



**Economic and Social
Council**

Distr.
GENERAL

TRANS/SC.2/1998/4
27 July 1998

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

Working Party on Rail Transport
(Fifty-second session, 5-7 October 1998,
agenda item 7)

PRACTICAL IMPLICATIONS OF THE RISK ASSESSMENT TECHNIQUE

Transmitted by the Government of the Netherlands

Note: During its fifty-first session, the Principal Working Party discussed various aspects of risk assessment in rail safety and asked the Governments of France, Germany, Greece, the Netherlands and the United Kingdom to provide for the present session a note on the experience gained with the risk assessment technique (TRANS/SC.2/188, para. 21).

The Working Party may wish to consider the reply received from the Government of the Netherlands, which is reproduced below.

Please note that the distribution of documentation for the Working Party on Rail Transport (SC.2) is no longer "restricted". Accordingly, the secretariat has adopted a new numbering system whereby all working documents other than Reports and Agendas will be numbered as follows: TRANS/SC.2/year/serial number. Reports, Agendas, resolutions and major publications will retain their previous numbering system (i.e. TRANS/SC.2/189).

Risk Management for the transport of hazardous substances, the Dutch approach

1. Introduction

The Netherlands is one of the most densely populated industrialized countries in the world. Consequently, space for living, working, and nature is at a premium. Choices will often have to be made in which a variety of purposes will have to be served. One of the questions that need answering is whether and to what extent the handling of hazardous materials might conflict with the safety in the direct vicinity.

Depending on the volume of the transport flows and the specific hazards these involve for the surrounding areas, a certain separation between transport routes and office and residential areas may be desirable. In determining criteria, the interests involved must be weighed up: the transport industry as an economic factor, safety and the necessity to sometimes plan social (often even vulnerable) functions near transport routes. Irrespective of the transport flow or the location, the result of such considerations must guarantee a certain level of safety, but it must also be feasible and affordable.

The risks are charted using a figure-based approach (the risk analysis) and, if necessary, checked against the appropriate risk criteria. On the basis of the results of that check, any additional measures are taken into consideration. This approach is called the A "risk approach". The risk approach is desirable for assessing the handling (production, storage, transport and use) of hazardous materials. Such an approach ensures that the well-considered development of the industry using these materials as well as of planned developments remains possible even in the future.

This paper is focused on transport activities (road and railroad: freetrack and railroad yards).

2. The risk approach in general

The risk approach regarding activities involving hazardous materials is explicitly concerned with the probability of fatalities occurring in vulnerable functions, such as residential areas, shopping centres, recreational areas and offices, as a result of these materials being released into the environment. It is characteristic for such an accident that there is a relatively slight chance of it occurring. However, huge consequences may be possible while users of the vulnerable functions have no influence over this. The aim of the risk policy is to arrive at a well-considered positioning of vulnerable functions on the one hand, and of activities involving the possibility of accidents that will affect the surrounding area on the other. For this purpose, the risks as calculated are checked against criteria and in the event a relatively high risk is found, measures are taken into consideration.

2.1 The risk approach in practice

For an objective assessment of risks, a figure-based approach is used that combines the probability of serious accidents and their effects. In the risk analysis, the concepts, individual risk (IR) and societal risk (SR) are used.

2.1.1 Individual risk

Individual risk (IR) represents the probability of a fatal situation occurring at a particular location with regard to the activity in question. As the distance to the activity in question increases, the risk of (fatal) injury decreases. On certain distances of the transport route for which a risk assessment has been made, identical so-called individual risk contours can be drawn on a map (like contour lines giving height on a topographical map). This makes the IR suitable for determining a safe zone between a route and vulnerable functions such as residential areas. A certain IR value is used as a threshold limit.

2.1.2 Societal risk

Societal risk (SR) gives an indication of the probability of a calamity with a certain number of fatalities occurring. The number of persons present in the vicinity of a route is therefore material in determining the value of the SR. Accordingly, the SR indicates locations of importance with regard to possible "disaster situations". The aim of checking the (calculated) SR against the provisional SR value (target value) is to reduce the probability and extent of a serious accident. The SR can also be used to compare (route) alternatives by calculating the overall societal risk of each (route) alternative and comparing the results of each. The SR is also a measure on the basis of which priorities for fighting disasters can be determined at a local level.

Societal risk is calculated per industrial activity (a plant, a storage with all the handling involved, a railroad yard etc.). In the case of transport activities (free railroad track, highways etc), it was important to define "location". The societal risk depends on the length of the route. It was decided to use the societal risk criterium (target value) for 1 km routes. This 1 km approach fits well in the possible effect distances of accidents and is a practical value for decision making.

2.1.3 Risk criteria

It is not possible to reduce every risk to nil without grave social and economic consequences. The purpose of using risk criteria is to handle risks for a specific location in a consistent manner compared with the policy for all other locations in the country. The risk criteria (a certain level of risk, i.e. safety) are based on an overall (whole country) assessment of risks of a great number of representative locations. After that a political decision has been made with respect to the consequences of risk criteria levels: costs of measures and space (the area where vulnerable dwellings would be restricted). In this respect, the criterium is a chosen reference that is used to check whether a situation is involved for which risk-reducing measures must be taken into consideration, given the fact that it is a location with relatively high risk. The risks referred to in this case are the risks (probability of death) to persons present in the direct vicinity of transport routes for hazardous materials because of possible accidents.

2.2 Risk policy and the transport of hazardous materials

In spite of the measures in general use, hazardous materials may be released as a result of a serious traffic accident. In the event of such an accident occurring in the vicinity of e.g. a residential area, there is a

chance of fatalities occurring. This affects the so-called external safety, the safety of third parties in the direct vicinity of transport routes.

Therefore, the following aspects are important when assessing the safety of transport flows relative to their surroundings:

- The volume of the transport flow, which determines the probability of an accident that will affect the surrounding area;
- The type of hazardous materials involved, which determines the way in which the surrounding area will be affected;
- Road safety, which affects the probability of a large-scale accident occurring;
- The number of people living, working, recreating, etc., along the route, which determines the number of possible fatal victims.

The combination of the above-mentioned aspects determines the risk level for specific locations along transport routes. The risk policy as referred to is used to assess the risk per location and to take into consideration any location-specific measures. For each specific situation, the options (instruments) comprise measures at the source and - where necessary - effect measures (zoning).

Source measures include:

- the avoidance of vulnerable functions (routing);
- road safety measures, such as
 - speed limits;
 - traffic control;
 - rail conveyor systems;
 - separation of traffic flows;
 - safety measures at crossroads;
 - improved infrastructure.
- screening transport routes off from residential areas.

In addition, the insight gained into the risks makes it possible to prepare effectively in anticipation of the need to counteract in the event of an accident (disaster control).

2.3 Risk policy for stationary activities (railroad yards)

In spite of the measures in general use, hazardous materials may be released as a result of a serious accident by handling railroad tank cars on a shunting yard. In the event of such an accident occurring in the vicinity of e.g. a residential area, there is a chance of fatalities occurring. This affects the so-called external safety, the safety of third parties in the direct vicinity of such yards.

Therefore, the following aspects are important when assessing the safety of railroad yards relative to their surroundings:

- The volume of the transport flow, which determines the probability of an accident that will affect the surrounding area;
- The type of hazardous materials involved, which determines the way in which the surrounding area will be affected;
- The specific handling that takes place with trains or separate railroad tank cars: shunting, waiting given the schedule of handling, changing

locomotives etc., which affects the probability of a large-scale accident occurring;

- The location on the yard where handling of trains or of separate railroad tank cars takes place, which affected the consequences of a possible accident.

- The number of people living, working, recreating, etc., along the route, which determines the number of possible fatal victims.

The combination of the above-mentioned aspects determines the risk level for the neighbourhood of railroad yards. The risk policy as referred to is used to assess the risk per yard and to take into consideration any location-specific measures. For each specific situation, the options (instruments) comprise measures at the source and - where necessary - effect measures (zoning).

Source measures include:

- safety measures, such as:
 - advanced and protected switches;
 - separation of handling;
 - safety measures at railroad tracks;
 - improved infrastructure;
 - hydrants on the location etc.
- screening railroad yards off from residential areas.

In addition, the insight gained into the risks makes it possible to prepare effectively in anticipation of the need to counteract in the event of an accident (disaster control).

2.4 Developing criteria

Based on the assumption that the risks involved in the transport of hazardous materials with regard to vulnerable functions are generally acceptable, the criteria have been related to the present risk level.

The choice of a risk level is then based on a calculation of the risk levels of a large number of locations. Naturally, such a stock-taking will show up locations with a relatively high risk level. The final choice of the criteria is determined on the one hand by the desire to provide a solution for such bottlenecks, and on the other hand by the desire, bearing in mind feasibility and affordability, to limit the number of possible future situations in which the criteria will not be met. The choice of criteria is therefore not a matter of principle, but rather a pragmatic one.

The primary purpose of setting criteria is to prevent possible high-risk situations when new developments take place. An effects study has been used as a basis to investigate whether such a set of instruments with risk criteria is and will remain feasible and affordable. Some results of the study done for transport activities are given in table 1.

Table 1 number of locations along at least 1 km of route

Mode of transport	locations investigated	exceeding IR (residential areas)	exceeding SR
ROAD	2505	0 - 5	10 - 20
RAIL	304	0 - 5	5 - 10
WATER	238	5 - 10	0 - 5
PIPELINE	39	0 - 5	0 - 5
TOTAL	3086	25 locations max.	40 locations max.

In general, the locations in the table in which the criteria are exceeded are for a length of a few kilometres at most. An exception is formed by transport by sea, which involves larger areas.

3. Risk criteria

On the basis of the study results and the talks with the authorities and the industry involved, agreement was reached about the introduction of criteria for individual risk and societal risk. The status (use and meaning) of the criteria is the same for stationary plants and transport activities alike. However, the criteria (specifically for societal risks) for transport activities cannot be compared as such with stationary activities, especially when taking into account the calculation method: in fact the mentioned 1 km route approach (para. 2.1.2) is a pragmatic one and has an influence on the risk criterium for societal risk, while the risks of a plant or shunting yard are calculated for such a stationary activity as a whole.

It is possible that relatively high IR will be calculated that comply with the provisional value for SR and vice versa. Therefore, relatively high risk levels for IR and SR need not go together, as IR is linked to the activity, whereas SR takes also into account the number of persons in the vicinity of the activity.

3.1 Individual risk

3.1.1 Criterium

With regard to the transport of hazardous materials and to stationary activities, in principle a limiting value for the IR applies of 10^6 per annum (i.e. vulnerable functions will be admissible only in locations where the probability of a fatality due to an accident involving hazardous materials is no more than one in a million per annum).

For new situations (a new route, a new shunting yard, a significant change in the transport flow, new vulnerable functions), the IR criterium applies as a limiting value.

The aim for existing situations with an IR exceeding 10^6 per annum is to reduce the IR to the set criterium along the perimeter of vulnerable functions. For situations like this, the stand-still principle applies to new

developments until the criterium is complied with. As many of these situations are historical in origin, it will not always be possible to comply with the criterium set for new situations. Opportunities for reducing risks could in such cases be presented by infrastructural alterations that were planned for quite different reasons. In other words: it is not the intention to carry out an isolated reorganization policy. For existing situations this IR criterium is a target value.

For existing situations, urgent reorganization will be required only when vulnerable functions lie within an area with an IR in excess of 10^6 per annum. (This IR criterium is a limiting value). No such situation has been found in the course of the study, but this does not preclude the possibility of one presenting itself.

3.1.2 Using the IR criterium

For new developments, an improvement of the situation can be anticipated. However, such an improvement must be foreseeable within a period of no more than five years. For special situations, the possibility is left open to deviate from the IR limit on the basis of an integrated weighing of interests. In situations like that an undesirable situation could be accepted in spite of the criterium being exceeded.

The conclusion that the criterium for individual risk be deviated from on the basis of this integrated weighing of interests is presented to the relevant ministries (transport/infrastructure and environmental affairs / physical planning) for approval. Consequently, the national authorities become co-responsible for situations in which an increased individual risk is accepted. The integrated weighing of interests deals with (a combination of) possible interests and facts relating to the risk such as:

- Transport interests, mostly of supralocal importance; in some cases international connections are involved;
- The possibly disproportionate costs resulting from compliance with the criterium; In this respect, it is also important whether other arguments exist to resolve a problem location through the use of source measures;
- Interests of local and regional significance (public planning);
- Any alternatives possibly involving a higher risk which would otherwise be involved;
- The degree to which the IR limit is exceeded in a particular area, taking into account the developments in transport;
- In situations in which a small change at the source has an extreme effect on the distance at which the limit for individual risk is complied with, and thus on space requirements.

Checking against the criterium is done on the basis of the IR calculated at the perimeter of vulnerable functions along a route. Vulnerable functions are defined in the same way for both stationary situations and transport routes. Vulnerable are: living areas, hospitals, schools, etc. Less vulnerable are: industrial activities, recreation areas, etc.

3.2 Societal risk

3.2.1 Criterium

The provisional SR value per km of route has been determined at 10^4 per annum (one in ten thousand per annum) for 10 fatalities; 10^6 per annum (one

in a million per annum) for 100 fatalities; etc.

The provisional SR value per stationary activity (railroad yard) has been determined at 10^{-5} per annum (one in hundred thousand per annum) for 10 fatalities; 10^{-7} per annum (one in a ten million per annum) for 100 fatalities; etc.

3.2.2 Using the provisional SR value

In assessing the SR, the local and regional authorities are given the opportunity to deviate from the provisional SR value with proper motivation. The primary function of the proposed figures is to facilitate weighing at local/regional level. Interests should be considered in a public and clear manner and, based on the assumption that the provisional SR value should be complied with, the reason for deviating from that value in a specific case must be given. The manner in which the SR is thus used implies that local and regional authorities are themselves responsible for situations in which a higher risk level is accepted. However, the decision to deviate from the provisional value is subject to appeal.

3.3 Possible effects

3.3.1 For transport routes

It is expected that overall, the risk criteria will (possibly) be exceeded in less than five per cent of the locations along transport routes. These are the locations to note for which additional measures and/or additional planning requirements will be needed. For most (95%) of these five per cent of locations, the use of the IR criterium means that, depending on the possible measures, a zone on either side of a route of less than 100 metres should be designated in which vulnerable functions cannot be realized, or only in a very limited fashion. For railroads and roads it is calculated that the maximum zone is 40 m and less than 100 m respectively. The societal risk is calculated for the entire relevant area. "Relevant" means where there is still a lethal effect in the neighbourhood of the (part of the) route being calculated. If necessary and possible, measures are taken at the source to reduce the risk at least to the provisional value. However, where planning prerequisites are involved, for practical reasons (feasibility and affordability) the area to be considered is maximized to 200 metres from the route.

Infrastructure for road and rail transport often includes a zone as a result of right in rem or noise reduction requirements. In such cases there may be other reasons than just external safety for limiting development along a route. However, external safety may well impose additional restrictions.

3.3.2 For railroad yards

It was concluded that in the Netherlands 25% of all railroad yards (ca 20) need a thorough assessment of risks due to IR and or SR. 10% (ca 10) of all the yards in the Netherlands needs additional measures (costs ca fl. 75 million). In 3 cases it will not be possible to met the SR criterium. The societal risk is calculated for the entire relevant area. "Relevant" means where there is still a lethal effect in the neighbourhood of the yard being calculated. If necessary and possible, measures are taken at the source to reduce the risk at least to the provisional value. However, where planning prerequisites are involved, for practical reasons (feasibility and

affordability) the area to be considered is maximized to 300 metres from a yard.

4. Calculation instruments

It is of principal importance to standardize risk assessment when using risk criteria. The Ministries of Transport/infrastructure and Environment/physical planning, together with the provincial authorities and the railroad company, developed a tool for the PC to calculate both societal and individual risk. This program is used for all kinds of purposes: to compare route alternatives, and to compare risks of a certain location with the risk criteria. Sometimes it is necessary to go into more detail because of deviations with a standard situation and/or in the case a discussion concerning the results of a risk assessment are very tough. In that case a more specific assessment is required: protocols for risk assessment and more sophisticated analysis methods are available.

The program is "free available": it was distributed to possible users, consultancies included. The program and manual will be translated in English.

5. Developments

The risk management approach as described is meant for external safety purposes only. It is an approach to manage the risks of people living or working near an industrial activity. The approach has proven to be an useful instrument for physical planning of both new industrial activities and new vulnerable dwellings. However, passengers in trains and people on the road are excluded from calculations and from this risk management process.

There is a difference in risk perception between so-called third parties (for which the external safety policy is meant) and people using traffic systems voluntary (the so called internal safety).

Until a year ago there was no particular reason to be concerned about the (low probability /high consequences) risks of these people. Although the number of people killed in "regular" traffic accidents are of great political importance. There are, however, reasons nowadays to develop a QRA based risk management system for internal safety. Apart from a better understanding of the total risk involved on certain locations, QRA based risk management seemed to be a necessity in the political discussions concerning "vertical building" i.e. infrastructure underground: roads or railroads with a roof above it or a road or railroad in a tunnel.

The advantages of "vertical building" are obvious: in a crowded country such as the Netherlands, space for new developments is important. Infrastructure, although a necessity, is a nuisance for living areas because of noise, air pollution and external safety. Local environmental problems which can be solved by building the infrastructure underground. An underground infrastructure means less distance between infrastructure and living areas, even the possibility of dwellings above the infrastructure. However, the mentioned advantages for the neighbourhood causes disadvantages within the infrastructure. A matter of concern is the possibility of a calamity because of a huge fire or because of an accident with dangerous goods (traffic jam, a lot of people involved, difficulties to help these people, no protection, difficult to evacuate). The problem mentioned is the trigger for studies for a societal risk criterium for people in tunnels and/or people on the road or railroad posed to the risks of dangerous goods; again for

locations with a relatively high risk. One of the ideas is to find out what the consequences of such a policy would be by using a societal risk criterium of a factor 10, less stringent (in probability) than the criterium used for routes for the management of external safety. The individual risk is because of its definition (a risk for a person staying under standard conditions on a specific location) being not useful and also not necessary.

6. Conclusions

The chosen policy of setting criteria as outlined above for risks of road and railroad activities is based on the idea of a consistent and rationalized risk approach. This approach is used for both stationary installations (rail road yards) and transport activities (roads and free track). The outlined policy will be converted as much as possible into easy to use tables in order that (additional) risk calculations may be dispensed with in most situations. The policy is already developed and accepted by Parliament for external safety purposes. Studies will be carried out to develop such an approach also for internal safety. A consultative body is necessary for obtaining and securing a uniform and as generally accepted as possible calculation method for the risks involved in the transport of hazardous materials.
