COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

SAFETY

Working Paper

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List of Abbreviations

ADNR	Accord Européen relatif au transport international des marchandises Dangereuses par voie de Navigation du Rhin
AIS	Automatic Identification System
ECS	Electronic Chart System
ECDIS	Electronic Chart Display and Information System
GR	Group Risk
GRP	Glass Reinforced Plastic
GPS	Global Positioning System
IR	Individual Risk
LR	Local Risk
NS	Nautical Safety
RIS	River Information Services
VTMIS	Vessel Traffic Management and Information Service
VTS	Vessel Traffic Services

1 Preface

1.1 Introduction

Risks[1] and safety levels related to inland navigation can be expressed in three different ways. The first one is dealing with the risk that people are exposed who live ashore and have no relation with the transport whatsoever. This risk is called **external risk** and can be divided in individual risk and group risk.
The second way is the **internal risk**. That is the risk related to people who are actually part of the transport via water, i.e. are on board of the ships and includes also the nautical safety
The **Nautical Safety** is dealing with the probability that accidents occur and focuses on economical damages (including damage to the environment).

Inland navigation is famous in Europe for it's remarkable safety record. Compared to other modes of transport, inland navigation takes the lead in safety, **see Lit 1**. To give an example it appears that comparing the number of casualties per ton kilometre with respect to the internal safety level, the inland navigation is 500 times safer than road transport. For the number of accidents this number amounts up to 165.

This document focuses on the external risks and external safety level of inland navigation as well as on Nautical Safety. Especially the external risk is of the utmost importance from policy point of view. The internal safety of the people aboard or the safety of waterway traffic is not elaborated in the present report.

Some countries where inland shipping plays an important transport role have set standards and safety margins for the acceptable external risk level as a consequence of inland navigation. In the Netherlands the standards for external risk are elaborated in the brochure to be referred to as RNVGS**, see lit II.** On basis of the methods described, calculations were made for all relevant fairways in the Netherlands. The results are depicted in the so-called Risk Atlas **(lit. III),** that charts the 'risk contours' for inland waterways. <u>The accidents did not have any impact on the public so far (see external risk in Chapter 2) and till today have never exceeded safety margins or standards.</u>

> *As a consequence inland navigation is – due to its excellent safety record – the pre-eminent transport modality of* ***hazardous goods.*** *At present, inland shipping is responsible for roughly 80% of all transported hazardous goods. One can only imagine how risk contours and external risks for populated areas would change if these goods were no longer transported by inland vessels due to safety issues, and would instead pass through cities by truck or rail.*

Because the phenomenon of risk is complex, a brochure was composed especially dedicated to assist the local authorities, **see Lit IV.**

Even though inland navigation has proven to be safe in the past and enjoys a perfect reputation with respect to safety, there are considerations which stress the need to keep

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[1] *Risk is defined as probability that an accident occurs times the consequences of the accident, i.e Risk = probability X consequences, see Chapter 2.*

monitoring (possible) incidents and to keep safety level as high as possible. These aspects are especially of importance when looking at the Nautical Safety as mentioned before.

- First of all, the **reliability** of waterborne transport is at stake. When incidents or unsafe situation hamper the free flow of traffic, the effects may be considerable. Even a short obstruction of a river may delay the timely delivery of thousands of tonnes of goods. Many industries rely on inland shipping for a constant supply of these goods. Of course, it should be kept in mind that transport planners will built some elasticity into the transport system.
- Next, **damage** to the cargo and the transport chain should be avoided as much as possible. The same holds of course for the direct and indirect economical damage to the ships involved in case of accidents.
- Also **damage to the environment** (not taken into account in the external risk considerations) should be limited as far as possible.

For these – and of course also for the determination of the external risk level - it is necessary to monitor incidents in a consistent manner and to develop and deploy models that can accurately describe and predict risks and safety levels. Predictions and monitoring results are valuable inputs for further safety measures – both source measures and effect measures – that are being developed at present with regard to (external) safety. Examples on the River Scheldt to reduce the probability of accidents are in this respect are worked out in **Lit V.** Consequent studies and ongoing risk and safety standardisation are certainly part of this safety improvement process. Of course, the human element plays an important role in many accidents. In this report this aspect is taken into account in an indirect manner: it forms always an inseparable part of the measures to be taken and is thus always present.

The following seven chapters describe the various aspects of safety in inland navigation:

- Chapter 2 focuses on transport risks, methods for risk calculation and monitoring[2] of incidents.
- Chapter 3 describes the inland vessel in it's nautical environment, especially in areas with high complexity like ports and waterway intersections. The various applicable safety measures and traffic guidance will be highlighted along with new developments in those particular fields.
- Next, the vessel, its safety aspects and on-board safety measures are discussed in chapter 4. Three specific safety issues will be highlighted:
    - Pro-active Safety measures aimed at minimising the effect of incidents, like spill prevention;
    - Measures aimed at minimising the occurrence of events, such as collision avoidance;
    - Measures aimed at damage control and management, once an incident has taken place.
- Chapter 5 focuses on the safety of transport of hazardous goods and the role current and future legislations play in this particular field.
- Possible effects (positive and negative) of new safety measures described in chapters 3 and 4 will be discussed in chapter 6.
- Chapter 7 describes the education and training that is required for maintaining safety and executing new safety measures.
- Finally, conclusions and recommendations are given in chapter 8.

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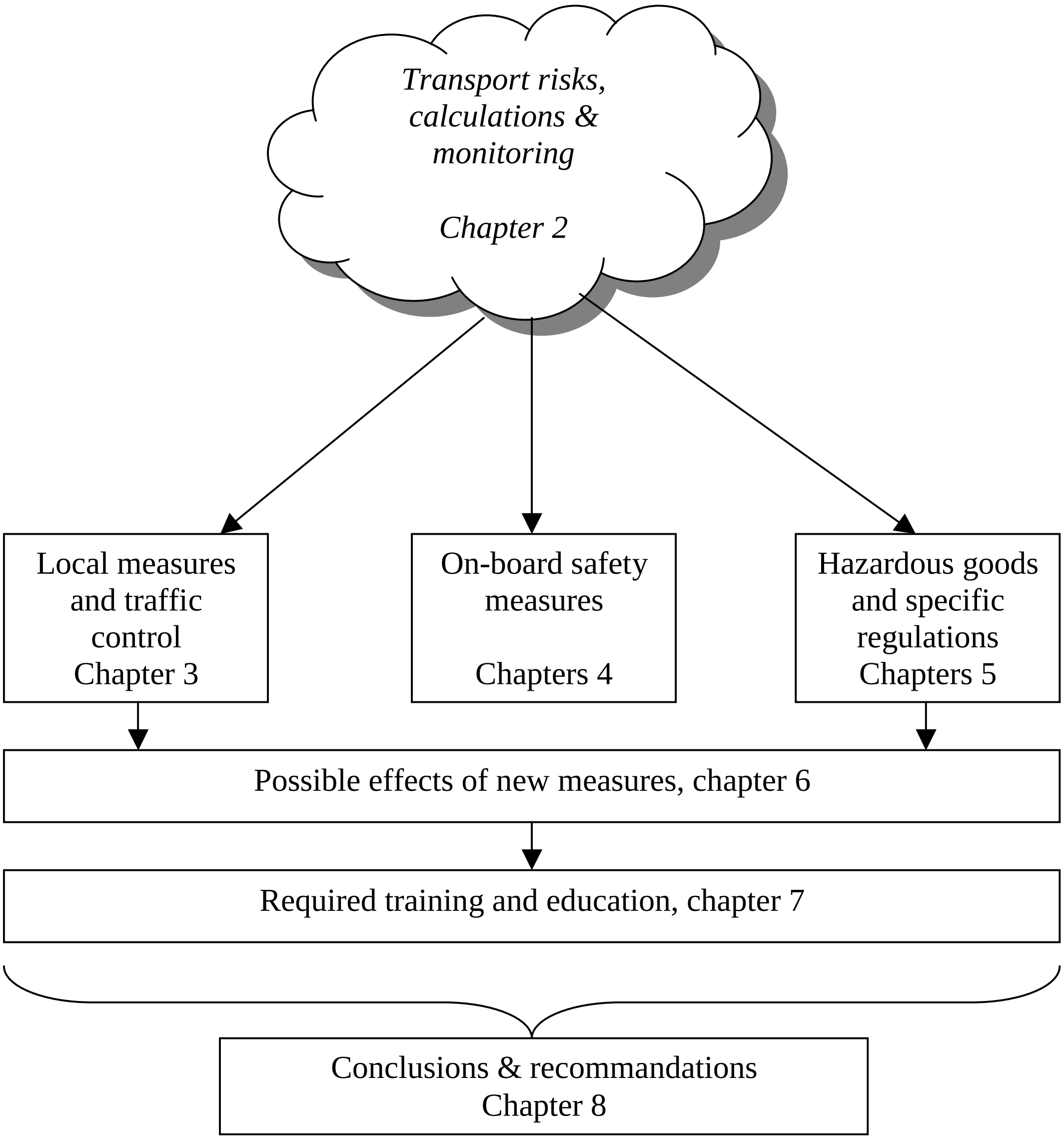
[2] Monitoring implicates the accurate description of accidents that took place in such a way that efficient statistical elaboration is possible.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1.2 Summary

The transport of hazardous goods by inland navigation is (both in terms of internal as external risk) significantly safer than transport by truck. Furthermore, the unused capacity of the inland waterway network allows a considerable growth of waterborne transport without causing an equal increase in incidents, congestion or environmental problems. To safeguard these benefits of waterborne transport, investments in the waterway infrastructure should be given the same priority as investments in the road and rail infrastructure. Furthermore, current developments that can significantly improve the safety and reliability of waterborne transport should be supported by governments in Western Europe.

Based on the results of this study, the following recommendations with respect to the development of policies are formulated.

Monitoring and calculation of external risk
Besides the important definitions of external and internal risk the term Nautical Safety should be defined,[3] *referring to economical damage, damage to cargo, damage to the transport chain, damage to the environment and suspension of traffic.*

It is essential that all EU member states with an inland navigation interest set up a uniform system and procedures for monitoring accidents. These systems should enable governments to take safety measures to improve nautical conditions, based on statistics and analysis of accidents. This implies, that the system should provide information about the cause of the accidents and the effects.

A uniform method for calculating the external risk is required for all EU member states[4] *with an inland navigation interest. This not only applies for the way statistical data is processed, but also for the calculation of the effects of collisions and other accidents. These calculations are especially important to qualify safety levels and to compare these safety levels with alternative modes of transport. These calculations are to be performed only on specific and relevant situations. Statements regarding general safety levels of the entire inland shipping sector based on these calculations are not desirable.*

Stimulating transport of dangerous goods via water
Transport of dangerous goods via water has to be increased because this is (by far) the safest way of transportation.

National implementation of RIS directive
It is advised that the National governments adapt as soon as possible the RIS directive once adopted by the EU Parliament and support the navigation by realizing the AIS network infrastructure and providing the navigation with adequate information on basis safe and efficient navigation will be enhanced. The required information is clearly described in the RIS directive.

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[3] *Proposals in this respect can be elaborated within the framework on Creating, WP 8 and subsequently proposed to the Commission.*
[4] *In the Netherlands for many years rules for the individual risk (compulsory to stick to the goals)) and group risk (obligation to invest effort to reach the goals exist). They could be discussed by experts to consider application EU wide.*

Obligatory instruments on the bridge coping with RIS

It is advised that proper measures are taken that it is at least stimulated (but preferably arranged obligatory) that ships longer than 20 m have to be equipped such that they can cope with all requirements emanating from RIS.

Adoption of ADN by all member states

ADN should be adopted by all member states *to enable safe transportation of hazardous goods and provide a level playing field throughout Europe.*
Moreover it is advised to incorporate the requirements emanating from Security as part of RIS.

Special attention to education and training

Much effort shall have to be invested in proper education and training as well as the development of the required tools to introduce and maintain the introduction of RIS (both ashore as on board). Besides various skill trainings also resource training is of importance. The use of simulators is stressed especially when looking at learning new professional attitudes and when the trainees have to get acquainted with new technical developments.

2 Risk analysis

2.1 Introduction

This paper focuses on the external risk that is generated by freight transport by inland navigation. As explained in Chapter 1, the expression ‘external risk’ is defined as the risk to people that are not involved in the activities that cause the risk, but are possibly affected by it. Safety policies for freight transport, among other considerations, concentrate on the risk posed by the transport of hazardous goods. The transport risk is generally expressed by the following equation:

Risk = Chance x Effect.

This equation learns that even a minute chance of an accident involving very toxic or very flammable cargo in a densely populated area still poses a bigger risk than a considerable change of an accident with less dangerous goods outside populated areas.

Apart from this rather mathematical approach to safety, policy makers tend to involve the perception of safety or danger of e.g. people living close to a waterway. This approach is however very ambiguous and subjective, because many people know that some goods are very dangerous, like chlorine gas or ammonia, but they hardly realise that the chance of an accident in which those chemicals may be released into the atmosphere is extremely low.
The perception approach therefore causes significant imbalances in policies, that may over exaggerate safety measures for some well known chemicals, while being off guard when other less known substances are involved.
In this paper only the mathematical (scientific) approach is used.

2.2 Methods for calculating risks

External risk falls into two categories: local (individual) risk and group risk. The local risk is defined as the annual chance that a unprotected person that continuously remains in close proximity of a waterway dies because of an incident involving the transport of goods.
The group risk is the chance per annum and per kilometre of the transport route that a group of ten or more people in the close proximity of this transport route become a victim as a result of an incident on this transport route. A more detailed description can be found in the Manual for External Safety regarding the Transport of Hazardous Goods (**Lit. II**)

There is a two-step approach to asses these risks:
1. First a quick-scan is performed to get an idea of the risk a certain cargo flow poses. The methods for performing such a quick scan are described in the so-called Purple Book **(Lit. VI).** These methods and procedures were drawn up during the development of the abovementioned Manual.
2. If the quick scan shows that safety standards i.e. risk level targets will probably be exceeded, then a more detailed analysis is required, involving the mapping of safety contours. These procedures are described in the Risk Calculation Methodology **(Lit. VII and VIII).**

In the process of risk calculation two types of variables are calculated:

- Factors that influence the chance of an incident:
  - The distance the goods are carried.
  - The number of vessels involved in the transportation of certain goods.
  - The number of other users on the same waterway (traffic density).
  - The type of users on the waterway.
  - Available means of avoiding a dangerous situation e.g. manoeuvring space, communication equipment.
  - Presence of external control, like traffic guidance or traffic management, police control etc.
  - The physical condition of the waterway e.g. many curves, narrow passages.
  - The presence of parts of the waterway that are visible to radar, like ports, objects behind bridges etc.
- Factors that influence the external effects of an incident:
  - The type of cargo (natural state, toxicity, flammability etc).
  - The amount of cargo.
  - The presence of cargo protection measures (double hull, self-sealing tanks etc.).
  - The proximity of people that are not involved in the transport activities.
  - The presence of measures to limit the damage after an incident has taken place (fire extinguishers, chemicals to neutralise acids or toxic cargo etc.).
  - The presence of escape routes for members of the crew, inhabitants of houses, workers on a terminal.

After the group risk and local (individual) risk have been calculated, based on these variable and/or additional statistical data from monitoring systems, it has to be determined whether the local and group risk of a certain cargo flow remain within the limits of the safety standards, and if not, whether measure are available to reduce the risk to an acceptable level.

The transport risk of inland navigation is dominated by the transportation of flammable and/or toxic liquefied gasses in bulk. This mainly concerns propane, butane, liquefied petroleum gas (LPG) and on some routes also ammonia. Although these substances are the most important high risk goods, the transport risk of other liquid chemicals should not be underestimated.[5]

2.3 Incident monitoring

In order to properly calculate transport risks, the case history of incidents and accidents (if possible including near misses) needs to be recorded. A reliable registration of these cases is therefore essential. It allows calculations regarding the chance of an occurrence i.e. a collision in relation to the various classes of damage and the involved transport route.

The damage classes of light accidents are usually not recorded. If many light incidents would be recorded, a false image of the risk of a certain transport route may be formed, because the calculated risk is the product of chance and effect. If the effect is virtually zero, then the database would be filled with zero-risk statistics that might give a false sense of safety. These databases are meant to help calculate significant risks and predict serious incidents. Many light incidents will not help create a picture of such occurrences.

[5] The transport risk of hazardous goods in containers is normally not taken into account in this type of risk studies. Often the interaction of the many different substances that may be present in a single cargo hold is unknown. Fires in such cargo holds may burn for days and may involve very high temperatures and the formation of very toxic gasses.

It is essential that registration systems are set up in such a way that they provide (statistical) data about the main causes of an incident.

A complete and preferably uniform way of recording incidents is of the utmost importance, especially when waterways reach beyond the borders of a member state. The methodology, definitions and systems need to be synchronised between the countries that are linked by a waterway or an entire river basin.

These cross border issues are equally important in the fields of policy making, policy deployment and enforcement. It seems quite obvious that the safety standards on one side of the border should equals those on the other side, otherwise enforceability and unity of the safety policies is negated. Not only the levels for the local risk should be the same, also the group risks on either side of the border should match. Recent studies[6] show that this is not always the case. This may lead to inequality of justice, imbalances in the equal competition and business climates and different restrictions with respect to the transport of hazardous goods.

At present, the registration of incidents and accidents in the ‘inland navigation member states’ in Western Europe is poor. There is no proper survey of incidents and accidents, nor of their main causes or their effects. Data remains with various local authorities and is not shared with neighbouring countries. On a European scale there are no reliable statistics regarding the safety of inland navigation.

Main causes of accidents with inland vessels

Recent studies regarding the external safety of the Westerschelde **(see Lit VIII)** showed the following main causes of accidents with inland vessels:

Out of 225 occurrences in a period of 5 years (1998-2002) 37% of all damage cases were caused by groundings, 19% was caused by the wake of fast moving ships (mostly seagoing), 14% was caused by the collision of two vessels and 11% was caused by vessels colliding with other objects (either fixed or mobile). The cause of another 19% of all accidents in unknown. Of all accidents, 37% took place in close proximity of a harbour or water locks.

The effects range from minor damage to the sinking of a vessel. None of the cases however lead to personal injury as mentioned in the definitions of external risk.

2.4 Future developments

Economic growth and new technical developments in inland navigation have led to an increase in the average ship size. Since 1995 the average loading capacity of inland vessel has increased from 800 tonnes to 1.100 tonnes. The maximum capacity has increased from approx. 3.000 tonnes per ship (110 x 12 meters) to 9.000 tonnes (135 x 22 meters).
Given the projected economic growth and the increase in transport, this growth of the inland fleet capacity will probably continue in the next decades.

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[6] *In 2003/2004 during an investigation regarding the transport risk on the Westerschelde it became clear that the Netherlands and Belgium used different risk levels for external safety on either side of the border. It is not yet clear how these differences will effect the safety policies in both countries.*

The European scenarios (Divided Europe, European Co-ordination, Global Competition) for economic growth predict an increase in transport of approx. 100% between 2000 and 2020.

Although the statistics do not (yet) allow a detailed prediction per market segment, it can be assumed that the transport of hazardous goods will equally increase, i.e. double in the next two decades.
Taking into account the continuous expansion of the populated areas in Western Europe and the fact that especially the areas in the proximity of waterways are popular for housing development, it cannot be excluded that additional safety measure need to be taken in order to facilitate the growth of the transport of hazardous goods via water, while maintaining safety levels for the public. It will be necessary to increase the minimum safety distance between the waterways and housing. Furthermore, measures to reduce the possible effects of accidents and their chance of occurrence need to be taken in densely populated areas.
It is also of importance that navigation safety is also addressed in terms of environmental spills.

Proposed Policy Measures:

- *Besides the important definitions of external en internal risk the term Nautical Safety should be defined, referring to economical damage, damage to cargo, damage to the transport chain, damage to the environment and suspension of traffic.*
- *It is essential that all EU member states with an inland navigation interest set up a uniform system and procedures for monitoring accidents. These systems should enable governments to take safety measures to improve nautical conditions, based on statistics and analysis of accidents. This implies, that the system should provide information about the cause of the accidents and the effects.*
- *A uniform method for calculating the external risk is required for all EU member states*[7] *with an inland navigation interest. This not only applies for the way statistical data is processed, but also for the calculation of the effects of collisions and other accidents. These calculations are especially important to qualify safety levels and to compare these safety levels with alternative modes of transport. These calculations are to be performed only on specific and relevant situations. Statements regarding general safety levels of the entire inland shipping sector based on these calculations are not desirable.*
- *Transport of dangerous goods via water has to be increased because this is (by far) the safest way of transportation.*

[7] *In the Netherlands for many years rules for the individual risk (compulsory to stick to the goals)) and group risk (obligation to invest effort to reach the goals exist). They could be discussed by experts to consider application EU wide.*

3 Local (on-shore) measures and traffic management

3.1 Introduction

In ports and port approaches the local (nautical) condition may be very complex due to busy traffic, the presence of both inland vessels and seagoing vessels, complex infrastructures, weather conditions and influences of the tides.
As the flow of cargo to the European main ports grows, so does the frequency and activity of the ships that carry these goods to the hinterland. Due to the increase in scale in the inland navigation sector, this does not necessarily lead to an increase in the chance of collision between two vessels, but it may increase the amount of cargo that is possibly discharged to the atmosphere and/or the surface waters. Furthermore, in an increasing number of cases the capacity of the waterways in port areas is insufficient to facilitate the larger vessels at peak hours. These developments do certainly not improve transport safety.

In order to safeguard and maintain the required safety levels, on-shore measures are being taken. This chapter focuses on physical measures such as aids to navigation, navigational aids (buoys, beacons, lights etc.) on one hand and traffic management measures, such as Risk Control Options) on the other hand.

3.2 Port infrastructure and navigational aids

As mentioned above, ports and port approach lanes cause complex situations. Especially at port entry points, where buildings and other structures may obscure the view, even to radar, vessels with intersecting courses or at close proximity are at risk of collision. Also water locks, bridges, waterway intersections and junctions may cause traffic conditions that are difficult to overlook and therefore increase the chance of collision and possible accidents. As mentioned in paragraph 2.3, in the Scheldt area approx. 37% of all registered incidents take place in ports and in proximity of locks.
Physical measures may increase the lines of unrestricted vision and the clarity of traffic situation. Buoys separate and guide the flow of traffic within the boundaries of the navigable part of the waterways. Beacons and lights mark important points in the waterway infrastructure, either visually (lights) or to radar (beacons, racons and reflectors). Signs indicate important information regarding collision rules, special waterway conditions such as shallows or narrows, radio frequencies for VTS etc.

In port areas the Port Authority is responsible for installing and maintaining such physical measures. Furthermore, they appoint places for anchorage for hazardous and non-hazardous vessels and enforce the port traffic rules. Depending on their size and business ports may be equipped with strategically located VTS centres that allow traffic management and control from shore.
For seagoing vessels it is (in most of the cases) compulsory to have a pilot onboard when entering or leaving the port area. Especially ships with considerable draughts may require a pilot with knowledge of the local waterway and water depth conditions to safely navigate unknown or treacherous waters to the master.

Many of these measures are already at stake in the major ports and along waterways in Western Europe. These measures have significantly increased the safety of traffic in these areas. In particular, traffic control or Vessel Traffic Service has improved transport safety. This subject will be discussed in detail with respect to inland navigation in the following paragraph.

3.3 Vessel Traffic Service

The increasing traffic density and growth of waterborne transport in the last decade raised governmental concern regarding the safe and free flow of traffic on the waterways. This lead in the Netherlands to the institution of a state controlled traffic guidance and control system, which were primarily only operational at sea ports en their entrances.

This Vessel Traffic System is only required in areas which are very densely navigated and where the nautical conditions are complex. Examples in the Netherlands are: the Port of Rotterdam area, the Scheldt area, the island of Dordrecht and the bends in the Waal near Nijmegen.

Dedicated inland ships, i.e. ships carrying dangerous cargoes, passenger ships and inland ships greater that 1150 tons, have to report their call sign, location, cargo and destination to the traffic control centre by radio when entering or leaving the controlled areas. This centre monitors and controls the traffic in the area using radar and computerised tracking systems. The traffic controllers inform the dedicated ships about the traffic situation and give instructions about speed, heading etc. but only when the situation this requires.

Because the transport via water is expected to increase and the physical infrastructure will only be marginally being adapted to facilitate these larger vessels and growing cargo flows, traffic control will also be required for less complex traffic situations along the inland waterways.
Furthermore, governments are increasing their efforts to carefully monitor the flow of hazardous cargo as public concern over this type of transport grows.

This gave rise to the development of more strategic pro-active instruments like River Information Services (RIS) that also allow governments to monitor the effects of traffic and safety policies and transport developments. This RIS system will be set up for all waterways in Western Europe **(Lit. IX).**

RIS encompasses AIS (Automatic Identification System) and also relevant information for a safe and efficient navigation.
It is anticipated that also on board of the ships adequate instruments should be placed like Inland Ecdis (see next chapter).

On basis of the possibilities generated by RIS it will be possible to manage the whole traffic fleet and not only the dedicated ships like ships transporting dangerous goods or passengers. The introduction of AIS implies that the ships have a good insight in the surrounding traffic and need far less support from the VTS stations.
Subsequently, the traffic managers will get the opportunity to manage the whole traffic and only take (pro active) action when this is necessary. This will require a change in professional working attitude which will require much training and has certainly consequences for the education.

These new possibilities also enable to cope with the requirements which will probably set forth by Security: all details about the ship, the cargo, the destinations and ETA's as well as people on board will have to be known by the relevant authorities.

The introduction of traffic control systems in ports and along waterways has significantly reduced the chance of collisions and accidents. The estimation of the author is in this respect boils down to a reduction of 10% on rivers and up to 25% in ports. Further development of these systems, as shortly indicated above, is highly recommended.

Proposed Policy measures

It is advised that the National governments adapt as soon as possible the RIS directive once adopted by the EU Parliament and support the navigation by realizing the AIS network infrastructure and providing the navigation with adequate information on basis safe and efficient navigation will be enhanced. The required information is clearly described in the RIS directive.

4 On-board safety measures

4.1 Introduction

The external risk of inland navigation is from the ship’s side mainly influenced by design and equipment of the vessel. While high-quality navigational equipment and communication equipment reduce the chance of an accident, such as collisions, groundings and contacts, will the layout and construction of the vessel, its tanks or cargo holds and the ship’s hull limit the effect of a possible collision and the possible discharge of cargo to the atmosphere or the surface waters.
The following paragraphs will discuss the influence of these on-board measures on the external safety of inland vessels that transport hazardous goods.

4.2 Constructional measures

The ship’s construction is mainly responsible for the extent of the effects of an accident. Due to the nature of waterborne transport – large quantities of bulk goods – the effect of an accident may be that a large quantity of hazardous goods are discharged into the atmosphere or to the surface waters. The amount of cargo that is discharged at once can be reduced by dividing the cargo hold into many closed compartments, cells or tanks. Furthermore, the vessel can be constructed in such a way that a possible collision will only damage the outside of the vessel while the cargo compartments remain intact.
The following construction options are being used in vessel construction:

1) Placing a buffer space between the outer hull of the vessel and the cargo compartments. This creates a so-called double-hulled vessel, that also has an additional collision bulkhead between the bow and the cargo compartments.
2) Reduction of tank size to approx. 300 m^3.
3) Use of a high impact resistant hull that absorbs and dissipates the impact energy. This new development, either the so-called Schelde-hull developed by the Dutch Wharf “Schelde” or the Y-shaped support web hull, is not only constructed to withstand high energy impacts, but is also very light due to the use of composite synthetic fibres, so little of no cargo capacity goes to waste (**LIT X**).
4) Alternative design for anchors and other protruding parts of the vessel, so that these parts do not cause serious damage to other vessels. In many accidents, anchors act as can openers, tearing open the outer hull of other vessels.

With respect to the reduction of the size of separate cargo holds or tanks, is has been suggested to further reduce compartments to a cell of 100 m^3. These cells may be stacked vertically in a double or single hulled vessel. When these cells are cylindrical (highest side impact resistance), it is obvious that the rectangular cargo hold is not used optimally. This may increase the transport costs to unacceptable levels. Cubical cells are much more space efficient, but require measures such as the abovementioned high impact hull, due to their lower side impact resistance. Cellular tankers have not yet been built in the inland shipping sector. State aid may help initiate this development.

An alternative to transport by cellular tanker is the use of tank containers in double hulled container vessels. Due to the obvious disadvantages of these even less space efficient cargo units in double hulled vessels, that have already lost cargo capacity compared to single hulled vessels, this option is only economically feasible when the use of tank containers is obliged for certain types of hazardous cargo.

A new development in the design and construction of inland vessels is the use of composite synthetic materials for the entire hull. Ships are regularly made out of steel, which is easy to handle and process and available at relatively low costs. Although composite materials are much more expensive than steel and more difficult to process, there are significant advantages to the use of these materials in ship building:

- Composite material it is much lighter than steel, while maintaining the same strength, so the cargo capacity–weight ration of composite vessels is much better than that of steel vessels.
- Composite material has a higher tolerance to dynamic stress and impact forces, due to higher flexibility.
- Composite material, especially Glass Reinforced Plastic (GRP) has a low thermal conductivity. Therefore the chance of overheating cargo holds or tanks is significantly lower, thus lowering the risk of fires, explosions or cascade effects of fire spreading to other compartments.
- Composite material is hardly affected by corrosion. This is not only a benefit for the outer hull that is in direct contact with water (possibly polluted by corroding agents in case of an accident), but also for the cargo tank lining. In steel vessels tanks need to be coated to resist corrosion by chemicals, acids etc. When constructed of high-quality composite materials, this might not be necessary.

These benefits of composite materials may outweigh the higher costs and difficult handling. Further development of composite vessels is certainly recommended from the safety viewpoint.

4.3 Navigation equipment

The chance of an accident may be decreased by instruments that help the inland vessel to better and quicker anticipate the presence and movement of other vessels or objects in and on the waterway. To this end, not only buoys, beacons and depth gauge readings are required, but also more detailed knowledge of the local conditions of the waterway and the local traffic image.

This can be realized by equipping the bridge with instruments to enable the ships to fully comply with the possibilities created by RIS.

The electronic chart of the waterways (Inland Ecdis) facilitates the integration of all required information on the bridge and forms the basis of the necessary bridge equipment together with AIS: the Automatic Identification System[8] . This transponder technology allows exchange of online data between vessels and between vessels and between vessels and RIS centres along the waterways. The identification of ships including information on ship, voyage and cargo is

[8] *There are several developments with respect to AIS like systems. It is important that the systems available stick to the requirements set forth by RIS*

directly known to all surrounding AIS stations. AIS is based on a GPS, so the position of the own ship is known to all other surrounding users of AIS. In reverse, the identity of all AIS equipped ships can be visualized on the own ECDIS screen.

The ships' own gyro compass and radar system provide additional data (if necessary completed with a shore based radar traffic image sent to the surrounding ships).
All input data is combined with chart data that is stored in the charting system and complemented with online meteorological and hydrological data such as water depths, current velocities and wind speeds.

An additional benefit of AIS – which is already compulsory for seagoing vessels – is the availability of all relevant data of the vessel, it's cargo etc. in case of an accident. If this data is available quickly after an accident, emergency services may respond more adequately to a possible threat to the public or the environment.

With respect to the interoperability of the electronic charting systems as well as the automatic identification systems it is essential that both inland vessels and seagoing vessel are able to exchange data with the on-shore transponders and information centres.

Modern navigational equipment operates in direct interaction with information send to the ships on line from the shore based information centres. These flows of information can be divided into three different types, each with their own specific requirements, i.e.:

LONG TERM DATA

- Geometrical information concerning the wet infrastructure as well as locks and bridges
- Relevant details such as opening times, possibilities with respect to communication

MEDIUM TERM DATA

- Hydrographical information

ON LINE DATA

- Meteorological information
- Hydrological information
- AIS information from other ships
- Tactical traffic image on board

The flows of information to and from the waterway authorities has to be facilitated by an AIS network. Doing so, the authorities dispose of an excellent system of information concerning all ships which is indispensable (for instance) in case of calamity abatement.
It will also be possible to execute a number of optimizations related to traffic management and even (if so required) with respect to fleet and cargo management. However, these aspects concern commercial activities which not further be elaborated here.

4.4 Advantages of RIS

The introduction of modern aids to navigation located on board in direct combination with RIS offers a number of positive effects on the safety and efficiency of navigation.
To illustrate this a number of examples will be given in the following.

4.4.1 Preventing groundings

In large open waters groundings are a main cause of accidents. If the ship is equipped with a AIS in combination with an ECDIS and receives hydrological data (i.e. water depths) from the shore based station, groundings can be avoided to a large extent. Of course the own draught should be taken into account.

4.4.2 Preventing collisions

The introduction of AIS will have a positive impact on the reduction of the number of collisions. All relevant data of the surrounding ships are readily available and projected over the own radar image. In VTS areas even the traffic image of the remaining traffic can be sent to the ships and this information completes the information with respect to the other traffic on the bridge enabling the skipper to navigate safe and efficient in the fairway.

4.4.3 Actions from the traffic officers

Also the VTS stations dispose of AIS and ECDIS. Because of these instruments they can use the information for instance by giving extra attention to ships in the area carrying dangerous goods. It will also be possible to monitor vessel traffic better than is possible now. Consequently RIS operators are able to act pro active and avoid collisions more effective than is possible now.

4.4.4 Calamity abatement

When RIS is operational all information concerning the navigating ships in the area of concern is known, for instance in or via the RIS server. When an accident takes place details of ship, cargo and crew are known so appropriate measures can be taken. Also all details of shipping near by is known, so it will also be possible to re-direct these ships if necessary.

Proposed Policy Measures

It is advised that proper measures are taken that it is at least stimulated (but preferably arranged obligatory) that ships longer than 20 m ***(see Lit XI)*** *have to be equipped such that they can cope with all requirements emanating from RIS. These measure should be taken for all inland navigation in the EU.*

5 Hazardous goods and specific regulations

5.1 Introduction

The chance of an incident it not only influenced by waterway or weather conditions, but also by the activities of regulatory bodies like governments. They can for example, prescribe the maximum speed on waterways, thus influencing the chance but also the effect of possible incidents. Especially in the field of construction requirements and prescribed equipment, the effect of governance is evident, but governments are also responsible for standardisation of information formats, requirements with respect to the education and training of the ship's crew etc.
On the one hand governments are reluctant to intervene in commercial processes, on the other hand it is necessary to safeguard some minimum requirements and procedures. Especially in the field of security and public safety the government's influence has to increase.

5.2 Existing international regulations

The ADNR, short for "Accord Européen relatif au transport international des marchandises Dangereuses par voie de Navigation du Rhin" (European accord regarding hazardous goods in inland navigation), has certainly been the most influential regulatory measure in Europe with respect to the transport of hazardous goods in inland navigation. The rules and regulations in the ADNR are set up by the Central Commission for the Navigation on the Rhine (CCNR), which is the appropriate regulatory body with respect to (among others) technical requirements for inland navigation in Western Europe. The ADNR deals with all hazardous cargo, in bulk or packed, either solid, liquid or gaseous. The ADNR contains requirements regarding the following subjects:
- construction of vessels, cargo handling systems etc.
- packing and grouping of goods (what substances are or are not to be combined)
- loading and unloading procedures
- safety procedures and behaviour

The ADNR is only effective in the CCR member states[9], which makes it a purely Rhine-based regulation.

The EU, CCNR and UN are working together to update the ADNR to modern standards and give it a regulatory scope, starting 2005.

When the revised ADNR 2005 enters into force, it will be mandatory regulation for all the Rhine countries. The ADN is an addition treaty that has been drawn up between all 'inland shipping countries' in Europe. Every member state that ratifies the ADN treaty is obliged to implement it in it's national legislation. Furthermore, ratifying countries are obliged to admit ADN certificates from other ADN ratified member states.

[9] Switzerland, France, Germany, Belgium and the Netherlands.

Is has therefore a different status compared to resolutions of the UN.
Although the UN-ECE secretariat initiated and facilitated the ADN process, it is not a typical UN-resolution but an international treaty.

It is of great importance that the member states along other rivers in Western Europe, like the Danube, incorporate the ADN requirements into their national legislation as quickly as possible, in order to create a level playing field, especially in the countries that now operate in a common market, but have no ADN like regulatory framework yet.

Trans-border safety regulations require constant attention with respect to equality in policy, deployment and enforcement. Especially in the field of 'aligning' the levels of experience and training – not only for the ship operators but for the governing bodies as well – the implementation of the ADN in 2005 will bring a significant challenge.

There is a need to maintain the safety regulations. It requires more discussion to develop updated modern standards with respect to make safety regulations for all countries involved similar.

5.3 Required new regulations

The most important new regulations in the near future are undoubtedly the new ADN and ADNR, that will enter into force in 2005. The harmonisation of the regulatory framework regarding the transport of hazardous goods that comes from the implementation of these revised regulations will mean a significant improvement in transport safety.

Despite the improvements that come from the ADN 2005, still some other problems need to be resolved:

- Tracking and tracing hazardous goods as they pass through countries without visiting a port is difficult, because these transports are not properly reported and recorded by vessel tracking systems at the moment. Especially containerised cargo is difficult to track and trace, because specific data about the content of each cargo container is often not reported because that would require reporting large amounts of data for ships that carry as much as 400 containers at a time.
  Both technical measures, like easy and quick data communication between ship and RIS centres, and enforcement measures are required to solve this problem.
- The actual presence of supervising bodies like river police and waterway administrators 'in situ' is declining. Financial reasons are the most important cause of this phenomenon. It should be discussed how supervision will be possible in an effective way for instance by using methods and means as described in RIS (i.e. solving the problems by ICT). Also the effect of Security will play an increasing role and stress to cope with a proper supervision.

Proposed Policy Measures

ADN should be adopted by all member states to enable safe transportation of hazardous goods and provide a level playing field throughout Europe.
Moreover it is advised to incorporate the requirements emanating from Security as part of RIS.

6 Possible effects of safety measures

6.1 Introduction

In the previous chapters possible safety measures have been discussed. In general, these measures aim to:

- prevent incidents and accidents from occurring by reducing the chance of such an occurrence or probability, or;
- prevent or at least reduce possible negative effects or consequences of an accident.

These measures fall into three basic categories:

A) For ships: Measures that help the ship operators to better anticipate traffic dynamics, to have accurate and up-to-date information available and to prepare for possibly dangerous conditions and measures related to the construction of ships carrying dangerous goods aiming at a reduction of outflow in case of a severe collision.
B) Shore based: Measures that allow supervising authorities to better co-ordinate and monitor traffic conditions and flow of hazardous goods, and
C) Regulatory measures that lead to standardisation of equipment, procedures and behaviour.

With respect to the variables that determine the course and effects of incidents and accidents it has to be pointed out once more, that the conditions for transporting hazardous goods via inland waterways are very favourable compared to transporting the same goods by truck or train: due to their size and physical location, waterways almost automatically put a safe distance between the cargo carrying vessels and the public. Almost 95% of all waterways lie outside populated areas, including port facilities, thus minimising interference between the hazardous goods and the public.

6.2 Positive effects of new safety measures

After this homage to the safety of inland navigation one might wonder what the effects of al the discussed matters actually are. How does one express improvements in transport safety? The problem is: that's not really possible in an accurate way. All the discussed matters are not (yet) variables in the models that predict local, group or individuals risks. Although anybody can imagine how a double hull may better protect a ship from damaging its cargo compartments, yet the factor 'double hull' can be incorporated into a model. These technical measures have a limited effect range, not only physically, but also in modelling terms. In fact, it is only possible to properly determine the effects of new measures by monitoring the number of incidents, accidents and near misses. It can then be stated that the transport risk decreases equally to the decrease in accidents.
Until new modelling methods and/or new statistics are available, it is only possible to give a qualitative analysis of the possible effects of new safety measures.

As the abovementioned research of accidents on the Westerschelde showed, the larger part of all accidents occurred due to insufficient traffic and waterway information and insight. Also the confusing traffic patterns is detrimental since navigators are not able to monitor closely the movements of the vessels in the vicinity and make the right navigation decisions.

Therefore, measures discussed in chapters 3 and 4 regarding communication and information are likely to have the most significant effects on transport safety.
Structural measures will further minimise the effects of possible accidents, but these measure do have their limitations. The impact resistance of high impact hulls and double hulls is not infinite, nor are the possibilities to further reduce cargo compartment size, if one still wants to load and unload ships within a reasonable timeframe and exploit the vessel in a commercially sound manner. Therefore, structural measures take the second place in the hierarchy of positive effects to transport safety.

Finally, trans-European harmonisation of technical standards, procedures and policy deployment and enforcement will ensure that safety requirements do not stop at the border. A trans-European level playing field regarding safety will ensure that competition takes place in the commercial field, not in the safety field.
Regulatory measures take third place in the hierarchy of positive effects to transport safety.

Because the developments mentioned in the previous Chapter are in full swing it is hard to give a good idea about the net positive effects on the safety level.
However, it can be stated that constructional measures and developments as described being part of RIS will have a very significant positive effect on safety. It will prove to be possible to keep within safety limits set forth by authorities on basis of the navigational aides described in this Chapter.

7 Training and education

The first and foremost ingredient for the success of all safety measures discussed in this report is the capacity and willingness of the ship's crew to properly handle hazardous goods and to follow the proper procedures.
Certain measures also require additional education and training. Communication measures for example not only require knowledge and skill regarding the operation of new equipment, but also mastery of the appropriate languages. If these measures are introduced without the required training and education, the ship operations are very likely to fall back on the older systems and methods.

Besides supportive training like upgrading the use of languages, training in professional skill and (bridge) resource training have to be mentioned here. The use of simulators is indispensable in this respect. Besides basic training more specific training directly related to an area or situation and training dedicated to the appropriate use of new techniques can be distinguished. When new ways of dealing with the profession are at stake which require changes in human performance, these changing processes are very time consuming!

The indirect effects of training and education are not to be underestimated. They raise the overall safety awareness of the 'students'. Conversely, lack of training and education causes the safety awareness of ship operators to decline.

On a higher level, education of shipping companies, cargo handlers, ship-owners, ship designers and policy makers regarding newly implemented and foreseen safety measures is essential to safeguard that safety is not only a 'hobby' of barges, but an integrated discipline in the entire transport chain.

Despite that fact that many barges have a considerable knowledge and hands-on experience regarding the layout and condition of waterways, the effects of weather conditions etc. still this is not a guarantee for a safe operation of inland vessels, especially on wide waters and tidal waters. Specific and preferably multi-language information systems (e.g. a CD-rom) may help ship operators to adapt their behaviour to the difficult and sometimes treacherous conditions of these specific waterways.

Proposed Policy Measures

Much effort shall have to be invested in proper education and training as well as the development of the required tools to introduce and maintain the introduction of RIS (both ashore as on board). Besides various skill trainings also resource training is of importance. The use of simulators is stressed especially when looking at learning new professional attitudes and when the trainees have to get acquainted with new technical developments.

8. Survey of proposed policy measures

Monitoring and calculation of external risk
Besides the important definitions of external en internal risk the term Nautical Safety should be defined, referring to economical damage, damage to cargo, damage to the transport chain, damage to the environment and suspension of traffic.
It is essential that all EU member states with an inland navigation interest set up a uniform system and procedures for monitoring accidents. These systems should enable governments to take safety measures to improve nautical conditions, based on statistics and analysis of accidents. This implies, that the system should provide information about the cause of the accidents and the effects.
A uniform method for calculating the external risk is required for all EU member states[10] *with an inland navigation interest. This not only applies for the way statistical data is processed, but also for the calculation of the effects of collisions and other accidents. These calculations are especially important to qualify safety levels and to compare these safety levels with alternative modes of transport. These calculations are to be performed only on specific and relevant situations. Statements regarding general safety levels of the entire inland shipping sector based on these calculations are not desirable.*

Stimulating transport of dangerous goods via water
Transport of dangerous goods via water has to be increased because this is (by far) the safest way of transportation.

National implementation of RIS directive
It is advised that the National governments adapt as soon as possible the RIS directive once adopted by the EU Parliament and support the navigation by realizing the AIS network infrastructure and providing the navigation with adequate information on basis safe and efficient navigation will be enhanced. The required information is clearly described in the RIS directive.

Obligatory instruments on the bridge coping with RIS
It is advised that proper measures are taken that it is at least stimulated (but preferably arranged obligatory) that ships longer than 20 m have to be equipped such that they can cope with all requirements emanating from RIS. These measure should be taken for all inland navigation in the EU.

Adoption of ADN by all member states
ADN should be adopted by all member states *to enable safe transportation of hazardous goods and provide a level playing field throughout Europe.*
Moreover it is advised to incorporate the requirements emanating from Security as part of RIS.

Special attention to education and training

[10] *In the Netherlands for many years rules for the individual risk (compulsory to stick to the goals)) and group risk (obligation to invest effort to reach the goals exist). They could be discussed by experts to consider application EU wide.*

Much effort shall have to be invested in proper education and training as well as the development of the required tools to introduce and maintain the introduction of RIS (both ashore as on board). Besides various skill trainings also resource training is of importance. The use of simulators is stressed especially when looking at learning new professional attitudes and when the trainees have to get acquainted with new technical developments.

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