: 130 meters

To conclude for the design scenario 'pool fire', the heat radiation distance only differs for about several meters. However, still the damage of the same scenario could be significantly different in case the location of the marshalling yards is different from the Betuweline and Highway 15. However, the three infrastructures run for the bigger part parallel. Using Google Earth (25 July 2007), we drew the fire and intoxication contours for the design scenario's.

<sup>2</sup> The difference in effect distances between marshalling yards, Betuweline and Highway are caused by specification of input parameters: leakage debit, meteorological conditions and software.

For marshalling yard Europoort, we visualized the situation (figure 1). This situation is representative for the remaining 5 marshalling yards. The manually drawn yellow line indicates the  $3\text{kW}/\text{m}^2$  heat radiation contour. In the lower left corner, highway 15 is located. The Betuweline runs in the middle of the marshalling yard, for some other marshalling yards, these tracks run immediate along the marshalling yard.

Figure 1: Marshalling yard Europoort's heat radiation contour.



We made similar pictures for the Betuweline and highway 15. Based upon these pictures, we assessed the buildings and infrastructures within the damage contours. Table 4 summarizes the results. In the most left column, the marshalling yard is depicted. In the top row, the scenarios for each of the involved infrastructures is depicted. In the cell's, the type of infrastructure that is within the  $3\text{kW}/\text{m}^2$  heat radiation is presented. As from this table, one can see that for example the Europoort marshalling yard, Highway 15 causes a heat radiation contour in which the railway, a parking area and some windmill's are endangered.

Table 4: Infrastructure and buildings within  $3\text{kW}/\text{m}^2$  contour.

Marshalling yard	Marshalling yard scenario	Betuweline scenario	Highway 15 scenario
Maasvlakte	none	None	None
Europoort	Betuweline Several industrial Halls	Highway 15	Railway track Parking area Some windmills
Botlek	Betuweline	Highway 15	None
Pernis	Betuweline Parking area	Highway 15 Marshalling yard	Betuweline
Waalhaven	Betuweline	Marshalling yard	None
IJsselmonde	Railway track Industrial halls Parking area	Railway track Marshalling yard	Not apparent

$3\text{kW}/\text{m}^2$  op 35 meter

The result of this assessment is that there are hardly any differences for the same design scenarios in the amount of damage between the three infrastructures. The same conclusion we drew for flammable gas. For the toxic gas and liquid scenarios effect distances varied (about 500 meters). However, a company fire brigade is aimed at suppressing effects on the shortest moment and on the site and not in its environment. Hence, we should focus on the design scenario: pool fire.

The pool fire suppression strategy is to cool the rail tanker and to extinguish the pool fire. Both SAVE [2005] and VRR [2005] specified the required fire fighting capacity being in the range of: 1 fire engine, 4-5 fire fighters, operational within 5-6 minutes and using about 2-2.4m<sup>3</sup> foam.

Fire brigade Rotterdam is able to realize these suppression requirement, except for the foam, within 10-15 minutes and they compelled ProRail to meet these requirements within 6 minutes. In order to see if meeting these requirement would prevent further escalation, we calculated the effect of the pool fire after 6, 10 and 12,5 minutes [TNO, 2007].

Table 5: Pool dimensions over time.

Time (minutes)	pool radius (m)	Pool surface (m <sup>2</sup> )	Pool contour (m)
6	4,8	73	31
10	5,9	110	38
12,5	6,3	125	40

When starting the suppression activity after 6 instead of 10 minutes, this would result in a smaller pool surface. For the total amount of foam, this would mean 216 liters less foam. For the pool contour, this would mean a slightly smaller area to cool, however, the neighbor railcars still need to be cooled. Hence, the amount of water is the same for 6 or 10 minutes.

To start 4 minutes earlier might be useful to prevent a BLEVE (boiling liquid expanding vapor explosion) or domino effects, however, such scenario's were considered worst case scenario's by both ProRail as Rotterdam, and therefore not realistic or typical (credible).

In industrial areas such as the Rotterdam Harbor, and its marshalling yards, Betuweline and Highway 15, the Dutch legislation requires public fire brigades to start suppression activities no longer than 10 minutes after being alarmed [BZK, 1992; BZK, 2005]. The Rotterdam fire brigade takes 10-15 minutes, however, in that case and at that moment, they do not have foam at the accident scene.

To summarize, we conclude:

The marshalling yard credible scenarios are comparable to those of the Betuweline and highway 15. The damage of the design scenario of the pool fire is the for these three infrastructures the same. Suppressing a pool fire within 6 minutes instead of 10 hardly makes any difference in terms of damage control.

### **Juridical outcome**

In the Rotterdam harbor area, for several years, a (juridical) discussion has been going on between the Rotterdam municipality and ProRail concerning the marshalling yards in this area. In August 2007, this dispute was brought to the highest court for such affairs in the Netherlands, the Administrative Jurisdiction Division of the Council of State. The Council of State concluded:

- Instead of design scenarios, the credible accident scenarios should be used for the analysis. This would imply scenarios that are far bigger than the pool fire, e.g. BLEVE, for which the public fire brigades omits the suppression capacity.

- On the marshalling yards, several credible accidents are possible, resulting in damage beyond the marshalling yard boundaries.
- Public fire brigades are not able to suppress these consequences because of the time constraint of 6 minutes and the necessary foam

Hence, the marshalling yards cause an extraordinary danger and the Rotterdam municipality is allowed to compel ProRail to have a private fire brigade at their marshalling yards.

## Discussion

There are some points of discussion in the case.

Firstly, the term 'extraordinary danger'. Nowhere in the decree, this term has been operationalized, hence subjectivity could be the case. This subjectivity appears when reading the annex to the decree in which a danger is considered to be extraordinary in case the major considers it to be extraordinary.

Secondly, the decree mentions the sequence of developing credible scenarios and then selecting the design scenarios. The Administrative Jurisdiction Division of the Council of State does not use this sequence, but is the opinion that one should use the credible scenarios for assessing the requirement of a company fire brigade. From a pure juridical perspective, this might be in accordance to the decree. However, in this perspective, the Council of State should than be consequent and apply the definitions in the decree in a pure way too. According to the decree, the damage should be compared instead of the risks (probability and damage). The Council's motivation was based on the risks, hence inconsequent. The Council of States motivation to make use of the credible scenarios instead design scenarios is even more surprising because the Rotterdam municipality and ProRail agreed on the pool fire to be used for the analysis (design scenario) and not on for example a BLEVE (credible scenario) [Rechtbank, 2007-2006].

Thirdly, shouldn't the Rotterdam fire brigade be prepared for fire fighting in industrial areas, such as in which the marshalling yards are located, namely in the world's biggest harbor. This would mean a turn out time of 10 minutes maximum, and specific suppression equipment such as foam. In Dutch history, it is assumed that local authorities are prepared to suppress the day-to-day accident consequences. Both the State of Council and the Rotterdam fire brigade did not address this issue in their resumes.

Fourthly, ProRail operates about 40 marshalling yards with hazardous materials. Most of these, there is no personnel on the site. To operate a private fire brigade, this would involve multi million Euros per year per marshalling yard. It seems an unreasonably amount of money for a possible risk, which might occur once in 10 million year per marshalling yards [CPR, 1999] and for which experts concluded, these are not realistic and typical. In addition, all kinds of safety measures have already been incorporated in hazardous materials transportation by rail according to the European regulations (RID, rail transportation of hazardous goods) and the Dutch Environmental law.

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## **Author biography**

Nils Rosmuller has a Ph.D in transport safety at Delft University of Technology. Since July 2007, he is working at the TNO being head of the department for Industrial and External Safety. His main fields of interests are transport safety, tunnel safety and disaster management.

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