Towards a new perspective on rail transport of hazardous materials and its risks

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Keywords: Rail transport; hazardous materials; urban planning; scientific perspectives on risk

Abstract: The transport of hazardous materials is an activity that has the attention of the Dutch authorities due to the serious consequences this could have for the health of citizens in the vicinity of the transport. Rail transport of hazardous materials is a complex problem for the Netherlands, as the transport runs through dense urban areas. Apparently, the risk policy does not solve problems as the norms are exceeded in numerous cases.
This paper is meant to explore not how or why these risks exceed the norms, but to see whether or not the risks themselves are really as risky as thought. By looking at three different sciences and how these sciences regard to risks, the author hopes to create an answer to this question and to briefly regard to what this possibly means for the future with regard to Dutch risk management.

1 Introduction

A shortage of land across the Netherlands, however, has led to the development of design and construction techniques that enables intensive use of the limited space. In the last decade, the space available adjacent to and above the transport infrastructure - particularly railway tracks - has been used at a growing rate in city centres. In addition, line infrastructure for transport of hazardous materials is mostly also in use for passenger transport and therefore often crosses densely populated urban areas. Dutch spatial planning policy, which aims to intensify the use of space (Ministerie van VROM, 2001), may however come into conflict with the intentions set out in the Fourth National Environmental Policy Plan, which states that additional (open) space is sometimes necessary to guarantee external safety (Raad voor Verkeer en Waterstaat & Vromraad, 2003).
In the Netherlands, regulations for land-use planning with regard to safety are explicitly risk-based. This implies that potential adverse physical effects of incident scenarios are considered along with their probability of occurrence and their possible impacts. One of the main reasons for implementing the risk policy is a shortage of space, as a result of which the optimal space according to the effect distance of a worst case scenario between a risk generating activity and urban development cannot be achieved. Basically, risk consists of three components: the scenario, the probability of this scenario and the consequence of the scenario (Kaplan & Garrick, 1981). Risk is described in the Dutch policy practice as the formula: the probability of an accident multiplied by its effect. This is therefore the most frequently used definition in Dutch risk analysis.
The calculated data can be ‘visualised’ in two different ways. The first one is called Individual Risk (IR). This is the probability that an unprotected person dies due to an accident with hazardous materials per year on a certain spot when this person resides here a full year. The individual risk depends on the geographical position and is displayed in the form of iso-contours on a geographical map. The individual risk is thus not characteristic for any person, but only for the location for which it is calculated. Thus, the individual risk contour maps give information on the risk of a location, regardless of whether people are present at that location or not (see Figure 1). The maximum allowed risk as laid down in Dutch law, is $1*10^{-6}$. This means that a risk which is lower than once every million years is found acceptable according to Dutch policy. The second risk indicator generally

applied in the Netherlands is Group Risk (GR). GR is defined as the probability per year that in an accident more than a certain number of people are killed. Group risk is usually represented as a graph in which the cumulative frequency of more than *n* fatalities is given as a function of *N*, the number of people killed. This graph is called the fN curve (see Figure 2).

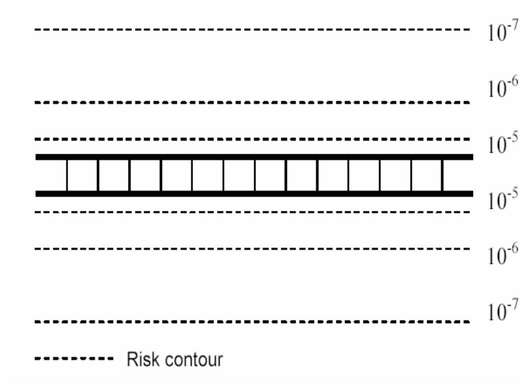

Figure 1: Schematic visualization of Individual Risk near a railroad.

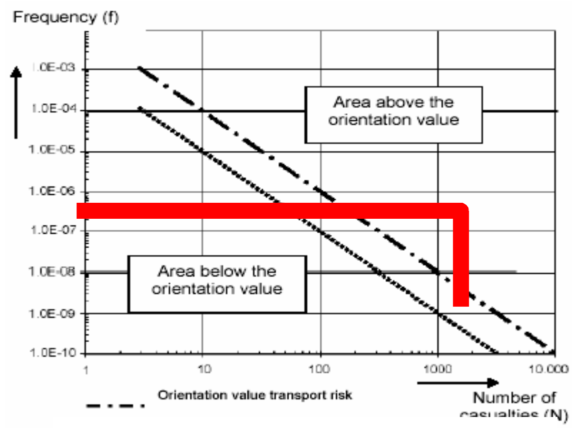

Figure 2: Schematic reproduction of an exceeding of the Group Risk criterion.

A calculated norm however, could provoke objections regarding the method of calculating risks. Several authors, such as Fischer (2003) and Healy (2001) object to these calculations since they consider it as a technocratic rational way of risk management and design of risk policy. In their opinion this way of managing risks is either a strategy designed to supply a technical rational basis for a centralized regulatory decision making (Fischer, 2003) or a scientific weakness to provide an instrumental, calculative and purposive rationality (Healy, 2001). However, from a command and control perspective, Dutch policy standards which relate to environmental issues are a common good. De Roo (2003) points out that the Dutch government has set out strict quantitative standards for human activities in favor of protecting the environment for more than thirty years. When the policy is made, norms effect regional and local authorities by means of generic norms which sets limits for other types of policy relating to the living environment. These norms include such environmental areas as to prevent air pollution, noise or to control soil pollution.

In order to reduce the risks concerning the transport of hazardous materials by rail within the boundaries of the risk criteria, technical measures are generally taken. For example, if the risk exceeds the norm on a certain location, measures taken are for example the decreasing the maximum speed, removing track-changes from a certain part of the railway track or preventing the dispersion of hazardous substances (Wiersma *et al*., 2004). These technical measures then reduce the risk of transport with respect to urban planning, due to the fact that either the probability variable or the effect variable (or, of course, both) are lowered. In practice, however, still problems occur with this more technical approach as the norms that are set for this so-called External Safety Policy are exceeded in several cases (see for example Raad voor Verkeer en Waterstaat & Vromraad, 2003; AVIV & Royal Haskoning, 2005).

The aim of this paper is to shed a light on risks through different perspectives and view whether or not these criteria are applicable to rail transport of hazardous materials. There are several sciences that try to explain risks from their own scientific view. In this paper three of scientific perspectives will be regarded, by explaining how these sciences generally distinguish risks. For a simple overview I have labeled these sciences as a *sociological* perspective, a *technological* perspective and a *psychological* perspective. Of course these labels are debatable, as they refer to a set of scientific publications which can overlap. Perrow’s work (see section three), for example, is also seen as sociological research (Taylor-Gooby & Zinn, 2006), whereas I prefer to label it as a more technological perspective. However, the aim of these three categories is obvious, to point out that there are several sciences that study risk from a certain perspective. Also, since this paper is limited to eight pages, the discussion has to be limited to three sciences, which are chosen with the idea that these also represent three dominant debates in scientific literature. In the following sections I will discuss these perspectives by pointing out what characteristics of risk they distinguish and relate them to the transport of hazardous materials by rail to see whether they are applicable to these risks.

2 A sociological perspective

The distinctive contribution from this perspective is that it emphasises the role of shared ideas and normative frameworks, understood in terms of the contribution of cultural and social factors, to the understanding and prioritizing of risks and responses to them among all those involved (Taylor-Gooby & Zinn, 2006). In a sheer

sociological view, risks are often associated with questions of positivist or constructionist nature (Renn, 1992, Taylor-Gooby & Zinn, 2006). However it is also often associated with a shift in modernity or new forms of modernization (see for example Giddens, 1990; Beck, 1992). The most well-known expression is of course Beck's 'Risk society' which is a stage of high or radicalised modernity.
Giddens (1999) notes there are two groups of risks. The first group is the group of *external risks*. These risks are caused by events that may strike individuals unexpectedly (from the outside, as it were) but that happen regularly and often enough in a whole population of people to be broadly predictable, and therefore insurable. Because of this 'well' calculable nature, sickness, disablement and/ or unemployment have been proven to be insurable. On the other hand he distinguishes *manufactured risks*, which is a type of risk which is created by the progression of human development, especially by the progression of science. Manufactured risk refers to new risk environments for which history provides us with very little previous experience. One often does not know what the risks are, let alone how to calculate them accurately in terms of probability tables.
In addition, Giddens shows that this transition from external to manufactured risk is bringing about a crisis of responsibility, because the relations between risk, responsibility and decisions alter. This has six consequences:

1. There is an emergence of '*organised irresponsibility*'. There is a diversity of humanly created risks for which people and organizations are certainly 'responsible' in a sense that they are its authors but where no one is held specifically accountable. This raises certain questions, such as: If there are damages to be paid, or reparations to be made, who is to decide about compensation? Who is to determine how harmful products are or what level of risk is acceptable? Coping with these types of situations of organized irresponsibility is likely to become more and more important in the fields of law, insurance and politics, but this will not be easy to do precisely due to the rather imponderable character of most circumstances of manufactured risk.
2. The most effective way to cope with the rise of manufactured risk is to limit responsibility by adopting the precautionary principle. Yet, the precautionary principle is not always helpful or even applicable as a means of coping with the problems of responsibility.
3. Situations of manufactured risk shift the relation between collective and individual responsibility in many situations. Although in many circumstances individuals cannot be held responsible, this is not the same as non-liability in conditions of organized irresponsibility. In the latter case, this could result from viewing responsibilities in terms of external or passive risk. An example is the way we look at future generations and what we think is a responsible level of protection from burdens from this generation. When most risk was external, such responsibility was relatively limited, because nature was largely intact. Our responsibilities to future generations now are thoroughly infused with decisions we have to take, resulting from our transformation from nature.
4. As the welfare state is a form of collective risk management, however, the debate around the welfare state has concentrated to a considerable degree upon its role in limiting or reducing inequality. The welfare state was built upon the presumption of external or passive risk. Nowadays, welfare states must confront large areas of manufactured risk, shifting the relation between risk and responsibility.
5. Where a society has not got effective means of dealing with organized responsibility, the result is not always that no one is held liable. On the contrary, the price of manufactured uncertainty is probably closely associated with the emergence of the litigious society.
6. The fact that risk is often a positive or energizing phenomenon is relevant to most of the situations of risk and responsibility discussed above, not just to economic risk. Thus to create a more effective welfare state, it is important that in some situations people are psychologically and materially able to take risks albeit in a 'responsible' way. Therefore, the theme of responsibility has to be integrated with a concern for the negative sides of risk as well as the positive sides, even though these two are often discussed separate from one another (Giddens, 1999).

When reflecting on the points made by Giddens, one might say that to some extent there is an organized irresponsibility with regards to the transport of hazardous materials. In this case the question is who or what was around earlier: transport of hazardous materials or urban development? At first site, this question seems to be simpler to answer than it in fact is. Of course, the existence of urban areas is longer than that of transport of hazardous materials by rail. However, in the last number of decades a situation has come to exist in which transport has been condoned and also, due to the free transport of goods rule by the European Union, is one of Europe's key institutions. On the other hand, in case of a disaster it is clear who is accountable and liable for the costs. Besides this, the precautionary principle is not really applicable, because transport can relatively easy be stopped at any time and because the principle is meant for (ecological) risks with possible irreversible effects. The points made by Giddens on the welfare state are of no importance for this case. The same accounts for the point made on future generations. In the respect of transport of hazardous materials by rail, there is no responsibility to future generations concerning risk, because this is a reversible process, as one could stop the process in principle at any time.

In this sociological respect, transportation of hazardous materials by rail, even though it is hard to calculate risks, can be seen as external risks.
Beck qualifies risks in the risk society with the following three criteria:

> *"In contrast to early industrial risks, nuclear, chemical, ecological and genetic engineering risks can a) be limited in terms of neither time nor place, b) are not accountable according to the established rules of causality, blame and liability, and c) cannot be compensated or insured against"* (Beck, 1996, p.31).

The question is to what extend these criteria are accountable to rail transport. First of all, the risks are clearly limited in place as a disastrous incident has a limited effective area. Also, the time at which an accident occurs is limited. It is only once and the affected area only has to deal with it at one moment and not constantly as compared to an incident with nuclear materials. Secondly, when an accident happens, a liable party can be appointed. Finally, these incidents can be insured against by either normal insurance companies or, in case of enormous disasters, as was the case with for example the September eleven terrorist attacks, with reassurance companies.
From the preceding can be derived that the sociological perspective investigates risk in terms of a risk society, in which it is hard to indicate who is responsible as risks have evolved from external to manufactured risks. In this case however, transporting hazardous materials by rail is an external risk of which it can be known who is responsible for possible disasters, i.e. the one who causes a disaster. However, it could be harder to point out who is liable for existing risks in the present situation, as the present situation is a concurrence of circumstances from past developments in urban planning and rail transport. More important, however, is to realise that the criteria discussed by these authors do not correspond to the risks that exist with the transport of hazardous materials by rail.

3 A technological perspective

When talking about scientific publications on technology and risks, one cannot neglect the work of Perrow. Perrow's (1999) view on risks has a more technical and organizational nature. According to him high risk has more to do with technological systems than it has to do with chances and effects. In this respect, a high risk is not a multiplication of the probability of occurrence of a large accident with its physical or societal implications, but a *tightly coupled* system with *complex interactions*. According to Gephart (2004) Perrow clearly argues that certain technologies have inherent catastrophic potential. Perrow thus provides his own assessment of the risks of technologies based on coupling and on complexity.
To start with the latter, Perrow distinguishes complex and linear interactions. Linear interactions are best described as common interactions, the kind we intuitively try to construct because of their simplicity and comprehensibility (Perrow, 1999, p. 75). Linear interactions are those in expected and familiar production or maintenance sequence, and those that are quite visible even if unplanned (Perrow, 1999, p. 78). Linear systems not only have spatial segregation of separate phases of production, but within production sequences the links are few and sequential, allowing damaged components to be pulled out with minimal disturbance to the rest of the system (Perrow, 1999, p. 86). Complex interactions suggests that there are branching paths, feedback loops, jumps from one linear sequence to another because of proximity and certain other features we will explore shortly. The connections are not only adjacent, serial ones, but can multiply as other parts or units or subsystems are reached (Perrow, 1999, p. 75). Therefore, complex interactions are those of unfamiliar sequences, or unplanned and unexpected sequences, and either not visible or not immediately comprehensible (Perrow, 1999, p. 78). Linear systems can of course also have interactions that are not visible, but they occur within well-defined and segregated segments of the production or maintenance sequence. Controls (warning lights, dials or audible alarms) read the presence of these interactions and inform the operators and allow them to intervene. Complex systems, however, do not necessarily have well-defined and segregated segments. When a jiggling unit or flashing light draws the attention for a problem in a certain unit, this unit may well affect other units, which affect other units and so forth. When a component is removed or shut down in a complex system, this could therefore cause a chain of readjustments and reconfigurations, because parts and units are multiply linked (Perrow, 1999, p. 86).
Tight coupling is a mechanical term, which means that there is no slack or buffer between two items. There is a causal connection between the two items, so what happens in one, directly affects what happens in the other. Perrow gives four characteristics for these systems. First of all, tightly coupled systems have more time-dependent processes, which cannot wait or stand by until attended to. Secondly, the sequences in tightly coupled systems are more invariant. The sequence of production must follow a logical order of A first, than B, C, D and so forth. Thirdly, not only sequences are invariant, but also the overall design process allows only one way to reach the production goal. This means that materials or methods for production cannot be easily substituted by other materials or methods. Finally, tightly coupled systems have little slack. Quantities must therefore be precise, no waste of supplies or equipment may occur, as this can bring down the system or damage it.

The most important difference between tightly and loosely coupled systems is that tightly coupled systems must have buffers and redundancies designed in the system itself and be thought of in advance. In loosely coupled systems there is a better chance that expedient, spur-of-the-moment buffers and redundancies and substitutions can be found, even though they are not planned ahead of time (Perrow, 1999, p. 95). This does not mean that loosely coupled systems necessarily have sufficient designed-in safety devices. Typically, designers perceive they have a safety margin in the form of fortuitous safety devices and neglect to install even quite obvious ones.
Apparently, rail transport is a linear and fairly loose coupled system. First of all, there is of course some time dependency in the rail system, but interventions in the system can be made. Secondly, there is not a certain order that has to be followed. Other trains could be given priority to other trains. Thirdly, with respect to an analogy of the substitution of other materials, rail transport could follow other routes to get from point A to point B. Finally, quantities do not need to be precise for a possible damage to the rail system. This would implicate, according to Perrow, that this is not a high risk *technology*. This conclusion is of course not complete, as rail transport is an open system and rail transport could be influenced from outside factors, such as vandalism, accidents with other traffic, human error, weather and so forth. This still does not mean that rail transport is a high risk *activity*. Still, if there are safety measures to avoid collisions, derailing or leaking, rail transport is, in itself, not to be regarded as a high risk.
Van Poortvliet (1999) sees a difference between Perrow's view and the view of Morone and Woodhouse. According to him, Perrow is keen on risk inducement, whereas Morone and Woodhouse stress the need of catastrophe aversion. Morone and Woodhouse (1986) wonder why, if there are so many threats of technical failures and catastrophes, there have not been any in the USA up to then. In this respect they are sceptical to the environmental threats of the 1960s and 1970s. However, to avert catastrophe by risky technologies they come up with five main strategies. The first of these strategies is protection against the potential hazard. This means that if errors are inevitable, protection against the worst consequences should be guaranteed. This can be done by either, containing the effects; by prohibiting the action or technology that poses the potential threat; impose a selective ban on the risky technology; take steps to prevent the errors from resulting in hazardous outcomes; or take steps to acceptably mitigate the impact. The second strategy is to proceed cautiously. When the potential of the hazard is unknown, err on the side of caution. Thirdly one should test the risks, which means that under controlled circumstances the hazard should be simulated to see what the effects are in controlled circumstances. Fourthly, one should learn from experience. This is an alternative strategy for testing the risks and seems to be quite reactive instead of proactive. However, less serious events can also issue moments of learning for serious mishaps. Finally priorities should be set when risks are numerous and it is impossible to evaluate them all.
When looking at these five strategies for effective dealing with risky technologies, it becomes clear that they are not completely applicable to the transport risks that are concerned in this paper. The first and the fourth strategy are still useful. Especially the five possible steps to protect against the potential hazard could be of use in the Dutch practice.
It has become clear that risks concerning transport of hazardous materials by rail are quite low, because it is a linear and fairly loose coupled system. The strategies used by Morone and Woodhouse (1986) to avoid catastrophes could be of use to lower risks even more as they are practical clues for dealing with risks.

4 A psychological perspective

There are two main streams in the psychological approaches to risk. The first approach is the cognitive or learning approach. Its central idea is that humans are more or less rational choosers, within the constraints of their capacity for reasoning and learning, the experiences to which they have access, and the context in which they live. The other approach is the psychometric approach. This particular research method emphasizes the importance of risk perception and behaviour. It makes use of questionnaire survey and experiments to stress the importance of affect and emotion on the (public) understanding of risk (see for example Taylor-Gooby & Zinn, 2006; Siegrist & Cvetkovich, 2000; Jasanoff, 1998; Slovic, 1993 or Slovic, 1992). A number of authors emphasize the importance of risk as a social construct instead of just a number to be calculated (see for example Renn, 1998; Slovic 1993). Also, several authors stress the need to take into account layman's knowledge and ideas on risk as the perception of risk, in terms of risk as a social construct, could be of importance to the outcome of risk management.
Perception, according to Slovic (1992) for example, is of utmost importance, as:

> *'(…) risk is inherently subjective. Risk does not exist "out there", independent of our minds and cultures, waiting to be measured. (…) There is no such thing as "real risk" or "objective risk". (…) Non scientists* (i.e. laymen, the public, other actors, et cetera, VvdV) *have their own models, assumptions, and subjective assessment techniques (intuitive risk assessments), which are sometimes very different from the scientist's methods'* (Slovic, 1992, p.120).

Early studies of risk perception demonstrated that the public's concerns could not simply be blamed on ignorance or irrationality. Research showed that many of the public's reactions to risk could be attributed to sensitivity to technical, social, and psychological qualities of hazards that were not well-modeled in technical risk assessments (Slovic, 1993). More recent literature also emphasizes the role of trust.
In the field of risk assessment, winning trust from the public is a tough battle, as distrust is more easy for the public to create. There are four reasons for this (Slovic, 1993, pp. 677-679). First of all, negative events are more visible or noticeable than positive events. Negative events often take the form of specific and well-defined events, while positive events are more often fuzzy or indistinct. Secondly, there is a psychological tendency for negative events to carry much greater weight than positive events. Furthermore, sources of bad, (i.e. 'trust destroying'), news, tend to be more credible than sources of good news. Fourthly, distrust, once initiated, tends to reinforce and perpetuate distrust. This occurs in two ways. First, distrust tends to inhibit the kinds of personal contacts and experiences that are necessary to overcome distrust. Second, initial trust or distrust colours our interpretation of events, thus reinforcing our prior beliefs. Siegrist & Cvetkovich (2000) believe that it is difficult for the public to rely on experts as experts themselves often differ in opinions. Moreover, they say:

> *'It can be assumed that lacking the knowledge, most people do not directly asses the risks and benefits associated with a technology'* (Siegrist & Cvetkovich, 2000, p.714).

This leads to a situation in which laypeople take other aspects into account, such as equity, catastrophic potential and controllability. It is therefore not a matter of legitimacy or rationality, but how to integrate these views into risk analyses and policy decisions (Slovic, 1992, p. 150).
However, rail transport of hazardous materials is already being conducted for decades (except for the area adjacent to the Betuwe Railroad). Therefore, it is not a new situation which is created, where people suddenly have to deal with transport of hazardous materials. This could explain the little attention that is paid to this transport by the public. The only debatable transport was the transport of chloride gas (Socialistische Partij, 2002). However, these transports are bought off by the Dutch Ministry of Housing, Spatial Planning and the Environment, also known as the 'Akzo chloride deal'. This deal was made with chloride producer Akzo Nobel and in fact is a covenant between Akzo and the Dutch State, in which Akzo agreed to move to another place in the Netherlands for their chloride production. Therefore, only incidental chloride transports by rail will take place in the Netherlands. Due to this success the Socialist Party now also attempts to get rid of the rail transport of ammonia (Socialistische Partij, 2006).
Of course, railways and transport by rail are no new frightening technologies which could imply strange or fear-provoking negative effects, such as nuclear power, new diseases like the bird flue, or genetically engineering of crops. Due to these reasons, transport of hazardous materials by rail is not as controversial as other 'risky' projects. This could change in case of a serious disaster, which was for example also the case with the fireworks disaster in Enschede in 2000, which triggered a lot of concern for firework depots in living areas. Still, due to the fact that there is hardly any true concern in media or ventilated by the public, the transport apparently has the trust. Besides this, transport of hazardous materials is not a *new* activity. Therefore, trust, perception or (a lack of) knowledge concerning risks need not to be integrated in cases where transport of hazardous materials already are being transported. This contrasts somewhat with views expressed by such authors as Jasanoff (1993;1998) or Bohnenblust & Slovic (1998). However, if a situation should arise where transport of hazardous materials is a new activity, for example if a new railroad is designed and built in an urban area, then trust and perception of the public should be integrated in decision making.

5 Towards a new conceptualisation of risks with regard to rail transport of hazardous materials

The preceding leads to a number of questions. If rail transport of hazardous materials does not need to be associated with the sociological or technological risks as stated and if trust and perception of the public is not necessary to be integrated, how should one then cope with risks in present situations in which norms are exceeded? Is there a concept that could serve as an answer of framework for the apparent conceptual void? To fill in this void, a number of thoughts should be given attention.
First of all, an answer should be formulated to the question of how to regard to these risks. Hajer (2005) in this respect talks about *old* and *new risks*. According to him, old risks are risks that are experienced voluntary and it is clear who causes those risks, because of which financial compensation is possible. New risks, however, confront the outside world with involuntary risks. They are not experienced directly, it is not clear who creates them and compensation is therefore difficult. In this view, a disaster as it happened in the city of Enschede in 2000, where a fireworks depot caught fire and exploded, resulting in 23 casualties is an old or 'traditional' risk.
However, this is, in my opinion, not completely analogues with the term traditional. Traditional here is a synonym for conventional or classical risk. This leaves out the fact that these risks are indiscriminate and, in

principle, can occur anywhere and anytime. For this reason, these risks are as normal as any day risks, such as home fires or car accidents. Therefore, these 'Normal risks' are not to be treated in such rigor and precaution as, for example, genetic engineering. This means if we can treat the risks associated with the transport of hazardous materials by rail as normal risks, a general norm might be inappropriate to judge these risks.
Secondly, as is pointed out by Fischhoff et al. (1981) risk problems are decision problems that require a choice among alternatives. Therefore, what is an acceptable or tolerable risk depends on the decision maker and how he or she deals with uncertainties and what is deemed acceptable. Furthermore, they say that there are no universally acceptable options, risks, costs or benefits as they depend on the set of options, consequences, values and facts examined in the decision-making process (Fischhoff et al., 1981, p. 3). This means that there is no single criterion or solution which makes that a solution can be found.
Combining the two previous notions leads to a *final* thought. Instead of calculating risks and see whether or not the outcomes are in accordance with the norms an attempt should be made for a project specific approach (see for example: Bowles, 2007). If, for example, in a present situation the norms are already highly exceeded, it is only possible by means of extremely high investments that the norms are met. A project specific approach has the advantage that a more cost-effective approach could be implemented such as the ALARP (as low as reasonably practical) approach (see for example Bowles 2003; 2007). In the Netherlands, there already is a political desire to use the ALARP approach as a desired phenomenon to be used in practice (Ministerie van Verkeer en Waterstaat, 2005). Ale (2005), however points out that ALARP is more of a token statement and that Dutch courts state that should the government want more safety it should put stricter levels in the law.
Perrow (1999) somewhat cynically points out that it is irrational from a calculative and a cost-effectiveness point of view to invest in the safety measures of e.g. nuclear safety, because it is much more expensive to save one life by making nuclear power more safe than it is to make automobile driving safer. Besides, Perrow ads, normal accidents will always be possible, due to a possible failure of organizational controls. In a less radical way, this is supported by research done by the Dutch National Institute of Public Health and the Environment (RIVM). In the report 'Nuchter omgaan met risico's' ('Coping rationally with risks', 2003) a plea for a cost benefit analysis is made to come to a 'well invested risk euro'. In the case of Perrow this would mean that one should look to all aspects of a society to see which aspect is the cheapest in saving lives (in other words, which one has the best cost-benefit ratio). In the words of the RIVM this is more focused on individual risk cases which are in need for ameliorations to come to lower risk levels and where it can be useful to see which options are more cost effective.
Still, this does not mean that no effort should be made to improve the present Dutch external safety policy. An attempt should therefore be made to implement the earlier mentioned notions in Dutch practice. The author hopes to make a contribution in the future to this debate.

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