

**THEMATIC SYNTHESIS OF
TRANSPORT RESEARCH RESULTS**

PAPER 7 OF 10

SAFETY AND SECURITY

Issued by:	The EXTRA project, within the European Community's Transport RTD Programme
Issue:	7 (final)
Disclaimer:	This paper does not represent the official viewpoint of the European Commission.

**European Commission
Transport RTD Programme
Fourth Framework Programme**

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EXECUTIVE SUMMARY

This paper provides a structured guide to the findings and policy implications of research relating to safety and security carried out in the Transport RTD Programme¹. (See Section 1 for advice on how to use the paper.)

In the light of increasing traffic numbers across all transport modes, safety and security need to be subject to further improvements. Maritime accidents and their considerable impacts on the environment, the overall safety concept of the upcoming European Rail Traffic Management System, and enhancements in air traffic control remain major issues. Though car safety has seen good progress over the last decade, the commitment to significantly reduce the number of casualties in this dominating transport mode prevails. Policy action promoting better levels of safety and security for all transport sectors will hence be mandatory. RTD is providing a vital foundation for this, developing hardware and software components, guidelines and tools to support the implementation of policy measures, and demonstrating their anticipated benefits and impacts.

In this paper, results are reviewed for “clusters” of research projects in eight inter-related areas:

Reporting and (common) guidance

Maritime accident investigation and prevention has been improved by providing computer-based tools for analysis and prevention of fire on-board ships, and a guideline document for structured accident investigation. A comprehensive methodology for accident recording and analysis has been outlined, while in a complementary step a structure for coding information in a database was elaborated. A thoroughly maintained maritime accident database is strongly recommended.

Similar, work has paved the way for the establishing of a harmonised pan-European road accident injury database by providing a set of quality assurance procedures for data collection, initial data processing, and comparison and analysis of data from different sources.

Assessments

Major achievements in the maritime sector have included the development of a simulator system to quantify risk levels and the effect of risk control options in defined geographical areas. A structured hazard identification process for the evaluation of risk control options and the development of risk models has been defined, while related simulator runs led to improved training schemes for crew members. In the meantime, the Marine Accident Risk Calculation System (MARCS) has been updated, which is an important component of a common international approach to accident and incident reporting in shipping. A specific Safety Assessment Philosophy led to a model for quantitative risk evaluation in the transport of dangerous goods for the categories crude oil, liquified petroleum gas and container service. In the air sector the assessment of human operators' performance in terms of ATM safety by means of using adequate stochastic models has led to a consolidated certification framework in ATM that allows for an effective safety management.

¹ Part of the Fourth Framework Programme for Community activities in the field of research, technological development and demonstration for the period 1994 to 1998.

Transport operation (active safety)

A huge set of software tools, hardware components and entire sub-systems contributing to the planned European Rail Traffic Management System has been verified and validated in laboratory and on-site tests, focusing on assuring true interoperability and reliability of railway infrastructures.

Work in the maritime sector has centred around improving existing Vessel Traffic Services and developed a complementary River Information Service. Another principal activity was the development of a conceptual standard for Ship Control Centre design, including layout recommendations for future ship bridges, and a so-called 'tactical display' combining anti-grounding and anti-collision information tools.

The use of Next Generation Satellite Systems was found to have a significant potential to enhance surveillance for Air Traffic Control, to improve pilots' situational awareness and to provide precision navigation.

The operational safety of smaller fixed-wing aircraft and helicopters was addressed by proposing several updates and extensions to existing regulations to cover critical weather conditions that trigger ice formation on airframe and wing.

Transport infrastructure

Speed management methods for roads across Europe were assessed, leading to recommendations, such as speed limits for roads of similar classification, guidelines for application of speed management measures, preparations for the introduction of in-vehicle speed limiters, "self-explaining" road design, automated speed enforcement, internalising external costs, campaigns to raise public awareness about the impacts of speed, and restriction of vehicle speeds.

Specifications on simulation facilities for the development of Ground Collision Avoidance Systems (GCAS) and their required certification were produced. Such systems will help to relieve cockpit crews from dealing with complex information about obstacles, terrain elevation or runway specifications, thus promoting in-flight safety.

Current operational regulations, that take account of weather induced runway conditions reflected by the so-called balanced field length, were found not applicable for smaller business and commuter aircraft. The results of full scale tests using three business and commuter aircraft are now the basis for recommended adaptations to existing regulations.

Driver/passenger safety

A methodology was elaborated to identify head injury mechanisms and to evaluate the current head injury criterion (HIC), based on the analysis and reconstruction of real world car accidents that had been leading to head injuries. An evaluation into the possible use of the new (US) THOR frontal crash test dummy in European legislative testing, showed the principal suitability despite deficiencies in the durability and handling of the dummy.

A European specification for child restraint devices was devised, aiming to reach the same safety standards as for other passengers, while limiting additional costs to the aviation industry, achieving compatibility with European automobile restraint standards, and seeking harmonisation with the upcoming US standard.

The influence of bio-mechanically relevant injury criteria for aircraft passengers in accident investigation was analysed by looking at two major commercial aircraft crashes, leading to proposals for improving passive safety in aircraft cabins, and to extend future accident analysis beyond technical and human factors related aspects of aircraft performance, and failure.

Non user safety

A set of common design criteria for roads and related traffic management schemes was devised, based on the knowledge of the specific mobility needs of pedestrians and cyclists, that aim at a better balance of the interests of different road users. The cost effectiveness of proposed infrastructure and organisational measures was assessed in order to outline a practical implementation strategy.

Qualifications/behaviour

Research evaluated seven selected ATC automation concepts that address the man/machine interface, which found cognitive (assistance) tools to be most promising for several ATC environments. A "Crew Resource Management (CRM) for glass cockpits" booklet was prepared that addresses the required specific skills for advanced cockpit layouts of commercial aircraft.

The work has identified ways to positively influence the employment of seafarers, by supporting their mobility through mutual recognition of certificates and (national) regulations. The intensified use of advanced simulators will help to meet the requirements of the STCW 95 (Standards of Training, Certification and Watchkeeping) convention, which is now assisted by provision of sample assessment tools and a comprehensive catalogue of training scenarios. For cross-border rail operations a practical toolkit of techniques for railway operators has been brought up allowing to identify differences in rail infrastructures and connected human factors issues, and human factor analysis techniques, to identify possible human errors, available failure recovery measures and risk reduction strategies.

Working conditions

Re-employment opportunities for disabled seafarers were assessed, leading to the conclusion that a switch to shore-based jobs, in maritime or related sectors, remains most likely due to inevitable safety constraints.

A Practical Handbook on 'Road Work Zone Safety' was produced, that provides a compilation of safety relevant recommendations for standardised planning, implementation and operation of road work zone measures on a pan-European level.

A study assessed the impacts of new technologies in freight transport on the number of employed workers, their working conditions, the quality of jobs, the time pressure dictated by efficiency considerations and the membership to trade unions.

Related to the operation of freight villages a Training Software Tool was devised providing recommendations on communication, organisational matters, professional skills and related training of staff.

1. INTRODUCTION

This paper provides a structured guide to the results of Research and Technical Development (RTD) projects relating to *safety and security*, carried out in the European Community's Transport RTD Programme. It is one of a series of papers:

Paper no.	Theme
1	Sustainable mobility – integrated perspective
2	Sustainable mobility – economic perspective
3	Sustainable mobility – social perspective
4	Sustainable mobility – environmental perspective
5	Urban transport
6	Efficiency and quality
7	Safety and security
8	Human factors
9	Interoperability
10	Freight intermodality

Of the 275 projects financed by the Programme, 53 dealt (partly or fully) with the issues of safety and security. Most of these projects were finalised in the year 2000.

How to use this paper:

You are recommended to use this paper to locate RTD results on topics where you have a particular interest, rather than reading the paper from start to finish:

- Start in Section 5 to get an overview of the topics addressed by “clusters” of RTD projects.
- Read the part of Section 6 that summarises the findings for each topic of interest to you.
- Use Annex 1 to identify the individual projects relating to that topic.
- Use Annex 2 to review the key results from each of these projects.

Further details on individual projects can be obtained from their web sites (noted in Annex 2, where available) and from the following Commission web sites:

- <http://europa.eu.int/comm/transport/extra/home.html>, which includes summaries and the full final reports of individual projects, as well as a variety of analyses and publications prepared by the EXTRA project;
- <http://cordis.lu/transport/src/project.htm>, which provides the project objectives and summary results as compiled by the RTD project teams.

The other Sections of this paper can help you to gain an overall picture of the safety and security theme, associated policy issues and the objectives for RTD.

The analysis in this paper is the responsibility of the EXTRA project team, and does not represent the official viewpoint of the European Commission.

2. SCOPE OF THEME

2.1 Definition of safety and security

Safety implies freedom from danger. The ultimate level of safety desired by human beings is to be in a situation without *any* risk of personal accident, injury or material damage. In reality, this is impossible because a widespread set of dangers cannot be avoided completely. So **safety** generally refers to the level of danger that is socially acceptable in a real-life situation.

In the case of transport safety, risk arises when human beings are exposed to any part of the transport system. Different levels of risk attach to different modes and to different activities. The acceptable level of risk is judged according to the choices made by individuals – as operating staff, drivers or passengers.

The safety performance of a technical system is the measurable consequence of the extent to which it behaves as expected, with and without the interaction of human beings. The objective is to come as close as possible and reasonable to the ideal safety performance.

Security is the undertaking to protect human beings, transport means and transport infrastructure against unauthorised and unexpected actions of any kind.

Safety issues concern the means of transport (like vehicles) and the infrastructure of transport (like roads), as well as human beings involved directly or indirectly in any transport operation. When the transport safety system, or the infrastructure on which the transport system operates, fails to behave as designed, there are often serious consequences. Such failures also decrease the efficiency of a transport system.

Elements of transport systems have to be tested and validated, concerning their ability to fulfil their functions and the consequences of malfunctions and failures. Safety issues affect operations, requiring ongoing organisation and expenditure to maintain levels of safety. Safety must be described in terms of the risks to different categories of transport users, as well as non-transport users who are in proximity to the transport system or suffer from the consequences of transport. Safety often is measured in terms of the numbers of fatalities, injuries and property damage per km, or the risk of serious injuries in percentage terms, or perceived safety in qualitative terms.

2.2 Topics included in the theme

Safety is a high priority affair within the transport sector across all modes. All Member States provide some guidelines for achieving similar goals:

- safer transport systems;
- technical standardisation;
- improved training.

Major topics to categorise safety aspects are:

- transport means;
- transport infrastructure;

- human performance and behaviour (including operation).

The topic involving human beings can be structured in terms of the affected groups of users and non-users:

Safety of users

- drivers;
- passengers.

Safety of non-users

- other drivers and passengers;
- other modes;
- general public;
- high risk groups.

Besides standardisation and regulation, improved (safety) procedures and safer design, the implementation of ATT (Advanced Transport Telematics) is influencing the safety of transport in Europe in a significant way. On the one hand, ATT components or systems have been specified to improve safety. On the other hand, new problems concerning safety and safety procedures have arisen. ATT covers the following areas:

- travel and traffic information;
- traffic management, operation and control;
- public transport;
- freight and fleet management;
- automatic debiting and demand management;
- driver assistance and co-operative driving;
- vehicle/vessel control.

Within the freight transport area, a further safety topic is the transport of hazardous goods.

2.3 Significance of the theme

Over 45,000 persons are killed each year and over 1,600,000 injured by transport in the EU Member States. The number of injured persons may be even higher, by a factor of two, due to under-reporting of minor incidents. These statistics demonstrate the significance of the theme.

The greatest share of victims is due to the road sector. Road accidents are estimated to cost 45 billion Euros per year - 15 billion Euros for medical care, police involvement and vehicle repairs, and 30 billion Euros in lost economic production due to fatalities or injuries. With 45 000 victims annually, the avoidance of a fatal accident would save 1 million Euros on average. There is therefore an economic justification for taking measures costing up to one million Euros in order to save a single life ("the million Euros rule").

Other modes like air and rail are much safer, but especially in aircraft accidents the chance of survival is very limited. Not only are the human tragedies of great importance, but also the external costs associated with accidents have a significant economic impact.

An estimation of the external costs of transport is shown in the Table below.

**Rough estimates of the external costs of transport
(expressed as percentages of gross domestic product)**

Air pollution	0.4 %
Noise	0.2 %
Accidents	1.5 %
Congestion	2.0 %

The listed external costs represent a value of 260 billion Euros. The socio-economic importance of safety for the European economy is obvious. There can be no real transport efficiency without transport safety.

3. POLICY CONTEXT

3.1 Policy objectives related to the theme

In the Treaty establishing the European Union, article 75 requested "*measures to improve transport safety*". The Maastricht Treaty likewise seeks to achieve improvements in safety within the European transport network.

Free movement of people and free circulation of goods are essential for the completion of the Single Market. Therefore the EU transport policy seeks to achieve an *integrated Trans European Network* which responds to people's desire for a cleaner environment and *safer* reliable mobility.

The Common Transport Policy Action Programme 1995-2000 places safety in a wide context. "The economic well-being of citizens and businesses and social cohesion in Europe are to a considerable extent based on an efficient, accessible and competitive transport system which reconciles the need for mobility meeting users' needs with the imperatives of *ensuring a high level of safety* and of protection of the environment."

Based on this objective, five areas are addressed in the Action Programme:

- The safety of transport, in the interests of user and non-user alike, is a major concern of those responsible for transport policy in the Community. In addition, as regards commercial operations, unduly divergent safety rules and enforcement regimes distort competition and can lead to better standards and practices being undermined.
- The completion of the internal market in transport, together with the continuing integration of the economies of the Member States, necessarily entails increased transport movements across frontiers and within Member States other than the country of origin of the transport operator. The need for appropriate Community action on safety is thus underlined and the Union Treaty contains a modification of the transport chapter in Article 75 to make explicit for the first time that the CTP should include "measures to improve transport safety".
- Improving safety in road transport constitutes a particularly important area, given the scale of deaths and injuries still caused every year. A global approach is required, involving legislative and other measures. This would include improved systems for analysing the causes of accidents and evaluating the costs and benefits of alternative responses, technical standards for vehicles and their enforcement, and improvements in infrastructure, including relevant telematic systems. Where the Community can act usefully, actions must also address the human element that frequently forms one of the key contributory factors to an accident.
- In the maritime field, the Commission will pursue the programme set out in its Communication on Safe Seas, giving priority attention to passenger vessels, in particular Ro-Ro ferries.
- As to aviation, emphasis will be placed on completing the harmonisation of rules and on the creation of a single European authority for air safety regulations.

The CTP objectives led to the consideration of safety impacts in the Green Papers "The Citizens' Network" and "Fair and Efficient Pricing".

Within the White Paper "Towards a New Maritime Strategy", a specific role was identified for RTD to improve safety in waterborne transport.

The policy paper "Promoting road safety in the EU" describes how the Commission has set out a new action programme. The Commission advocates a cost-benefit approach in the formulation of future road safety policy. The main objective of this new policy is to reduce the annual total of victims in the European Union to 18,000 in the year 2010, compared with the figure of 27,000 predicted under the continuation of current policy.

3.2 Policy issues related to the theme

The main policy issues concern the following objectives:

- to improve the safety of the means, facilities and infrastructure of each single mode and combination of modes, e.g. by the improvement/introduction of driver assistance systems;
- to reduce negative impacts to non users, by improvements in vehicle design;
- to promote a change in the modal split towards safer transport modes, e.g. from individual to more collective personal transport or from road freight transport to rail freight transport;
- to promote safe driving behaviour.

Important enabling factors will be the harmonisation of high-level safety standards and regulations, and the introduction of greater "fairness in transport costs" by internalisation of external costs by the different modes.

These issues are well underlined by policy initiatives of the European Community on different levels:

- ECMT decisions and resolutions;
- establishment of Task Forces and COST Actions;
- funding of relevant FP4 research in different Programmes, including Concerted Actions.

Due to safety being a primary concern of DG Transport and the road sector having the worst accident statistics:

- almost all legislative measures announced in the 1993 Action Programme on Road Safety have been undertaken;
- all planned studies have been carried out, focused mainly on vehicles (passive safety), telematic applications and behaviour analysis;
- non-legislative measures such as the Year of the Young Driver 1995 and the YES campaigns have been implemented;
- the CARE project has been initiated to create a detailed database on road accidents involving personal injury in the different Member States.

The trends and characteristics of road safety in the European Union underline the problems facing the sector:

- figures vary widely from one country to another;
- an explosion in the number of cars in certain Member States has gone hand in hand with a worsening of the situation in those countries;
- those most at risk are pedestrians, cyclists, motorcyclists, young adults and the elderly;
- alcohol is still a significant factor in accidents, despite the undoubted success of alcohol-related programmes in some countries.

A second Action Programme on "Promoting Road Safety in the EU" has been developed and launched, covering the period up to 2001.

Using a cost-benefit approach, the Commission has identified several courses of action involving:

- the wearing of seat belts;
- improved vehicle design (reduction of the risk to pedestrians, improvements to passive safety);
- the use of collision warning and cruise control systems;
- the use of day running lights;
- speed restriction;
- the reduction of blood alcohol levels while driving;
- awareness of the effects of drugs or medicines on driving;
- infrastructure investment.

4. RTD OBJECTIVES

In FP4, increasing the safety of transport systems is a cross-cutting issue and can be structured according to the following inter-related targets:

- to improve the Europe-wide knowledge about safety features and to develop new guidelines, methodologies, requirements and certification procedures;
- to increase active safety;
- to increase passive safety;
- to improve human elements in transport systems and processes.

There are various programmes within FP4 dealing with these targets. The greatest emphasis is given to this theme in the Transport Programme and in the Telematics Application Programme. In the Telematics Programme, emphasis is given to the development and improvement of telematics applications in transport systems, whilst in the Transport Programme overall safety and security aspects are in the foreground. Of course, there is a strong interaction of technologies and contents between these Programmes.

The general objective of the Transport Programme is to achieve a pre-normative or pre-legislative conclusion for incorporation into the transport sphere, where safety is identified as having a decisive role.

Specific RTD objectives vary within the different areas of transport research:

Strategic

In the strategic area, which has an "umbrella-function" within the Transport Programme, safety is integrated in the overall context of sustainable transport systems, as defined in the Transport White Paper:

"Safety in transport is seen both from the point of view of the system users and others who are placed at risk. Social protection and cohesion is to be promoted by the conditions under which the transport systems are provided, in order to pursue social efficiency and equity."

Therefore, problems that have to be solved and are concerned with safety have been identified as:

- increasing congestion problems
- the high number of traffic accidents.

Rail

A major focus is the development and implementation of components providing compatibility of train control systems (ERTMS), including:

- on-board safety systems (referring to fail-safe function);
- safe spot and semi-continuous transmission systems;
- safe continuous transmission over non safe links.

There are also investigations about safety in operation, concerning:

- reliability and maintainability;
- safety aspects of human management.

Safety aspects are also included in the development of interoperability.

Air

To ensure and improve safety while coping with increasing air transport demand is a main topic in the air transport research area, which is divided into:

- Air Traffic Management (ATM), to improve efficiency in air transport;
- air transport safety and environment, to introduce new technologies and operational procedures for enhancing safety with respect to
 - passenger survivability,
 - flight operations,
 - external hazards,
 - environment;
- airports.

Urban

In the urban area, the objective is to shift modal split towards safer transport modes, e.g. from individual to collective transport and to improve safety by transport demand management and strategy development. A second point is to improve traffic safety in general in the urban area, e.g. through the use of parking management, pedestrian crossings, pavements, and means of reducing temporary dangers caused by construction sites.

Waterborne

Safety-related objectives in the waterborne transport research area are:

- to raise the competitiveness of EU shipping while maintaining a high safety level;
- to improve information systems, human machine interfaces and efficiency of inland navigation;
- to increase safety, efficiency and environmental protection in maritime operation, including
 - vessel operation and the transport of dangerous goods,
 - methodology of safety in maritime operations,
 - integrated ship control systems,
 - traffic management,
 - ports;
- to investigate the safety-related behaviour of human resources.

Road

Improving road safety is one of the key issues in the CTP. Within this research area, four main factors have been identified to achieve progress in improving safety:

- road and intersection design;
- vehicle design (to reduce injuries of vehicle passengers as well as vulnerable road users);
- traffic signing and control;
- individual and collective driver behaviour (e.g. appropriate speed, no alcohol and drugs, and the wearing of seat belts).

5. SUMMARY OF RESEARCH CLUSTERS

5.1 Overview

The RTD projects contributing to the safety and security theme can be considered within eight clusters. Each relates to one of the four RTD target areas identified in Section 4.

The research on safety and security is focused in four main areas:

- *Develop knowledge and methods*
- *Increase active safety*
- *Increase passive safety*
- *Improve human elements*

In this paper, the RTD projects in FP4 contributing to the development of safety and security are considered within eight topic areas or “clusters”. These clusters are:

Clusters

Reporting and (common) guidance

Assessments

Transport operation

Transport infrastructure

Driver/passenger safety

Non user safety

Qualifications/behaviour

Working conditions

5.2 RTD clusters

The titles and objectives of relevant RTD projects are listed in Annex 1. They are identified here, followed by a synthesis of the expected overall contribution of the research in each cluster. (Many projects contribute to more than one cluster; the following Table indicates their main focus.)

Reporting and (common) guidance

In the area of *reporting and (common) guidance*, the research aims to understand the different reports and protocols for handling accidents within Europe, with a particular focus on the maritime and road sectors. Based on this knowledge, a common framework for unified reporting will be developed. This should provide a basis for deriving specific safety measures, such as a “black box” for ships.

Assessment

In the area of *assessment*, methods are being analysed and /or developed to assess safety impacts or to provide risk analysis, mostly supported by simulations. This is mainly for the air and waterborne sectors.

Transport operation (active safety)

In the area of *transport operation (active safety)*, the research aims to specify, develop and demonstrate a range of components and measures.

In the rail sector, the work is mainly concerned with the introduction of the ERTMS (European Rail Traffic Management System).

Transport infrastructure (active safety)

In the cluster *transport infrastructure (active safety)*, the research aims to develop, test and demonstrate components, measures and methods to increase active safety, affiliated to the infrastructure elements of a transport system.

Driver/passenger safety

In the area *driver/passenger safety*, research aims to minimise the consequences of accidents for drivers and passengers in their transport means.

Non user safety

In the area of *non user safety*, research aims to reduce the impacts of accidents on affected people who are not drivers or passengers of the transport means.

Qualification/behaviour

In the area of *qualification/behaviour*, research aims to investigate the human role in future transport systems. This includes assessing the necessary skills of staff affected by the introduction of new technologies or procedures, and the provision of tools for qualifying the people involved. An additional item in this context is the development of standards and simulators for training operators/drivers to minimise human errors in operation. A main issue for the road sector is the improvement of driver behaviour, promoting driver awareness and/or improving safety by strict enforcement.

Working conditions

In the area of *working conditions*, the safety impacts of methods of working are being analysed, and measures to improve the working environment are being developed.

6. SYNTHESIS OF FINDINGS FROM COMPLETED PROJECTS

This Section provides a synthesis of the research objectives and main findings from completed projects for each of the RTD clusters defined in Section 5. The key results, policy implications and achievements of individual projects are summarised in Annex 2.

Results from the following projects have been included in the current version of this working paper:

Clusters	Sector	Relevant RTD projects
<i>Reporting and (common) guidance</i>	<i>Waterborne transport</i>	BERTRANC, CASMET, PHOENIX
	<i>Road</i>	STAIRS
<i>Assessments</i>	<i>Waterborne transport</i>	FASS, FSEA, SAFECO, SAFECO II, SEALOC
	<i>Air</i>	ARIBA
	<i>Road</i>	
<i>Transport operation (active safety)</i>	<i>Rail</i>	ACRUDA, EMSET, ERTMS Tests, EUROSIG, REMAIN
	<i>Waterborne transport</i>	ATOMOS II, COMFORTABLE, ICE ROUTES, INCARNATION
	<i>Air</i>	EMERTA, EURICE, NEAP
	<i>Strategic research</i>	MUSSST
<i>Transport infrastructure (active safety)</i>	<i>Road</i>	MASTER
	<i>Air</i>	CONTAMRUNWAY, GORAC
	<i>Waterborne transport</i>	
<i>Driver/passenger safety</i>	<i>Road</i>	ADRIA
	<i>Air</i>	ICEPS, IMPCHRESS
<i>Non user safety</i>	<i>Road</i>	PROMISING
<i>Qualifications/behaviour</i>	<i>Air</i>	ECOTTRIS, RHEA
	<i>Waterborne transport</i>	MASSTER, METHAR
	<i>Road</i>	
	<i>Rail</i>	HUSARE
<i>Working conditions</i>	<i>Waterborne transport</i>	HANDIAMI
	<i>Road</i>	ARROWS
	<i>Strategic research</i>	WORKFRET
	<i>Integrated transport chains</i>	FV-2000

6.1 Reporting and (common) guidance

Research objectives

Objectives in this area are:

- to develop a common methodology for investigating maritime accidents and improving the understanding of human elements in accidents;
- to reach a Confidential Hazardous Incident Reporting on a European level for the maritime sector, and to develop an analysis of the types of failure that lead to shipping accidents;
- to determine the fire risks on ships and develop a procedure to improve awareness of fire fighting safety conditions;
- to analyse available databases to identify required parameters that are not reflected in current accident reports for ships;
- to develop a "Maritime Black Box";
- to determine a framework for the harmonisation of a European road accident and injury database;
- to create guidelines for the design and assessment of urban safety management schemes (e.g. *safety for all* concept).

Main findings

In maritime operations, the number one hazard remains fire on-board ships. To help understand the various pre-conditions and parameters that lead to fire-related casualties, the evaluation of those events is a crucial starting point. Comprehensive attempts have been made to exploit structured data that are now available in databases that serve as input for operational and maintenance regulations. Computer-based tools for analysis and prevention of fire on-board ships have been developed, in particular addressing the needs of ship inspectors. Case studies on fire propagation under real-world conditions have been undertaken to validate computer simulation tools. Relevant safety codes as issued by the International Maritime Organisation (IMO) will need to be adapted to address real user needs accordingly.

A concerted action analysed and assessed current working practices and methodologies for maritime accident investigation, which commonly are based on setting up self-standing accident/incident databases. A guideline document, that compares various experts' opinions on methodologies for accident investigation, was devised, and best practice examples for training of accident investigators were identified. Furthermore, a framework to adopt the aviation Confidential Hazardous Incident Reporting Programme (CHIRP) for maritime accident investigation was defined, accompanied by a draft guideline addressing the specific requirements for accident data gathering and obtaining vessel and traffic statistics. Identified remedial tools related to the human element in improving maritime safety have targeted the implementation of a positive safety culture, drawing on experience in other transport sectors, such as air and rail.

Another research study compared maritime accident investigation procedures outside Europe, and schemes employed in other industries, such as aviation, nuclear and off-shore operations. Derived was the outline of a comprehensive methodology for accident recording and analysis, while in a complementary step a structure for coding information in a database was elaborated. In conclusion, a thoroughly maintained maritime accident database is strongly recommended, that would allow for the detailed individual assessment and analysis of accidents, as well as the statistical evaluation of the entire casualty record.

With the aim to ultimately trigger the establishing of a harmonised pan-European road accident injury database, a complex set of variables, associated detailed data fields, descriptors, and a glossary of terms was specified. The principal investigation approaches were analysed, namely retrospective studies, on-the-scene and on-time studies, and hospital based studies. A set of quality assurance procedures for data collection, initial data processing, and comparison and analysis of data from different sources was defined. The elaborated methodology and the framework for harmonised accident injury investigation was communicated to the automotive industry, universities and research centres, the International Standardisation Organisation (ISO), and several road safety conferences.

6.2 Assessments

Research objectives

Objectives in this area are:

- to provide a commonly accepted approach for assessing the safety and environmental impacts of ships, including risk analysis;
- to assess the need for a common methodology to investigate ship accidents;
- to demonstrate the application of risk analysis methods to assess economical and safe improvements in solutions for total quality management in the waterborne sector;
- to provide recommendations for improving safety in maritime transport of dangerous goods in Europe;
- to evaluate the navigation risk factors and level of safety of fast vessel operation;
- to provide European aeronautical administrations with new methods for defining the lightning threat for each specific new aircraft or helicopter programme;
- to assess certification issues for ground air traffic management systems and procedures, which can be used in future certification practices;
- to analyse traffic safety measures in relation to driver behaviour, to compare the safety effects of various safety measures, to assess the interaction of safety measures, to assess cost-benefit ratios, and to identify obstacles and chances for the implementation of safety measures in the road sector;
- to assess road-side testing equipment for drugs and medicines.

Main findings

Major achievements in the maritime sector have included the development of a simulator system to quantify risk levels and the effect of risk control options in defined geographical areas. Outputs have included the development and analysis of databases for marine casualties which help in understanding and modelling the causes of ship accidents, and the further development of structural integrity models for reliability assessment of ship design and maintenance strategies.

Currently, a common international approach to accident and incident reporting in shipping is underway, with a particular focus on risk analysis. This forms part of a Concerted Action on the assessment of accident and incident schemes. The Concerted Action has ascertained that a common safety and environmental assessment approach needs to be further developed and identified a number of areas within this framework in which research and development is also necessary, in particular risk acceptance criteria, risk management, risk communication, organisational changes, human and organisational factors and databases to provide relevant data for the common approach.

Moreover, studies have defined a structured hazard identification process for the evaluation of risk control options and the development of risk models. Related test runs with maritime

simulators to assess and verify risk control options, in this case led to improved training schemes for crew members. A fault tree model has been developed that links to the Marine Accident Risk Calculation System (MARCS) in order to assess the effectiveness of risk control options and to quantify related implementation costs. This finally allowed for an update of MARCS, accompanied by the evaluation of three case studies – the Rotterdam port approach area, the North Sea area, and its validation against historical accident statistics.

A specific Safety Assessment Philosophy building on the FSA methodology supported by the International Maritime Organization (IMO), and outlining the four key factors for risk analysis – operation, man/machine interface, technique and environment – has been developed. Three case studies on the "Amoco Cadiz" crude oil tanker accident, the transport of liquified petroleum gas (LPG) in the Mediterranean Sea, and the transport of containers in the North Sea, identifying and evaluating potential hazards during the whole shipping operation from harbour to harbour, have helped to validate this methodology. For those three aforementioned scenarios a case study safety assessment has been performed comprising activity descriptions, hazard identification, accident event analyses, assessment of frequency and consequences of accidents, and risk control measures addressed by various regulations. The outcome was a model for quantitative risk evaluation in the transport of dangerous goods for the categories crude oil, LPG and container service.

In the air sector the assessment of human operators' performance in terms of ATM safety by means of using adequate stochastic models has led to a consolidated certification framework in ATM that allows for an effective safety management in the implementation phase by responsible actors.

6.3 Transport operation (active safety)

Research objectives

Objectives in the rail sector are:

- to prepare for full-scale trials of the ERTMS in a number of test sites;
- to define the assessment framework for safety architectures and development of a certification scheme, for the ERTMS validation;
- to prepare the on-board ERTMS sub-system for testing on the Madrid-Seville line;
- to harmonise the rules and regulations for the ERTMS control and command system;
- to design and prototype a safe signalling system for ERTMS;
- to create methods and tools for evaluation of reliability, availability and maintainability features in railway systems.

Objectives in the air and waterborne sectors are:

- to specify, develop, test and evaluate examples of airborne and ground-based user applications to enhance the surveillance for Air Traffic Control (ATC), pilot situation awareness and GNSS precision navigation capability for all phases of flight;
- to develop a revised icing certification scheme which more closely reflects real world icing environments;
- to demonstrate the feasibility of an ice routing tool for safer and more efficient ship transport in ice-covered waters;
- to provide a design and assessment capability for ship control;
- to identify administrative and organisational barriers and assess information and organisational requirements and functionality for an efficient inland navigation information

system;

- to develop tools for vessel traffic service (VTS) operators for the recognition and assessment of traffic situations.

Main findings

For various transport systems, there remains an urgent need to optimise operational conditions and procedures without endangering safety standards. Automated solutions are of particular interest since they can avoid putting additional strains on traffic management staff, and thereby allow for considerable growth in transport demand without compromising safety.

The assessment of software tools and hardware, and their influence on human/machine interfaces, have been vital research activities to ensure effective implementation of new automated concepts e.g. for the foreseen European Rail Traffic Management System (ERTMS). These have been validated in the course of pilot and demonstration projects. Complementary to operational issues, safety-critical maintenance and organisational procedures have been proposed and evaluated, again based on a thorough assessment of the safety-related performance of all developed components. It was recommended that subsequent RTD on maintenance in the rail sector should develop specific application guidelines for railway operators.

In the frame of tasks to establish ERTMS, a System Requirement Specification (SRS), which describes all technical details and integrates the Reliability, Availability, Maintainability and Safety (RAMS) documentation, has been produced. In particular aiming at railway infrastructure, a complete set of interface, test and test tool specifications, ensuring true functional interoperability for operators throughout European rail networks, has been developed.

A set of verification tools for testing of Eurocab components, that have been limited to moderate levels of overall system functionality, has been developed. Dedicated laboratory and on-site tests were complemented by the Eurocab simulator undergoing acceptance tests. Additionally, verification tests were performed on the Spanish high speed link Madrid – Seville, including the Eurobalise signalling sub-system, using functional on-board prototypes, and the Euroradio communications sub-system. The first sub-system verified the reliable interoperability of track side components, transmission antennas and cockpit equipment, while the latter successfully validated the proper interaction between company specific data receivers and the uniform message generator.

In the maritime sector the focus has been on improvements of on- and off-board traffic information for coastal and inland waters. New tools for operation of vessel traffic services (VTS) involving recognition and assessment of complex traffic situations, or a River Information Service (RIS) consisting of three elements traffic image on board, logistic information, calamity abatement and fairway information have been developed and assessed. Conclusions have been that the effect of Tactical Traffic Image on safety will be limited, being the safety levels on inland waters already fairly high and that even after its introduction on board there will still be an important role for the existing Vessel Traffic Service (VTS) along the waterway. New tools for operational use of VTS involving recognition and assessment of complex traffic situations have been developed. Here, a technology-led approach combined with user-form workshops (VTS operators and managers) and interactive procedures to evaluate operator's awareness of traffic situations was used. Enhancements developed which particularly contribute to the safe traffic management include traffic situation displays, e.g. for collision warning and short-term path prediction.

To enhance active safety in ship operations a principal new conceptual standard for Ship Control Centre (SCC) design, including layout recommendations for future ship bridges, and a so-called 'tactical display' combining anti-grounding and anti-collision information tools, has been developed. The verification of this conceptual standard for SCC design in relation to efficiency (cost-benefit analysis) and safety has been done, by performing a risk assessment for collision route and fire ignition scenarios.

Comparable to efforts made in the framework of ERTMS, computer-based solutions for ship routing will help to reduce the amount of time-consuming human interpretation of information, which has been the subject of safety concerns, ambiguity and complaints about insufficient all weather capability and efficiency. Recommendations have been made aimed at further advancing ship route modelling techniques, taking into account the foreseen International Polar Code of Navigation, which will ensure a consistent strategy for improving the safety, efficiency and overall capability of maritime navigation in European and Russian arctic waters.

Communication, Navigation and Surveillance (CNS) in Air Traffic Management (ATM) is seen as one of the primary fields for GNSS-based services. In particular enhanced surveillance for Air Traffic Control (ATC), pilot situation awareness, and GNSS precision navigation capability for all phases of flight are planned for early implementation. Main positive impacts on safety are expected for vertical guidance of aircraft and situation awareness of pilots in the approach and landing phase, suitable guidance for taxiing aircraft on the ground independent of the weather, the separation of approaching aircraft by delegating responsibility from ATC to the cockpit, ATC surveillance by improved radar tracking, and continuously updated visual information on helicopter position in an uncontrolled airspace without a radar coverage.

In the light of the Next Generation Satellite System (NGSS) apparently failing to deliver improved and cheaper Aeronautical Mobile Satellite Services (AMSS) to aviation, a new concept by the European Space Agency (ESA) was proposed, building on the use of a set of geostationary satellites, to establish next generation AMSS that would as well allow to serve high-density airspace areas, for which construction of a technical demonstrator is underway. A specific feature – the implementation of Airborne Separation Assurance System (ASAS) applications – was found possible and beneficial in the short term with respect to the given data availability aboard the majority of aircraft.

Several projects in the meantime laid the groundwork for the top priority implementation of a European Global Navigation Satellite System. An important step was the proposal of a safety approval methodology for GNSS navigation services, comprising the following steps: a safety case methodology as the basis for formal approval of any GNSS application, Signal in Space (SIS) verification, application identification, which highlights the use in civil aviation, waterborne transport, and terrestrial transport, sensor qualification, mobile certification, and operational approval. This complex methodology was applied to a typical first generation Global Navigation Satellite System (GNSS-1) application from the waterborne sector, as identified in the EGNOS programme, and to the Galileo programme, the current scheme for a second generation (GNSS-2) application offering navigational assistance and related communication services.

A severe problem of turboprop aircraft and helicopters – i.e. ice formation on airframe and wing triggered by Supercooled Large Droplet (SLD) conditions – was investigated through flight tests with twin engine turboprop aircraft, building on the compilation of a database of

world wide icing related accidents and incidents from 1980 to 1995. The outcome has been the proposal of several updates and extensions to the existing FAR 25 Appendix C regulation to cover SLD conditions, the instrumentation to measure these conditions and the characterisation of atmospheric phenomena.

6.4 Transport infrastructure (active safety)

Research objectives

Objectives in this area are:

- to assess the cost-benefit and safety impact of integrated management of multi-modal traffic in ports;
- to identify Community requirements for vehicle speed control standards on European roads;
- to develop safety standards for highway design and redesign on all classes of road, including tunnels and bridges;
- to develop a system for weighing in motion of axles and vehicles;
- to assess new ground collision avoidance systems and develop certification requirements;
- to review the validity of the design requirements for takeoff and landing on runways contaminated by water, slush or snow.

Main findings

Speed management methods for roads across Europe have been assessed, leading to recommendations for speed management in compliance with the objectives of the Common Transport Policy; in particular, speed limits for roads of similar classification, guidelines for application of speed management measures, preparations for the introduction of in-vehicle speed limiters, "self-explaining" road design, automated speed enforcement, internalising external (accidents, environment) costs, campaigns to raise public awareness about the impacts of speed, and restriction of vehicle speeds.

In addition to an integrated European Air Traffic Management System (EATMS), advanced collision avoidance systems are needed to cope with the rapid growth in overall air traffic. All such innovations require certification and regulation. Research work has produced specifications for simulation facilities for the development of Ground Collision Avoidance Systems (GCAS), as well as guidelines for their certification. Such systems will help to relieve cockpit crews from dealing with complex information about obstacles, terrain elevation or runway specifications, thus promoting in-flight safety.

The existing operational regulations, that take account of weather induced runway conditions reflected by the so-called balanced field length, were found not applicable for smaller business and commuter aircraft. Performed full scale tests simulating runways contaminated with water, slush or dry snow, and using two business jets and a turboprop regional aircraft confirmed that the effects of water induced drag do significantly relate to e.g. airframe and wheel size, thus hampering the safety of smaller aircraft during take-off and landing. The results have been communicated to the European Joint Aviation Authorities and other worldwide authorities in order to trigger the adaption of existing regulations.

6.5 Driver/passenger safety

Research objectives

Objectives in this area are:

- to provide advanced dummy research for injury assessment in frontal test conditions, supported by simulations to gain knowledge on how to reduce casualties of vehicle occupants in frontal collisions of cars;
- to improve crash compatibility between cars in frontal and side collisions;
- to develop and promote improvements in passive vehicle safety, with emphasis on aspects where Community intervention would be most effective, with the aim of reducing casualties amongst vehicle occupants and other road users, e.g. by giving information to consumers in the form of a car safety declaration;
- to improve safety of children whilst travelling in aircraft and increase survivability in the case of dangerous accidents;
- to develop injury criteria for enhanced passive safety in aircraft and to develop assessment techniques for improved passenger-friendly cabin interiors, e.g. based on automotive industry standards.

Main findings

Driver and passenger safety in individual cars has significantly improved in the last decades, but suffered head injuries are still a major concern. A methodology to identify head injury mechanisms and to evaluate the current head injury criterion (HIC), based on the analysis and reconstruction of real world car accidents that had been leading to head injuries, has been elaborated. Comparative test series of three advanced test dummy faces (GM face, Volvo's DLSF and the new THOR face dummy from the US) have been performed, focusing on biomechanical tests on legs – including pendulum tests on toe, heel and feet, and sled tests simulating footwell intrusion – below and up to the injury level. An evaluation into the possible use of the new (US) THOR frontal crash test dummy in European legislative testing, showed the principal suitability despite deficiencies in the durability and handling of the dummy.

The safety of marginal groups on-board commercial aircraft has been addressed by reporting on currently used infant and child restraint devices (CRD), discussing restraint regulations of aviation authorities, and presenting the opinions of aviation authorities, operating airlines, cabin crews and consumer groups on current CRD practice. The outcome has been a European specification for CRDs as a baseline for integration of the theme into certification and operational regulations by the Joint Aviation Authorities. Principal parameters underlying these specifications are the safe restraint of children to the standard of other passengers, the minimisation of additional costs to aviation industry, the compatibility with European automobile restraint standards, the harmonisation with the upcoming US standard, the flexibility in CRD design, the inclusion of different flight phases, and the need to use CRDs only for passengers of less than 18 kg weight.

The influence of bio-mechanically relevant injury criteria for aircraft passengers in accident investigation was analysed by looking at two major crashes involving an Airbus A320 in September 1993, and a Boeing B737-400 in January 1989. Specifically, the regulations relating to emergency landing conditions, crash test dummy testing, and evacuation procedures, and the design of modern passenger seats were examined. The outcome were proposals for improving passive safety in aircraft cabins, that would concern a variety of Joint Aviation Requirements (JAR's), such as the certification of passenger seats, evacuation procedures, or the installation of wall panelling in airliner cabins. In particular, it was recommended to extend accident analysis beyond technical and human factors related aspects of aircraft performance, handling and failure.

6.6 Non user safety

Research objectives

Objectives in this area are:

- to show the potential for restriction in casualties of vulnerable road users (like pedestrians, cyclists, pavement vehicles and motorised two wheelers) by technical non restrictive measures, and to provide recommendations for policy makers.

Main findings

A future, more mode specific transport policy, addressing the particular requirements of pedestrians and cyclists, will have to come up with a set of practical criteria for traffic flow management, right of way regulations and other safety improvements for vulnerable road users. Drawing on best practice examples of innovative traffic concepts from Sweden and the Netherlands, that aim to increase the safety of vulnerable road users, a set of common design criteria was compiled. These design criteria for roads and anticipated traffic management schemes based on the knowledge of the specific mobility needs of pedestrians and cyclists have been assessed through cost-benefit analyses, which looked into twenty infrastructure/design and organisational measures, ranging from roundabout design, upgrading of pedestrian crossings, design of dedicated bicycle lanes to e.g. the daytime use of light on vehicles. Finally, an outlined implementation strategy aims at a better balance of the interests of different road users, improved co-operation between local and national traffic authorities, and direct involvement of road users in the planning and design processes.

6.7 Qualifications/behaviour

Research objectives

Objectives in this area are:

- to harmonise European maritime education and training schemes, by development of harmonised curricula, and by qualification and adaptation of training courses to the requirements of advanced technologies;
- to specify ship manoeuvres and operations to be exercised in simulators for harmonisation of maritime education;
- to produce a skill and training analysis and identify training requirements for flight crews to use advanced technologies;
- to produce functional requirements for the role of human operators in future ATM systems and the use of automation assistance tools;
- to develop a proposal for promoting non technical skills in air transport;
- to establish a common method for evaluating and improving human management for European cross-border railway lines, by adoption of a risk-based approach;
- to identify areas of non compliant road user behaviour on EU roads, and to assess alternative enforcement, monitoring, legal and administrative tools for enhancing compliant behaviour.

Main findings

The work allocation between increasingly automated components for Air Traffic Control (ATC) and advanced cockpit layouts of commercial aircraft have been targeted by some studies.

The transition training of cockpit crews from conventional to automated "glass cockpits" has been questioned in the light of accident and incident reviews. An in-depth investigation of

glass cockpits skills, identifying seven different "skill-groups" relating to three principal types of individual behaviour, i.e. knowledge-based, rule-based and skill-based behaviour; the investigation was performed. Related research has led to recommendations for a "Crew Resource Management (CRM) for glass cockpits" booklet, containing a set of real-life incident scenarios, highlighting the need for proper CRM in glass cockpit environments.

The operational success of Human Machine Interface (HMI) enhancements and machine aided evaluation, and the current testing of co-operative tools and dynamic allocation for ATC have been evaluated in the light of seven selected automation concepts that address the man/machine interface, such as controller as supervisor, machine proposal strategy, machine-aided evaluation, dynamic allocation with human delegation, dynamic allocation with machine delegation, and the dynamic aircraft delegation and cognitive (assistance) tools, which have been found most promising for several ATC environments.

Cross-border rail operations have been analysed under typical, degraded and emergency situations with respect to human factor related issues. A practical toolkit of techniques for railway operators has been brought up including the following main features: data collection, comparison techniques and documentation forms for rules, procedures and operational practices, in order to identify differences in rail infrastructures and connected human factors issues, and human factor analysis techniques, to identify possible human errors, available failure recovery measures and risk reduction strategies.

Employment of seafarers can be positively influenced, if the mobility of employees is supported by mutual recognition of certificates and (national) regulations. The overall attractiveness of the maritime industry and its public image concerning safety and environmental protection needs to be considerably improved. On the other hand training schemes must be harmonized along the requirements of the STCW 95 (Standards of Training, Certification and Watchkeeping) convention. The intensified use of advanced simulators situated at a variety of national research facilities, and exchange programmes for maritime lecturers are among the proposed specific measures.

A further study elaborated on simulator training exercises, addressing STCW 95 objectives and additional training objectives, e.g. for high speed vessels, on management aspects, or about the introduction of advanced bridge displays, such as ECDIS. In this context a methodology was devised for the development of operational and training scenarios, and the corresponding required exercises with particular focus on human factors related training. Sample assessment tools supplementing the set of assessment criteria connected to training objectives, and a comprehensive catalogue of scenarios which allows for searching of the whole set of training objectives, function levels and defined competences along the STCW 95 guideline were developed, which support the implementation of STCW 95 conventions in EU member states and outside the community.

6.8 Working conditions

Research objectives

Objectives in this area are:

- to identify the different working cultures in intermodal freight transport systems, to propose measures for higher safety and efficiency and to propose policy changes;
- to develop guidelines and management tools to improve working conditions and security

for freight village operators;

- to develop European standards for road work-zone safety;
- to improve human behaviour on ships with special attention to emergency situations, and to identify ship design requirements to reduce operator workload and increase comfort and alertness.

Main findings

Re-employment opportunities for disabled seafarers, leading to the conclusion that a switch to shore-based jobs, in maritime or related sectors, remains most likely due to inevitable safety constraints, have been comprehensively assessed. Only a dramatic shortfall in the supply of seafarers is expected to create the possibility of re-employing disabled crew members. The comparison of equal opportunities in employment in land-based jobs showed that this issue is widely neglected in the maritime industry.

Concerted activities towards the pan-European harmonisation and standardisation of road work zones were initiated, leading to a compilation of safety relevant recommendations for standardised planning, implementation and operation of road work zone measures. The outline is a Practical Handbook on 'Road Work Zone Safety' that tackles aspects such as specific construction site safety problems with a clear definition of typology and terminology, an outline of road work zone safety objectives and principles, guidance on how to implement road work zone measures through all phases of the process, a set of ready-to-use safety tips, guidance on the layout of road work zones, and provision of indicative checklists.

The nature of prevailing 'working cultures', and the organisational and management structures in (intermodal) freight transport across Europe were reviewed and analysed. A study assessed the impacts of new technologies in freight transport on the number of employed workers, their working conditions, the quality of jobs, the time pressure dictated by efficiency considerations and the membership to trade unions. It produced a ranking of ten key issues in the development of freight transport systems, and identified a total of twelve policy areas addressing the barriers faced by intermodal developments. Among the policy relevant topics covered were aspects such as the size of the freight sector work force, labour regulations, payment, social security, education and training, health and work safety, recruiting, organisational structures, behavioural codes, bargaining, employee and trade union involvement, and the general promotion of intermodal transport. From this package ten policy suggestions were derived.

Establishing freight villages (FV's) – in particular those of the integrated type, that allow for a change of transport mode at the terminal – was found to yield major benefits for regional economic development, owed to improved intermodality, the availability of attractive services, and the proximity of different transport and logistics activities at one site. From the assessment of freight village operations three management tools emerged, comprising a user-friendly handbook (Good Practice Code), addressing transport and storage operations in FV areas, a field-tested Decision Support System meant to help assess the risks connected to handling of dangerous and flammable goods, and a Training Software Tool including technical guidelines for operators, and providing recommendations on communication, organisational matters, professional skills and related training of staff.

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ANNEX 1 RTD PROJECTS CONTRIBUTING TO THE THEME

This Annex lists the titles and objectives of RTD projects relevant to the theme of safety and security. The following Table identifies the RTD cluster(s) to which each project contributes significantly.

Clusters	Sector	Relevant RTD projects
<i>Reporting and (common) guidance</i>	<i>Waterborne transport</i>	BERTRANC, CASMET, MBB, PHOENIX
	<i>Road</i>	DUMAS, STAIRS
<i>Assessments</i>	<i>Waterborne transport</i>	FASS, FSEA, SAFECO I, SAFECO II, SEALOC
	<i>Air</i>	ARIBA, FULMEN
	<i>Road</i>	GADGET, ROSITA
	<i>Rail</i>	ACRUDA, EMSET, ERTMS Tests, EUROSIG, HEROE, REMAIN
<i>Transport operation (active safety)</i>	<i>Waterborne transport</i>	ATOMOS II, COMFORTABLE, ICE ROUTES, INCARNATION
	<i>Air</i>	EMERTA, EURICE, NEAP
	<i>Strategic research</i>	MUSSST
	<i>Road</i>	MASTER, SAFESTAR, WAVE
<i>Transport infrastructure (active safety)</i>	<i>Air</i>	CONTAMRUNWAY, GORAC
	<i>Waterborne transport</i>	INTRA-SEAS
	<i>Road</i>	ADRIA, COMPATIBILITY, TSM
<i>Driver/passenger safety</i>	<i>Air</i>	ICEPS, IMPCHRESS
<i>Non user safety</i>	<i>Road</i>	PROMISING
<i>Qualifications/behaviour</i>	<i>Air</i>	ECOTTRIS, JAR TEL, RHEA
	<i>Waterborne transport</i>	MASSTER, METHAR
	<i>Road</i>	ESCAPE
	<i>Rail</i>	HUSARE
	<i>Waterborne transport</i>	HANDIAMI, MASIS II
<i>Working conditions</i>	<i>Road</i>	ARROWS
	<i>Strategic research</i>	WORKFRET
	<i>Integrated transport chains</i>	FV-2000

Project acronym	Title	Objective(s)
ACRUDA	Assessment and certification rules for digital architecture	The main objectives of ACRUDA are the definition of the assessment framework and criteria for safety architectures used in the guided public transport industry and the development of a certification scheme for safety architectures. The results are intended for the ERTMS validation.
ADRIA	Advanced crash dummy research for injury assessment in frontal test conditions	The aim of the project is to improve testing of crash dummies in front collisions. The project will recommend a design of a biofidelic crash dummy face, and evaluate the current head injury criterion in computer simulation of brain injury. Furthermore the project will assess a new crash dummy and lower leg dummy components for application under European conditions.
ARIBA	ATM system safety criticality raises issues in balancing actors responsibility	The main objectives of the ARIBA project are to assess certification issues for ground ATM systems and operational procedures, and to produce templates that could benefit the present ongoing and planned certification activities in Europe. The focus will be on space based navigation and surveillance, advanced ATC automation support tools and flight plan exchange through air ground data exchange.
ARROWS	Advanced research on road work-zone safety standards in Europe	The aim of the project is to develop a unified range of road work-zone safety measures and principles so as to mitigate adverse safety effects on workers and road users, and to produce a practical handbook of guidance for network managers.
ATOMOS II	Advanced technology to optimise maritime operational safety, integration & interface	The aim is to develop conceptual standards for a safe and efficient ship control centre and an open integrated ship control system. The aim will be towards fast cost-effective operation and interconnection between system modules for improved command, control, alarm and information systems.
BERTRANC	Methodology of safety in marine operations	The aim is to improve maritime safety by gaining a thorough understanding of the existing safety procedures and methodologies currently employed by Member States; and by gaining an appreciation of other transport systems and operations modes which could be employed in the maritime sector.
CASMET	Casualty analysis methodology for maritime operations	The project is concerned with establishing a common methodology for safety in maritime operations and for analysing the impact of the human element on maritime safety.
COMFORTABLE	To comfort VTS management	The aim is to develop tools for operators of Vessel Traffic Services for the recognition and assessment of traffic situations.
COMPATIBILITY	Improvement of crash compatibility between cars	The aim of the project is to provide a scientific approach to the question of crash compatibility between cars.
CONTAM-RUNWAY	Take-off and landing on runways contaminated by standing water, slush or snow	The aim is to review the validity of the existing requirements for operation on runways contaminated by rain, snow or ice for small and commuter aircraft.

Project acronym	Title	Objective(s)
DUMAS	Developing urban management and safety	The aim of the project is to establish a methodology to demonstrate how safety can be improved as part of a package meeting wider urban objectives, to produce a framework and guidelines for design and assessment of urban safety management schemes, and to demonstrate the validity of the methodology.
ECOTTRIS	European collaboration on transition training for improved safety	The main objectives of the ECOTTRIS project are: <ul style="list-style-type: none"> • to produce an accident and incident analysis in relation to transition training factors; • to derive operational and/or training factors which lead to possible safety risks as well as a skill and training analysis; and • to derive requirements and recommendations for transition training. A further output will be recommendations for cockpit hardware changes where improved procedures and/or training cannot solve the specific problem.
EMERTA	Emerging technologies opportunities, issues and impact on ATM	One of the primary objectives is to investigate the possible use of new NGSS systems for Air Traffic Service and Airline Operation Centre requirements without changes to the available service. A next step will involve providing specifications of detailed requirements for second generation satellite systems and services which are expected to be operational not before the year 2005.
EMSET	Functional EUROCAE component validation on the Madrid – Seville line	The main objective of EMSET is to perform the preparatory activities conducive to a full-scale functional validation of the onboard ERTMS subsystem. Such validation includes interoperability tests via several external specific transmission modules with some main existing signalling systems used in Europe.
ERTMS Tests	ERTMS test preparation	The project addresses the full range of preparation activities leading to full scale trial tests of the European Rail Traffic Management System in a number of pilot sites to be located in France, Germany and Italy. This includes the functional, system and subsystem specification as well as an overall safety concept. Aspects on ergonomics and automation will be addressed.
EURICE	European research on aircraft ice certification	The main objective is to examine current aircraft and rotorcraft icing problems and the related certification process, operational requirements and flight standards. The results should lead to a revision of the Joint Airworthiness Requirements (JAR) and its associated advisory material. The output will be a European database on theoretical investigations and flight tests for the development of improved forecast models for icing effects like freezing drizzle and freezing rain. Further recommendations will be worked out to improve the onboard icing protection systems and corresponding regulations.
ESCAPE	Enhanced safety coming from appropriate police	The main objective of the project is to identify important areas of non-compliant road user behaviour on EU

Project acronym	Title	Objective(s)
	enforcement	roads, and to conceptualise alternative enforcement, monitoring, legal and administrative tools for enhancing compliant behaviour.
EUROSIG	Development of the complete ERTMS concept	The main objective of EUROSIG is the development of a European wide common concept for a railway safe signalling system. EUROSIG should demonstrate the technical feasibility of the ERTMS system concept as well as establish a common approach to assess the system safety.
FASS	Fast ships safety – operational safety requirements, procedures and training tools	The project is concerned with widening the understanding of the safety risks attached to the rapidly increasing deployment of high-speed craft in European waters and, in particular, heavy traffic areas.
FSEA	Concerted action on formal approaches to risk assessment for sea-borne transport in European waters	This Concerted Action aims to establish a common level of knowledge within European shipping of systematic methods to assess the levels of safety and the environmental impact of shipping. Further, the action deals with the risk associated with human factors.
FULMEN	Analysis of experimental data and models for upgraded lightning protection requirements	The aim is to provide new methods for defining the lightning threat for aircraft and give an evaluation of the threat levels.
FV-2000	Quality of freight villages structure and operations	The aim is to analyse and evaluate freight village structure and layout in order to determine the extent to which the proximity of various transport and logistics activities influences the use of intermodal transport. The study will also establish the merits and limits of freight village development to benefit intermodal transport.
GADGET	Guarding automobile drivers through guidance, education and technology	The aims of the project are to list, describe, analyse, compare and evaluate traffic safety measures that are known to influence driver behaviour, to assess cost-benefit ratios in those cases where possible, and to consider obstacles and prospects for the implementation of safety measures.
GORAC	GCAS Operational Requirements and Certification	The main objectives of the GORAC project are to identify the requirements for a Ground Collision Avoidance System (GCAS) and to elaborate acceptable certification requirements and procedures.
HANDIAMI	Investigation of the employment of disabled persons in the maritime industry e.g. new shore based jobs and the problems of disabled passengers in access and emergency situations.	The main objectives of the HANDIAMI project are: <ul style="list-style-type: none"> • to undertake a detailed comparative analysis of the level of existing provisions for disabled passengers in the maritime and other transport sectors, • to develop introductory training material for managers and staff in the maritime industry, • to promote the employment and retention of disabled maritime workers, and • to highlight any safety specific issues that impact on ship design, operation and training.
HEROE	Harmonisation of European rail rules for operating ERTMS	The main objective of HEROE is to harmonise rules and regulations for the new ERTMS control-command system in nominal and degraded situations. A common

Project acronym	Title	Objective(s)
		level of safety will be fixed and the transition period will be addressed.
HUSARE	Human safe rail in Europe - managing the human factor in multi-cultural and multi-lingual rail environments	The main objective of this project is to establish a common method for evaluating and improving human management in order to increase safety and reliability for European cross-border railway lines. A risk based approach will be adopted to ensure that the effort associated with standardising rules and operational procedures will be directed at those aspects of railway operations which are most critical in terms of the risks that could arise if human errors occur.
ICEPS	Injury criteria for enhanced passive safety in aircraft	The main objective of the ICEPS study is to develop new assessment criteria for enhanced passive safety in aircraft based on an accident analysis and the experience from the car sector. There exist obvious gaps in the existing standards and regulations, and the study results are intended to serve possible improvements.
ICE ROUTES	The application of advanced technologies to the routing of ships through sea ice	The overall goal of this research project is to demonstrate the feasibility of a sea-ice routing tool for safer and more efficient ship transport in ice-covered waters, including the developing trade route through the Russian Arctic to the Pacific.
INCARNATION	Efficient inland navigation information system	The aim is to examine the feasibility of providing vessel traffic information services for inland waterways. The project will examine the requirements for providing river navigators with operational traffic images from shore based radar and other information sources.
INTRA-SEAS	Safety and economic assessment integrated management of multi-modal traffic in ports	The project will provide a safety and economic assessment of the performance of port-related intermodal transport management together with the development of software simulation tools to assist in the assessment.
IMPCHRESS	Development of European specifications for improved infant and child restraint devices (air transport)	The main objective of the IMPCHRESS project is to improve the safety of children whilst travelling in aircraft, particularly in the event of a survivable accident or dangerous aviation incident. Outputs will be a survey and statistics about the present situation throughout Europe and the US, and an assessment of the feasibility of improvements. A key output will be a proposal for the modification of current JAA certification and operational requirements to bring children's survivability and safety standards to the level of adults.
JAR TEL	Joint Aviation Regulations – translation and elaboration of legislation	The main objective of the JAR TEL project is to improve human factors related requirements laid down in JAA regulations. This could be done by a proposal for a harmonised application of rules that could be laid down in an Acceptable Means of Compliance (AMC).
MASIS II	Human element in man/machine interface and interaction to improve safety and effectiveness of transport for	The main objective is the improvement of human behaviour and performance on board ships, particularly in an emergency. Practical tools and procedures will be developed for effective human-machine interfaces so as

Project acronym	Title	Objective(s)
	the European fleet	to reduce the impact of the human element in marine accidents.
MBB	Maritime Black Box	The Maritime Black Box (MBB) project aims to provide complete and reliable information on the circumstances on board ships suffering accidents, so that lessons may be learnt for their future prevention.
MASSTER	Maritime standardised simulator training exercises register	The aim is to harmonise maritime education and aid the standardisation of simulator exercises.
MASTER	Managing speeds of traffic on European roads	The aim is to provide recommendations for speed management strategies and policies and develop guidelines for the development of innovative speed management tools.
METHAR	Harmonisation of European MET Schemes	The aim is to contribute to the improvement of maritime education and training standards in Europe.
MUSSST	Methodology for the validation of the use of GNSS (including development of certification, qualification and standardisation)	The project aims at developing a methodology for the operational implementation of Global Navigation Satellite Systems (GNSS) for users in all transport modes. Major objectives are to define all relevant inputs and tools, as well as the most important actors, required for finally gaining operational approval for a GNSS application.
NEAP	North European CNS/ATM application project	The main objectives of the NEAP project are to specify, develop, test and evaluate examples of airborne and ground based user applications in the areas of enhanced surveillance for Air Traffic Control, pilot situation awareness and GNSS precision navigation capability for all flight phases.
PHOENIX	Identification and quantification of the variables and parameters that aid in evaluating fire risk on board ships in accordance with their condition	The PHOENIX project is concerned with the quantification of the risk of fire on board ships with a view to identifying underlying causes of non-compliance with fire prevention and fire-fighting regulations. PHOENIX aims to encourage a common approach to fire risk assessment and accident reporting in the human domain.
PROMISING	Development and promotion of measures for vulnerable road users with regard to mobility integrated with safety taking into account the inexperience of the different groups	The aim of the project is to show the potential for restriction in casualties of vulnerable road users: pedestrians, cyclists, motorised two wheelers and young drivers, by technical non-restrictive measures. These measures will be compared with other measures to enable (local) policy makers to weigh measures against each other. To judge the restrictiveness, criteria will be developed and the road user viewpoint will be taken on board.
REMAIN	Modular system for reliability and maintainability management in European rail transport	REMAIN aims to create practical and realistic methods and tools for evaluation of RAM (Reliability, Availability, Maintainability) in railway systems. Requirements for railway components crucial for safety and efficiency on a European basis will be defined.

Project acronym	Title	Objective(s)
RHEA	Role of the human in the evolution of ATM systems	The main objectives of the RHEA project are to provide automation strategies to guide systematically the decision process for automating functions in an Air Traffic Management System of the future. Based on currently important functions within ATM, future ones will be identified in qualitative and quantitative terms. In addition, the future functional requirements of human operators and automation assistance tools will be addressed.
ROSITA	Road site testing assessment	The objectives of the project are to establish a list of drugs/medicines that have a detrimental impact on road user performance, to determine the operational, user and legal requirements across the EU for road site testing equipment and to make recommendations for the state of the art application.
SAFECO	Safety of shipping in coastal waters	SAFECO aims to increase the safety of shipping in European coastal waters by analysing the underlying factors that contribute to the risk of accidents, thereby supplying policy-makers and regulators with improved information. The use of simulators to help establish risk quantification methods is a key element of SAFECO. A major contribution of the project will be the provision of a system to assess the performance of ship bridge trainees and to model crew errors so as to enable the study of combinations of human failures.
SAFECO II	Safety of shipping in coastal waters: Demonstration of risk assessment techniques for communication and information exchange	SAFECO II is concerned with safe, pollution-free and economical shipping in European coastal waters. The project focuses on risk analysis and the application of risk analysis methods to assess improvements in safety, environmental performance and cost effectiveness. The SAFECO II project builds on a risk model developed in the first SAFECO project. It is concerned with demonstrating the application of risk analysis methods to the assessment of the safety, environmental and financial benefits of improved technologies and procedures for communication and information exchange in a shipping traffic context.
SAFESTAR	Safety standards for road design and redesign	The aim of the project is to formulate safety arguments for selecting certain design elements or recommending certain dimensions to be included in design guidelines or possible standards for road safety conditions.
SEALOC	Assessing concepts, systems and tools for a safer, more efficient and lower operational cost of the maritime transport of dangerous goods.	The aim is to provide recommendations for the improvement of safety in maritime transport of dangerous goods in Europe, through the implementation of telematic solutions. To achieve this, three case studies will be carried out using a Formal Safety Assessment methodology.
STAIRS	Standardisation of accident and injury registration systems	The aim of the project is to propose a framework for the harmonisation of European in-depth road accident and injury databases, and to produce recommendations for conversion factors, common formats and methodologies for collecting data from road accidents.

Project acronym	Title	Objective(s)
TSM	Traffic safety model	The aim of this project is to develop a car safety declaration model for cars.
WAVE	Weighing-in-motion of axles and vehicles for Europe	The aim of the project is to improve the accuracy of conventional Weigh-In-Motion systems through the use of arrays of sensors, and to develop and improve the function and accuracy of bridge based Weigh-In-Motion systems under different conditions.
WORKFRET	Working cultures in the face of intermodal freight transport systems	The aim of the project is to contribute to the development of an efficient freight transport system in Europe, taking into account the interests and requirements of the people who actually operate them.

ANNEX 2 MAIN FINDINGS FROM COMPLETED RTD PROJECTS

This Annex summarises the findings from completed projects for which the Final Report has been approved or made available (in alphabetic order of project acronyms). Project web page references are provided where known. Summaries of all projects are available from the two web sites given in Section 1 of this paper.

Index of available RTD project results:

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Project acronym and title**Key results and policy implications****ACRUDA:****KEY RESULTS****Assessment and certification rules for digital architectures**

ACRUDA has produced:

- recommendations on the content of a Quality Handbook that describes a quality system for assessment of safety-critical digital structures in the field of railway signalling;
- a common set of assessment criteria to evaluate the processes and products of the digital architecture with regard to product life cycles – the ACRUDA assessment procedures and criteria for vital computers;
- software assessment criteria that address requirements, planning, design, testing, integration and validation of software products; and
- hardware assessment criteria that cover requirements, design and testing with respect to defined standards like CEN03 or IEC01.

The following steps have been carried out to validate the assessment framework for practical use:

- three application cases helped gain experience on the use of the assessment methodology, for different types of safety digital structures
 - DIGISAFE, single channel architecture, based on the coded mono-processor,
 - ELEKTRA, dual channel architecture, adopting safety bag techniques,
 - SARA, modular computer-based architecture including distributed processing and a hierarchical layered control system, adopting hardware redundancy for vital sections;
- close interaction with the ERTMS (European Rail Traffic Management System) project strengthened technical links for the application of assessment methods on ERTMS test sites;
- integration of two demonstration sites in Paris and Naples; and
- organisation of two User Group Meetings with the aim of reaching relevant actors in the European rail industry, especially those involved in ERTMS.

POLICY IMPLICATIONS

The project's results will be adopted for ongoing validation of ERTMS demonstration sites. The contribution to policy issues is expected to evolve in the overall frame of the development of rail traffic management concepts.

ADRIA:**KEY RESULTS****Advanced Crash Dummy Research for Injury Assessment in Frontal Test Conditions**

ADRIA has produced:

- a methodology to identify head injury mechanisms and to evaluate the current head injury criterion (HIC), based on the analysis and reconstruction of real world car accidents that had been leading to head injuries;
- tests, utilising so-called post mortem human surrogate (PHMS) specimens, increasing the biomechanical knowledge on the dynamic response and tolerance of the human face under realistic impact conditions;
- comparative test series of three advanced test dummy faces (GM face, Volvo's DLSF and the new THOR face dummy from the US), evaluating results against findings from PHMS testing;
- an in-depth, retrospective accident analysis to investigate the types and mechanisms of lower leg (leg, foot and ankle) injuries sustained by car occupants in frontal collisions;
- a series of biomechanical tests on volunteer and PHMS legs – including pendulum tests on toe, heel and feet, and sled tests simulating footwell intrusion – below and up to the injury level; pendulum tests were reproduced with two advanced dummy legs and feet;
- an evaluation into the possible use of the new (US) THOR frontal crash test dummy in European legislative testing, which showed the principal suitability despite insufficiencies in the durability and handling of the dummy.

Project acronym and title**Key results and policy implications**

The project website can be found at

<http://www.automotive.tno.nl/crash-safety/html/mframe.htm>

POLICY IMPLICATIONS

The project's findings on the usability of new crash test dummies, such as the THOR face dummy and the THORix leg dummy, should be thoroughly evaluated in future research and must be validated against the current Hybrid-III test dummy, before a next generation crash test dummy can be introduced in European legislative testing.

ARIBA:**ATM System Safety Criticality Raises Issues in Balancing Actors Responsibility****KEY RESULTS**

ARIBA has produced:

- five in-depth studies covering the following aspects:
 - an assessment of existing certification practices in other risk critical domains,
 - an assessment of the human operators' performance in terms of ATM safety by means of using adequate stochastic models,
 - a case study on safety impacts of advanced ATM automation equipment in order to relate performance settings on automated sub-systems to overall safety design targets;
- a consolidation of results to bring up a certification framework in ATM that allows for an effective safety management in the implementation phase by responsible actors:
 - Part I presenting an improved ATM safety certification framework applicable for various commercial actors in ATM, identifying how authorities could support best practice approaches by enforcement of formal survey and approval;
 - Part II outlining in guidelines the safety validation of changes to systems or operations in ATM by development of suitable risk criteria, dependability techniques for the assessment of technical (sub-)systems, task load analysis for pilots and controllers, fast-time simulation to assess air traffic network characteristics, hazard identification and classification techniques, accident risk assessment techniques, feedback to advanced operation, and techniques to identify pro-active and reactive safety improvements of operation and service;
 - Part III outlining in guidelines the safety validation of automated ATM systems by manufacturers of those components.

The project website can be found at

<http://www.nlr.nl/public/hosted-sites/ariba/index.html>

POLICY IMPLICATIONS

The project's results will be utilised to further develop recommended standards in the implementation of safety related ATM equipment. This may in particular comprise the development of a safety forecasting model using a set of measurable and available indicators prior to the system becoming operational, but taking into account data and feedback from already operational systems.

ARROWS:**Advanced Research on Road Work Zone Safety Standards in Europe****KEY RESULTS**

ARROWS has:

- compiled a comprehensive list of road work zone safety principles, understood to be suitable for guidance in planning, design and operation of construction sites, such as typology, standards and practices, behavioural factors, accidents and countermeasures;
- performed a pilot study on accident scenario construction, after available accident studies showed little useful information related to work zone casualties;
- outlined a set of safety relevant recommendations for standardised planning,

Project acronym and title**Key results and policy implications**

- implementation and operation of road work zone measures; and finally
- produced a consolidated Practical Handbook on 'Road Work Zone Safety' comprising the following aspects:
 - definition of specific construction site safety problems (awareness raising),
 - clear definition of typology and terminology,
 - an outline of road work zone safety objectives and principles,
 - guidance for all involved actors, i.e. road authorities, designers, contractors, site personnel and executive bodies (e.g. traffic police), on how to implement road work zone measures through all phases of the process, i.e. planning, design, installation, operation and removal,
 - a ready-to-use set of safety tips for the aforementioned implementation phases,
 - guidance on the layout of road work zones with respect to traffic control, information and warning equipment, guiding and protective elements on the road, and safety equipment for workers, and
 - provision of indicative checklists that can be used in the planning, as well as in the operational phase, covering the specific details of road work zone safety, such as
 - traffic and speed management,
 - physical design of construction sites,
 - work zone operation and maintenance,
 - individual safety of workers.

The project website can be found at <http://www.ntua.gr/arrows/>

POLICY IMPLICATIONS

The ARROWS project has initiated concerted activities towards the harmonisation and standardisation of road work zones, which should be exploited by applying the recommendations compiled in the Handbook on a pan-European level. The established dissemination forum will help to reach all involved actors, and will assure easy accessibility of useful tools – in particular the ARROWS Handbook – via the project website.

ATOMOS II:**Advanced Technology to Optimize Maritime Operational Safety, Integration and Interface*****KEY RESULTS***

ATOMOS II has produced:

- a conceptual standard for Ship Control Centre (SCC) design, including layout recommendations for future ship bridges, and a so-called 'tactical display' combining anti-grounding and anti-collision information tools;
- an Advanced Information Processing;
- the verification of the conceptual standard for SCC design in relation to efficiency (cost-benefit analysis) and safety, performing a risk assessment for collision route and fire ignition scenarios;
- a conceptual standard for Integrated Ship Control (ISC) systems;
- a harmonised Human-Machine Interface (HMI);
- a standardised process network; and
- a conceptual standard for ISC Systems versus interoperability and interconnectivity.

The project website can be found at <http://www.atomos.org/>

POLICY IMPLICATIONS

The project's brought up conceptual standard for SCC design and contributions to the ISC standard have provided the called-for framework and standard architecture. Appraisal of key output documents from the ATOMOS II project by the chairman of the current IEC (International Electrotechnical Commission) working group on the standardisation of ship bridges has been very positive and found the results visionary.

**Project acronym
and title****Key results and policy implications****BERTRANC:****Methodology of
Safety in Marine
Operations****KEY RESULTS**

BERTRANC has:

- held ten meetings of experts in the so-called Concerted Action Committee (CAC);
- analysed and assessed current working practices and methodologies for accident investigation, which commonly are based on setting up self-standing accident/incident databases;
- identified best practice examples for training of accident investigators, found considerably varying among EU member states;
- identified best practice examples of methodologies for accident investigation, which have been synthesised into a guideline document, that compares various experts' opinions;
- defined a framework to adopt the aviation Confidential Hazardous Incident Reporting Programme (CHIRP) for maritime accident investigation;
- drafted guideline documents addressing the requirements for accident data gathering and obtaining vessel and traffic statistics, respectively;
- specified a pan-European Common Maritime Accident Investigation Methodology, building on a complementary framework for data collection and analysis; and
- identified remedial tools related to the human element in improving maritime safety, based on the implementation of a positive safety culture, that would draw on experience in other transport sectors, such as air and rail.

POLICY IMPLICATIONS

The BETRANC concerted action has outlined three major in-depth tasks to be considered in the 5th Framework Programme. Firstly, a pilot project to test the CHIRP concept has been proposed, focusing on incident reporting rather than just analysing maritime accidents. A further proposal targeted the training of accident investigators, based on a pilot scheme of an Open Flexible Learning (OFL) approach. Finally, a study has been suggested concentrating on the human factor in maritime and other accidents. The basic idea has been to allow accident investigators to understand and assess the human element, drawing on a database set up to provide the suitable questions required for analysis.

CASMET:**Casualty Analysis
Methodology for
Maritime Operations****KEY RESULTS**

CASMET has:

- carried out a critical assessment of current (European) practices for maritime accident investigation and analysis;
- found existing practices for casualty investigation considerably varying, even though common features could be identified as well;
- discovered a frequent shortcoming in taking into account Human and Organisational Errors (HOE), or an inadequate treatment of these issues, respectively;
- compared maritime accident investigation procedures outside Europe, and schemes employed in other industries, such as aviation, nuclear and off-shore operations;
- described a comprehensive methodology for accident recording and analysis, while in a complementary step a structure for coding information in a database was elaborated;
- tested and validated the project's approach by considering a set of typical accident scenarios and occurred, well documented casualties, that had been attributed to technical as well as HOE factors; and
- performed a simplified cost-benefit analysis aimed to assess the actual benefits of implemented risk reduction measures, however with respect to a rather limited

Project acronym and title**Key results and policy implications**

availability of significant cost figures.

POLICY IMPLICATIONS

One of the key findings from CASMET is that a common, European-level, comprehensively structured, and thoroughly maintained maritime accident database is strongly recommended. Such a database would allow for the detailed individual assessment and analysis of accidents, as well as the statistical evaluation of the entire casualty record.

COMFORTABLE:***KEY RESULTS*****Advanced benefits for logical VTS equipment**

COMFORTABLE has developed new tools for operation of vessel traffic services (VTS) involving recognition and assessment of complex traffic situations. A technology-led approach combined with user-form workshops (VTS operators and managers) and interactive procedures to evaluate operator's awareness of traffic situations (SAtest, Situation Awareness Testing) was used. Enhancements developed which particularly contribute to the safe traffic management include:

- traffic situation display including collision warning for dense traffic coastal VTS and short-term path prediction in non-dense traffic VTS areas;
- regional traffic image including processing methods to construct the traffic state of any regional sea area (MATIA project, Maritime Traffic Image Advanced System); and
- the use of short-term past to predict the short-term future including the recognition and assessment of traffic situations that provide the users with statistics of traffic events (improved EPTO tool, European Permanent Traffic Observatory).

POLICY IMPLICATIONS

Recommendations have been produced which relate to short-term prediction and presentation factors. The development and testing of enhanced automatic collision warnings showed that more efficient detection of collision danger is possible. The aim of reducing alarm frequency significantly can be pursued by research on warning ranking and best design for warning presentation, continuation of the experiments involving VTS operators, harmonisation of simulator experiments, optimisation using scenario studies of encounter situations in narrow waters.

COMPATIBILITY:

The final results of this project were not available when this Thematic Paper was prepared.

Improvement of crash compatibility between cars**CONTAMRUNWAY:*****KEY RESULTS*****Take-off and Landing on Runways Contaminated by Standing Water, Slush or Snow**

CONTAMRUNWAY has:

- reviewed existing regulations and manuals relevant for aircraft certification with respect to runway conditions;
- conducted water pond trials, in order to simulate runway contamination, with two aircraft models, a Cessna Citation II business jet and a larger Dassault Falcon 2000 business jet, assumed to represent a wide range of executive and commuter aircraft;
- performed complementing tarmac tests on dry snow using the above aircraft plus a Saab 2000 turboprop regional aircraft, focusing on the measurement of hydrodynamic drag and aquaplaning phenomena;
- theoretically studied the effect of water induced drag corresponding to e.g.

**Project acronym
and title****Key results and policy implications**

airframe and wheel size, and proposed a computer based forecast methodology for spray impingement drag in order to increase the safety of smaller aircraft during take-off and landing;

- concluded that the mentioned AMJ 25x1591 directive is in general not applicable for smaller aircraft with respect to certification and operation; and
- communicated results to the JAA Flight Study Group and other worldwide authorities, in order to pave the way for adaptations of existing regulations.

POLICY IMPLICATIONS

Indeed the study CONTAMRUNWAY has been limited to smaller business and commuter aircraft which points at the need to enlarge the data base to allow for a comprehensive assessment of operational regulations, such as JAR-OPS1. Airworthiness authorities are asked to promote more advanced computation models that would allow for the calculation of aircraft specific values for the so-called balanced field length, as recommended in existing operational regulations.

**DUMAS:
Developing urban
management and
safety**

The final results of this project were not available when this Thematic Paper was prepared.

**ECOTTRIS:
European
Collaboration on
Transition Training
Research for
Improved Safety*****KEY RESULTS***

ECOTTRIS has produced:

- a comprehensive analysis of flight deck design philosophies employed by various aircraft manufacturers, focusing on automated flying functions like steering, navigation, system management, communication and lookout;
- an accident and incident review, identifying factors related to automation/glass cockpits and poor transition training of crews;
- an in-depth investigation of glass cockpits skills, identifying seven different "skill-groups" relating to three principal types of individual behaviour, i.e. knowledge-based, rule-based and skill-based behaviour; the investigation was performed by distributing a targeted questionnaire to glass cockpit pilots in Europe; the most important skill-groups found in the evaluation related to knowledge of automation and decision-making;
- an assessment of current training and transition activities at prominent airlines (British Airways, Lufthansa) and the aircraft manufacturer Airbus;
- recommendations for a "Crew Resource Management (CRM) for glass cockpits" booklet, containing a set of real-life incident scenarios, highlighting the need for proper CRM in glass cockpit environments;
- an assessment of PC-based simulation software by performing tests with sample pilots from British Airways and later evaluating feedback by means of a questionnaire; and
- a set of specific recommendations concerning training content, training methods and the associated training media.

POLICY IMPLICATIONS

The project's results – in particular the detailed set of recommendations for pilot training and performance – will be used to enhance future transition training initiatives for glass cockpit pilots. The transition of crews from conventional or hybrid cockpits to state-of-the-art glass cockpits (with the underlying automation process) will influence working conditions to a considerable extent and thus have to be addressed in coming studies on human factor related safety of flight operations.

**Project acronym
and title****Key results and policy implications****EMERTA:****Emerging
Technologies
Opportunities, Issues
and Impacts on ATM****KEY RESULTS**

EMERTA has produced:

- assessed the use of current Satellite Communications (SATCOM) technology aboard some 2000 aircraft, mainly serving oceanic and remote routes;
- found that NGSS has apparently failed to deliver improved and cheaper Aeronautical Mobile Satellite Services (AMSS) to aviation since its introduction in the mid 1990s;
- discussed the impact of the recent demise of the Iridium satellite system on industry efforts to establish Aeronautical Mobile en-Route Satellite Services (AM[R]SS), that would require to address the specific needs of civil aviation as endorsed by the International Civil Aviation Organization (ICAO);
- proposed a new concept by the European Space Agency (ESA), building on the use of a set of geostationary satellites, to establish next generation AMSS that would as well allow to serve high-density airspace areas, for which construction of a technical demonstrator is underway;
- forecast a Europe-wide commercial aviation related AM[R]SS market of some 20 to 60 million Euro by the year 2008; and
- concluded that the implementation of Airborne Separation Assurance System (ASAS) applications is possible and beneficial in the short term with respect to the given data availability on board the majority of aircraft, once the remaining technical and institutional barriers have been overcome.

POLICY IMPLICATIONS

The study EMERTA recommends further activities to encourage NGSS and ASAS applications in order to improve safety and capacity in Air Traffic Management. Those future work needs to be integrated in RTD initiatives focused at establishing an overall European Air Traffic Management System (EATMS).

EMSET:**Eurocab Madrid –
Seville European
Tests****KEY RESULTS**

EMSET has:

- completed the specifications of the Eurocab tests, and associated tools for site tests;
- developed 40 Eurocab tools for dedicated laboratory and on-site tests, with the Eurocab simulator undergoing acceptance tests;
- performed FFFIS (Form Fit Functional Interface Specifications) verification tests on the Spanish high speed link Madrid – Seville
 - for the Eurobalise signalling sub-system, using functional on-board prototypes from companies Adtranz, Ansaldo, Alstom and Siemens; in particular the reliable interoperability of track side components, transmission antennas and cockpit equipment was verified, and
 - for the Euroradio communications sub-system using equipment from companies Alstom, Adtranz, Ansaldo (with CSEE Transport), Alcatel and Dimetronic; more specifically the proper interaction between company specific data receivers and the uniform message generator was successfully validated.

POLICY IMPLICATIONS

The EMSET project has developed a set of verification tools for testing of Eurocab that have been limited to moderate levels of overall system functionality. The future reference (i.e. Class1 functionality) for interoperability testing and validation of the complete ERTMS will be derived from the set of tools that have been specified and

Project acronym and title**Key results and policy implications**

<p>ERTMS Tests:</p> <p>ERTMS Proof of Feasibility and Preparation of Tests</p>	<p>applied during the EMSET project duration. For the Euroradio component of the whole system some inconsistencies with the definition of transmission protocols at user level and GSM specifications have been determined, which hint at the need for additional compliance testing in this area.</p> <p>KEY RESULTS</p> <p>ERTMS Tests has produced:</p> <ul style="list-style-type: none"> • a System Requirement Specification (SRS), which describes all technical details and integrates the Reliability, Availability, Maintainability and Safety (RAMS) documentation; • a review of interface specifications between the elements of the system in order to ensure interoperability of the European Train Control System (ETCS); • a set of specifications for testing the system, including scenarios for demonstration sites in different countries; • Specific Transmission Module (STM) prototypes for future testing; • three contracts for pilot and demonstration sites, taking account of the need to upgrade existing commercial lines; the selected trial sites comprised an approx. 40 km long TGV link between Paris CDG airport and Tournan (SNCF), an approx. 40 km long section of the Berlin – Halle/Leipzig main line (DB), and a 70 km long high speed line between Arezzo and Firenze (FS); and • regular CD-ROMs to disseminate all project results to relevant stakeholders and actors. <p>POLICY IMPLICATIONS</p> <p>The project's results contribute to the implementation of the whole ERTMS/ETCS concept by proofing the feasibility of new common approaches towards rail traffic management systems. From elaborating all relevant technical specifications the project helped bridge the gap to pilot and demonstration applications of existing railway environments.</p>
<p>ESCAPE:</p> <p>Enhanced safety coming from appropriate police enforcement</p>	<p><i>The final results of this project were not available when this Thematic Paper was prepared.</i></p>
<p>EURICE:</p> <p>European Research on Aircraft Icing Certification</p>	<p>KEY RESULTS</p> <p>EURICE has:</p> <ul style="list-style-type: none"> • reviewed the scope of icing hazards in aviation, evolving into a database of world wide icing related accidents and incidents from 1980 to 1995; • collected and analysed existing icing atmosphere data, and developed a relational database accessible via the internet; • carried out flight tests with twin engine turboprop aircraft employed by three national research centres to investigate into Supercooled Large Droplet (SLD) conditions that trigger ice formation on airframe and wing, while utilising the latest measurement equipment; • reviewed existing regulations for design and certification of fixed-wing aircraft and helicopters with respect to operation in icing conditions, and sought feedback from manufacturers of turboprop aircraft and rotorcraft on their experience with current icing standards; • interviewed operators about specific ice information and crew training aspects; • proposed several updates and extensions to the existing FAR 25 Appendix C regulation to cover SLD conditions, the instrumentation to measure these conditions and the characterisation of atmospheric phenomena; and

Project acronym and title**Key results and policy implications**

- compared current 'means of compliance' in certification and design, such as the analysis of ice accretion, system safety, laboratory trials and flight tests.
- The project website can be found at <http://eurice.cira.it/>

POLICY IMPLICATIONS

Co-ordinated efforts by Europe's Joint Aviation Authorities (JAA), the US Federal Aviation Administration (FAA) and others, such as Transport Canada, are considered beneficial to bring up harmonised design and certification rules concerning icing hazards. The EU's R&D programmes in collaboration with the JAA's Flight Study Group may help to update and extend airworthiness regulations, found to be insufficient at the moment.

EUROSIG:**Development of the complete ERTMS concept****KEY RESULTS**

EUROSIG has produced:

- a complete set of interface, test and test tool specifications which will be adopted for other ERTMS projects, ensuring true functional interoperability for operators throughout European rail networks;
- tools for the EUROBALISE project, allowing actual components to be checked against defined interface specifications; and
- tools for the EURORADIO project regarding the definition of test configurations for laboratory or in-situ system tests; this work was carried out in close co-operation with the EMSET project.

POLICY IMPLICATIONS

The specific contribution of the EUROSIG project to the overall ERTMS concept will be further pursued by projects like EMSET, which focuses on test specifications and test tool development. ERTMS is a high level scheme aiming at developing a new control command system for railways, with the final purpose of ensuring interoperability of trains throughout the European railway networks. Subsequently, the achievements of EUROSIG are intended to be the base for (future) national bodies responsible for interoperability certification.

FASS:**Fast Ships Safety****KEY RESULTS**

FASS has produced:

- an analysis of the growth potential of High Speed Craft (HSC), their main technical features, shortcomings of onboard detection systems, as well as the lack of appropriate certification rules for crew members;
- a Formal Safety Assessment (FSA) of high speed vessels, defining 13 subsets of hazardous situations for open sea and port areas;
- PC-based simulations covering collision avoidance scenarios, approach speed constraints and the mandatory readjustment of minimal distances between vessels, e.g. ferries;
- proposals for revised operational procedures focusing on issues such as collision avoidance, manoeuvrability, man overboard situations, or critical approaches with other vessels;
- a validation of aforementioned proposals using a ship bridge simulator in Hamburg (Germany);
- a prototype simulator for HSC crew training, which was implemented at Warsash Marine Centre (UK);
- an algorithm assigning "performance indices" to so-called risk control options being the output of the FSA methodology and assessment, respectively; and
- an algorithm to calculate those performance indices by characterising the efficiency of measures in hazardous situations.

Project acronym and title**Key results and policy implications*****POLICY IMPLICATIONS***

The study's findings on fast ship safety have been limited to navigational aspects, whereas the complexity of determining factors, such as the vessels' structural design, shall be addressed in further EU level research.

FSEA:**Concerted action on Formal Safety and Environmental Assessment of ship operations*****KEY RESULTS***

The FSEA Concerted Action has produced:

- an evaluation of the current state-of-the-art of present methodologies, including in particular the following:
 - a Formal Safety Assessment methodology, which is seen as a valuable tool for establishing a general overview of risks and risk control, covering people, property and the environment, for rule-making purposes,
 - environmental indexing of ships, a ship-type specific system, estimating probabilistic and deterministic pollution and compares this with desired reference levels to calculate a ratio or index for the individual ship,
 - environmental accounting of individual ships, an approach focusing on the deterministic pollution from ships, suggesting a system to keep track of the operational emissions and releases from individual ships,
 - the Green Award System which emphasises the environmental aspects in particular; compliance with (inter)national laws and regulations, technical and operational standard on-board the individual ship and management standard on-shore are audited and scored,
 - the International Marine Safety Rating System (IMSRS) which constitutes an approach based on management system audits and physical condition checks,
 - the particular Port State Control approach which focuses on the identification of deficiencies on ships and their follow-up, using a scoring system in order to reduce the number of sub-standard ships,
 - human and organisational factors assessment, in which several approaches were identified, mainly concentrating in human errors on the one hand and emphasising the importance of management and environment on the other hand;
- a review of current assessment practice and risk assessment approaches in other industries;
- a study of the current state of the art of databases, data availability, applicability and suggestions for an accident/incident reporting scheme, which included indications for data collection based on a common approach;
- an analysis of the integration of the human and organisational factors in safety and environmental assessments;
- a review of the current regulatory requirements and techniques for rule making, which in general revealed that regulatory systems are lacking clear statements of safety approaches. The Concerted Action suggested that an introduction of risk based approaches could help to structure the principles of new regulations;
- aspects linked with the environmental sensitivity of marine areas, related to shipping, were widely discussed including types of pollution, emissions and noise, and a method to identify sensitive areas using environmental assessment was suggested; and
- the Concerted Action has ascertained that a common safety and environmental assessment approach needs to be further developed and identified a number of areas within this framework in which research and development is also necessary, in particular risk acceptance criteria, risk management, risk communication, organisational changes, human and organisational factors and databases to provide relevant data for the common approach.

The project website can be found at <http://www.germanlloyd.org/fsea>

**Project acronym
and title****Key results and policy implications*****POLICY IMPLICATIONS***

The Concerted Action recommends to focus on the development of a common approach to safety and environmental assessment, common to all major actors, and consisting of several complementary suitable methods to be applied according to the user needs, rather than a single common methodology.

The crucial step to succeed concerning the common approach is that of obtaining a profound understanding of the decision problems and needs within shipping involving all actors. Collaboration should therefore be promoted with the range of relevant actors at European as well as national and international level to understand the decision mechanisms in shipping and the kind of assessments needed. Collaboration among is also crucial for several other connected issues in order to establish a set of common objectives and risk acceptance criteria aiming at the promotion of a risk-based rule making procedures.

FULMEN:
**Analysis of
experimental data
and models for
upgraded lightning
protection
requirements**

The final results of this project were not available when this Thematic Paper was prepared.

FV-2000:
**Quality of Freight
Villages Structure
and Operations**

KEY RESULTS

FV-2000 has:

- performed case studies in seven European countries covering a total of 14 freight villages (FV) representing two principal models, i.e. integrated FVs and non-integrated FVs, whereby the latter type does not allow for a change of transport mode at the terminal;
- carried out some 130 interviews with FV managers, logistics and transport providers, and public authorities involved with planning and developing freight terminals;
- found major benefits for regional economic development where integrated freight villages have emerged, owed to improved intermodality, the availability of attractive services, and the proximity of different transport and logistics activities at one site;
- assessed the environmental impacts of FV operation with particular respect to dangerous goods; from this assessment three management tools emerged
 - a Good Practice Code, in the form of a user-friendly handbook (available via the internet or on CD-ROM), addressing transport and storage operations in FV areas,
 - a Decision Support System (DSS), that has been field-tested by three FVs, meant to help assess the risks connected to handling of dangerous and flammable goods; this DSS builds on a database of some 160 substances and materials, and
 - a Training Software Tool (again available via the internet or on CD-ROM) comprising technical guidelines for operators, and providing recommendations on communication, organisational matters, professional skills and related training of staff, ultimately promoting the implementation of an environmental management system in FVs.

The project website can be found at <http://www.freight-village.com/fv2000/>

POLICY IMPLICATIONS

From the results of FV-2000 it is obvious that both types of FVs, but integrated

Project acronym and title**Key results and policy implications**

freight villages – which allow for modal change and in addition offer a broad range of logistics and transport services at one single spot – more significantly, do foster intermodality and efficiency, as addressed by major themes of current European RTD programmes.

GADGET:
Guarding automobile drivers through guidance, education and technology

The final results of this project were not available when this Thematic Paper was prepared.

GORAC:
GCAS operational requirements and certification

KEY RESULTS

GORAC developed the requirements for a new generation of Ground Collision Avoidance Systems (GCAS) in terms of certification (airworthiness) and operational issues. GORAC has produced:

- specifications for possible GCAS simulation facilities and identification of five suitable simulators in France, Germany and the Netherlands that apply both to validation requirements and the necessary implementation verification;
- a survey of applicable existing specifications and regulations, in particular following European Joint Airworthiness Requirements (JAR), and the determination of regulatory gaps linked to GCAS features;
- proposals for validation methods, seeking compliance with certification requirements, for the three main areas of data base integrity, dynamic algorithms and HMIs, which address the interaction between cockpit crews and GCAS visual and aural outputs;
- guidelines for GCAS data base certification, specified for Terrain Elevation Data Bases, Obstacle Data Bases and Airport Runway Data Bases;
- a preliminary regulation document for the "Preparation of the Certification Requirements" which describes the certification methodology for GCAS and proposes corresponding Means of Compliance.

POLICY IMPLICATIONS

The project has set the framework for establishing regulatory and certification requirements to be included in JAA's airworthiness requirements to ensure large-scale implementation of GCAS in commercial aircraft. This effort can be seen in the context of several new developments addressing in-flight safety, e.g. like the Traffic Alert and Avoidance System (TCAS).

In co-operation with aviation authorities, the EC's R&D initiatives will contribute to increased flight safety while coping with rapidly growing overall air traffic.

HANDIAMI:
An investigation into the problems of disabled passengers in access and emergency situations when using marine transport and the employment of disabled persons in the maritime industry

KEY RESULTS

HANDIAMI has produced:

- the first scientific overview of specific needs of disabled people with a surprisingly blunt set of pragmatic and cheap to implement suggestions for change in design and operation of vessels;
- an outline of demographic findings underlining the growing relevance of addressing the needs of disabled passengers as a major target group, e.g. in cruise travel, thereby highlighting the sound economic basis of desired modifications;
- recommendations for improved crew training focused on better awareness of elderly and disabled passengers onboard vessels with reference to existing Standards of Training, Certification and Watchkeeping for Seafarers (STCW 95);
- an overview of obstacles preventing quick and efficient evacuation of disabled passengers; recommendations on how to overcome those barriers, and a

**Project acronym
and title****Key results and policy implications**

qualitative appraisal of associated costs if considered from the initial stage in the design process of ships;

- an assessment of re-employment opportunities for disabled seafarers, leading to the conclusion that a switch to shore-based jobs, in maritime or related sectors, remains most likely due to inevitable safety constraints; only a dramatic shortfall in the supply of seafarers might create the possibility of re-employing disabled crew members;
- a comparison of equal opportunities in employment in land-based jobs shows that this issue is widely neglected in the maritime industry.

The project website can be found at <http://www.solent.ac.uk/handiemi/>

POLICY IMPLICATIONS

Three aspects as discussed in the study may benefit from actions to be initiated by the EU. The exchange of information and experience between, for example, disability organisations and technical experts (ship designers, naval architects, and lawyers) should be facilitated. Secondly existing and effective IMO recommendations on addressing the needs of elderly and disabled people should be enhanced and promoted. Finally the anticipated shortfall in the supply of seafarers may offer some opportunities for re-employment of crew members with impaired fitness if safety, operational and organisational regulations are slightly adapted.

HEROE:**Harmonisation of
European rail rules
for operating
ERTMS**

The final results of this project were not available when this Thematic Paper was prepared.

HUSARE:**Human Safe Rail in
Europe (Managing
the Human Factor in
Multicultural and
Multilingual Rail
Environments)****KEY RESULTS**

HUSARE has produced:

- selected human factor analysis techniques which were applied to eight test scenarios comprising hazards related to cross-border rail operations under typical, degraded and emergency situations;
- a practical toolkit of techniques for railway operators including the following main features: (a) data collection, comparison techniques and documentation forms for rules, procedures and operational practices, in order to identify differences in rail infrastructures and connected human factors issues, (b) human factor analysis techniques, to identify possible human errors, available failure recovery measures and risk reduction strategies; and
- suggestions for possible generic risk reduction measures, based on the analysis of the specific test scenarios.

POLICY IMPLICATIONS

The main output of the study was the practical toolkit for the management of human factors related risks in cross-border rail operations. Responsibility for the actual use of this toolkit lies with the European railway companies who need to ensure safe operations. Dedicated (policy) measures to promote the implementation of the toolkit and to foster its introduction as a common European rail standard should be promoted.

ICEPS:**Injury Criteria for
Enhanced Passive****KEY RESULTS**

ICEPS has produced:

- performed an accident analysis, with respect to injury mechanisms, comprising

Project acronym and title**Key results and policy implications****Safety in Aircraft**

two major crashes at Warsaw Airport (Poland) involving an Airbus A320 in September 1993, and near Kegworth (UK) involving a Boeing B737-400 in January 1989, respectively;

- reviewed ECE regulations regarding the design and certification of aircraft cabin components, such as seats and their anchorage, seat pitch, restraint systems, or interior fittings;
- reviewed Joint Airworthiness Requirements for large aeroplanes (JAR 25) related to emergency landing conditions, crash test dummy testing, and evacuation procedures;
- examined modern passenger seats for two aircraft types – an Airbus A310 and a Boeing B737-400 – installed in typical seating configurations;
- evaluated cabin impact areas for the same two aircraft, corresponding to seat types and seat pitch;
- presented project findings to a number of JAA working groups at the German aviation authority LBA and Austro Control, and discussed possible changes to airworthiness regulations with members of these working groups; and
- sketched proposals for improving passive safety in aircraft cabins, that would concern a variety of JARs, such as certification of passenger seats, evacuation procedures, or the installation of wall panelling in airliner cabins.

POLICY IMPLICATIONS

The study ICEPS concluded that further research into bio-mechanically relevant injury criteria for aircraft passengers is necessary. In particular, it is recommended to extend accident analysis beyond technical and human factors related aspects of aircraft performance, handling and failure. Investigations into passive safety of passengers in a given emergency or crash situation is foreseen to improve the understanding of the correlation between accident and injury mechanisms.

ICE ROUTES:***KEY RESULTS*****The ice routes project**

ICE ROUTES has demonstrated the feasibility of an ice routing tool that would provide safer and more efficient ship transport in ice-infested sea regions. The project has produced:

- an analysis of current ice charting and ship routing in the Northern Sea Route, which relies on manually interpreting sea ice conditions and the characteristics of icebreakers and convoy ships; this task included analysis of helicopter ice reconnaissance and high resolution Synthetic Aperture Radar (SAR) images used for tactical navigation;
- a computer programme called FRAM to identify and optimise vessel routes in ice-infested sea by calculating a set of alternative routes and selecting the most appropriate for specified preferences related to cost or time effectiveness; FRAM is a prototype which is not capable of covering all aspects necessary for commercial application, but which demonstrates the principal possibilities and advantages of the automatic solution;
- two ice charting concepts, i.e. the Fuzzy Expert System (FES) and Neural Networks (NN), that build on artificial intelligence to deliver satellite-based information for practical ship routing without the need for human image interpretation, which is found to be very time consuming, demanding and subject to ambiguity.

POLICY IMPLICATIONS

The study has identified a feasible approach for short-term operational use that will build on a combination of computer-based, automatically generated ice information and manual interpretation of results by skilled experts. All recommendations aim at further advancing ship route modelling techniques, taking into account the foreseen International Polar Code of Navigation, which will ensure a consistent strategy for

Project acronym and title**Key results and policy implications**

improving safety, efficiency and overall capability of maritime navigation in European and Russian arctic waters.

IMPCHRESS:**Improved Child Restraint Systems****KEY RESULTS**

IMPCHRESS has produced:

- a Present State Document (PSD) reporting on relevant travel and accident statistics, summarising test experience with currently used infant and child restraint devices (CRD), discussing restraint regulations of aviation authorities, and presenting the opinions of aviation authorities, operating airlines, cabin crews and consumer groups on current CRD practice;
- a Technical Reference Document (TRD) covering biomechanical parameters that have to be considered when applying and using CRD systems; issues have been the definition of child groups, relevant test criteria applied to standard aircraft seats, specification of test dummies, categorisation of CRD tests, definition of test equipment, definition of standard adult seats, performance criteria to be adopted, and general concepts for the protection of children; and
- a European specification for CRDs as a baseline for integration of the theme into certification and operational regulations by the Joint Aviation Authorities; principal parameters underlying these specifications are the safe restraint of children to the standard of other passengers, the minimisation of additional costs to aviation industry, the compatibility with European automobile restraint standards, the harmonisation with the upcoming US standard, the flexibility in CRD design, the inclusion of different flight phases (take-off and landing, cruise flight), and the need to use CRDs only for passengers of less than 18 kg weight.

POLICY IMPLICATIONS

The project's elaborated set of specifications for Child Restraint Systems (CRD) shall be used to formally bring up harmonised certification regulations and operational requirements for affordable safety improvements for children travelling in commercial aircraft. Those CRD requirements shall be issued by the European Joint Aviation Authorities, seeking compliance with respective US standards.

INCARNATION:**Efficient inland navigation information system****KEY RESULTS**

The basic concept of INCARNATION is to improve the on-board information available to skippers as well as the information available to parties involved in logistics.

The River Information Service (RIS) developed and assessed consist of three elements: traffic image on board, logistic information and calamity abatement and fairway information.

Conclusions are that the effect of Tactical Traffic Image on safety will be limited, being the safety levels on inland waters already fairly high and that even after its introduction on board there will still be an important role for the existing Vessel traffic Service (VTS) along the waterway. An AIMS (automatic identification and data management system) implemented on a large proportion of inland vessels across Europe providing all relevant parties in the logistic process with up to date position information of vessels and cargo will contribute to the safety of navigation.

POLICY IMPLICATIONS

Discussions are needed within the EC Member States to take account of the INCARNATION results in their respective policies. It is equally important to consider the legal aspects of INCARNATION and the need for reserved radio frequencies. In order to implement RIS across Europe, it is recommended that the

Project acronym and title**Key results and policy implications**

preparations are made with respect to the organisation of each RIS, and the definition of rules and regulations for satisfactory performances of a RIS within legislation. The EC and other responsible bodies (e.g. Rhine and Danube Commissions) should be informed at an early stage in order to improve prospects for implementation. There is a need to harmonise reporting and communication procedures and ECDIS standards as a part of European-wide RIS. The project results will help the EC to further enhance and exploit the MARIS initiative (comprising the MARNET and BOPCOM projects and aiming at demonstrating the potential benefits of information technologies and telematics applications for a broad range of maritime activities).

INTRA-SEAS:
Safety and economic assessment integrated management of multi-modal traffic in ports

The final results of this project were not available when this Thematic Paper was prepared.

JAR TEL:
Joint Aviation Regulations – translation and elaboration of legislation

The final results of this project were not available when this Thematic Paper was prepared.

MASIS II:
Human element in man/machine interface and interaction to improve safety and effectiveness of transport for the European fleet

The final results of this project were not available when this Thematic Paper was prepared. The project website can be found at http://www.isl.org/english/text/projekt/project.show.php?p_num=2189&lang=en

MASSTER:
Maritime Standardised Simulator Training Exercises Register

KEY RESULTS

MASSTER has:

- prepared an overview of existing simulators – both full-mission and part-task types –, their capabilities, foreseen future developments, simulator availability and suitability for desired training schemes;
- listed training objectives based on the Standards of Training, Certification and Watchkeeping for Seafarers (STCW 95) guideline;
- highlighted simulator training exercises, addressing STCW 95 objectives and additional training objectives, e.g. for high speed vessels, on management aspects, or about the introduction of advanced bridge displays, such as ECDIS;
- elaborated a methodology for the development of operational and training scenarios, and the corresponding required exercises with particular focus on human factors related training;
- developed sample assessment tools supplementing the set of assessment criteria connected to training objectives, as initially identified; and
- developed a comprehensive catalogue of scenarios, provided as a Microsoft Access database, which allows for searching of the whole set of training objectives, function levels and defined competences along the STCW 95

**Project acronym
and title****Key results and policy implications**

guideline.

POLICY IMPLICATIONS

The project MASSTER has build on experience from the METHAR project, which had been preparing harmonised European curricula reflecting the STCW 95 requirements. Hence, it was a major step in ensuring the implementation of STCW 95 conventions in EU member states and outside the community. The latter aspect must not be neglected because tendencies towards moving training programmes to low wages countries tend to put the successful implementation of STCW standards at risk.

MASTER:**KEY RESULTS****Managing Speeds of
Traffic on European
Roads**

MASTER has produced:

- a review of current speed management methods and the various levels of responsibility for implementation of measures;
- a survey of current speed limits across Europe for typical road categories;
- a framework for the systematic and comprehensive assessment of the impacts of changes in speed, starting with a social cost-benefit analysis and taking into account quantitative and qualitative effects;
- a comprehensive analysis of the reasons for a driver's choice of speeds, including interviews of drivers and pedestrians in six countries;
- a review of Advanced Transport Telematics (ATT) and traditional speed-reducing systems, and tests of the most promising ones in a driving simulator;
- an assessment of 25 different speed management measures and tools in terms of impact on speeds, cost-effectiveness and other relevant information; and
- recommendations for speed management in compliance with the objectives of the Common Transport Policy; in particular, speed limits for roads of similar classification, guidelines for application of speed management measures, preparations for the introduction of in-vehicle speed limiters, "self-explaining" road design, automated speed enforcement, internalising external (accidents, environment) costs, campaigns to raise public awareness about the impacts of speed, and restriction of vehicle speeds.

The project website can be found at <http://www.vtt.fi/yki/yki6/master/master.htm>

POLICY IMPLICATIONS

The study has made recommendations for further research in the field of speed management. Benefits could arise from investigation into the impacts of speed on emissions, noise, vehicle operating and time costs, network level effects, the choice of road according to the trip purpose, the impacts of speed changes and in particular the impacts of in-vehicle speed limiters on accident rates and severity. Additional work is needed on monetary valuations of the impact of speed on the value of time, environmental aspects and accident costs, methods for assessment of distributional and equity impacts of speed changes, sampling and reporting requirements for speed data, and behavioural adaptation effects related to speed limits.

MBB:**Maritime Black Box**

The final results of this project were not available when this Thematic Paper was prepared.

METHAR:**Harmonization of
European Maritime
Education and
Training Schemes****KEY RESULTS**

METHAR has produced:

- recommendations to improve economic efficiency and competitiveness by concentrating and focusing the resources of MET institutions for all kinds of marine operations;
- recommendations to foster mobility of seafarers by mutual recognition of certificates and (national) regulations;

**Project acronym
and title****Key results and policy implications**

- proposals to improve the attractiveness of the maritime industry and its public image concerning safety and environmental protection;
- recommendations to raise awareness of technological progress – with IT being a driving force in shipping – in MET programmes and staff;
- an analysis of the contributing factors for the declining interest in job careers in the maritime sector with the recommendation of joint national efforts to revert this trend and the proposal to look at and study the successful national approaches towards attracting young people to seafaring (e.g. in France, the Netherlands and Norway);
- proposals for a bottom-up approach towards harmonisation of MET syllabi in repeated steps from general to specific and based on the requirements of the STCW 95 Convention (Standards of Training, Certification and Watchkeeping) convention;
- recommendations to intensively use advanced simulators in MET schemes, and to increase the cost-effectiveness of MET;
- recommendations for maritime lecturers update and qualification enhancement by a systematised approach, by the promotion of international co-operation of lecturers, and exchange programmes; and
- considerations for the transition from ship to shore, as often desired by employees, through an enrichment of MET programmes with integrated and harmonised education and training elements on shipping and port operations.

POLICY IMPLICATIONS

The project's findings highlight the need for political contribution to improve and harmonise more widely applicable MET for ship officers. These targets clearly aim at common European objectives of increased employment through an enhanced employability as a result of increased competitiveness through improved quality and innovation as well as extended mobility. METHAR addressed MET taking into account all these elements. In addition, it also addressed the increase in safety, environment protection and efficiency of sea transport through an overall better MET.

MUSSST:**Multimodal Safety
Satellite System for
Transport*****KEY RESULTS***

MUSSST has:

- proposed a safety approval methodology for GNSS navigation services, comprising the following steps:
 - a safety case methodology as the basis for formal approval of any GNSS application,
 - Signal in Space (SIS) verification, which means the technical and functional specification of e.g. frequencies, message content, environmental constraints and interfaces,
 - application identification, which highlights the use in civil aviation (in flight and at airports), waterborne transport (sea and harbour navigation; search and rescue), and terrestrial transport (rail, road and general guided transport),
 - sensor qualification, which defines the technical requirements for GNSS receivers,
 - mobile certification, addressing compatibility between mobile units and GNSS core components with particular emphasis on safety and efficiency of communication, and
 - operational approval, itself being divided into the definition of operations and procedures, the derivation of specific requirements, a hazard assessment process and the generic approval by responsible authorities;
- applied the elaborated methodology on a typical first generation Global Navigation Satellite System (GNSS-1) application from the waterborne sector, as identified in the EGNOS programme;
- applied the same methodology to the Galileo programme, the current scheme for a

**Project acronym
and title****Key results and policy implications**

second generation (GNSS-2) application offering navigational assistance and related communication services.

POLICY IMPLICATIONS

The MUSSST project is part of several actions to elaborate methodological baselines for the use of GNSS. First and second generation applications, such as EGNOS in civil aviation or Galileo for all transport sectors, are understood to be already covered by current EU policy priorities.

NEAP:**KEY RESULTS****North European
CNS/ATM
applications project**

NEAP aimed at developing, testing and evaluating data link applications within an integrated CNS concept. NEAP has provided the basis for verifying the overall capability and suitability of the STDMA/VDL Mode 4 platform as a single system solution for seamless gate-to-gate operations across CNS domains.

The main impacts on safety of the applications above are, respectively, as follows:

- lack of vertical guidance and poor situation awareness in the approach and landing phases is a main reason of accidents; differential corrections broadcast from ground stations and ADS-B reports received from equipped aircraft can provide benefits in terms of improved situation awareness for pilots and controllers;
- provided that a suitable taxi guidance display is available, safety can be increased and taxi time reduced in unfamiliar airports and a higher flow of ground traffic is possible under low visibility conditions; on-ground situation awareness allows aircraft to maintain separation independent of weather;
- if relevant surveillance information is presented in the cockpit, new operational procedures could be implemented that would allow delegation of separation responsibility from ATC to the cockpit; ADS-B based in-flight situation awareness forms the basis for additional safety net with longer pre-warning times and therefore allows for early tactical flight path co-ordination rather than last minute conflict avoidance resulting in increased safety margin and redundancy;
- ATC surveillance by radar tracking could be improved by using down-linked aircraft parameters; access for ATC to flight path, which is known exactly by the on-board flight management system, can provide an additional safety net; the system allows aircraft intentions and manoeuvres to be detected faster;
- continuously updated visual information on helicopter position in an uncontrolled airspace without a radar coverage, improves situation awareness and reduces the tension for ATC should a position-over-voice arrive later than expected; information relating to the last known position would improve the probability for a successful search and rescue operation, especially in poor weather and visibility conditions;
- hazardous conflict situations may arise between aircraft and airport ground vehicles due to unauthorised or unintentional entry onto runways or taxiways; safety can be increased by using ADS-B reports from equipped aircraft and vehicles being presented on a dedicated display in the control tower and a system including functions which enable controllers and vehicle drivers to be automatically alerted when a hazardous situation develops; the system has shown significant operational benefits.

Proposals for improvements of the individual applications have been provided. Main recommendations at system level include:

- accelerating the introduction of ADS-Broadcast (ADS-B) in Europe, which calls for close co-operation with airframe and ATC airport system manufacturers;
- initiating extensive cost/benefit analyses and developing operational procedures with respect to ADS-B;
- analysing certification issues and promoting development of international standards for ADS-B;
- initiating research on human factors regarding cockpit layout of traffic information; and
- analysing safety, certification and operational approval aspects of using a common

**Project acronym
and title****Key results and policy implications**

data link and a mix of CNS applications.

POLICY IMPLICATIONS

The individual NEAP applications show that cost-effective technical solutions exist for European and world-wide capacity and safety issues but these solutions are constrained by the lack of a coherent European regulatory framework that is needed to bring them to the market. Key recommendations are the development of European and international standards and certification strategies.

NEAP is based on European developments and technology which are estimated ahead of the rest of the world with respect to ADS-B. The list of aviation industries with a potential interest in the development is extensive, ranging from manufacturers to providers of communications, ATC and training services. Further development of STDMA/VDL Mode 4 requires active participation of industry which is already involved in the development of equipment for this technology in compliance with the emerging ICAO standards.

A direct continuation of the NEAP activities will take place in the NUP (NEAN Update Programme), the follow up of the NEAN (North European ADS Broadcast Network) project. NUP aims to move from research and development to actual operational introduction.

PHOENIX:**Identification and quantification of the variables and parameters that aid in evaluating fire risks on board ships in accordance with their condition*****KEY RESULTS***

PHOENIX focused on fire risks as the single most important source of on-board casualties for commercial ships. It aimed to identify and quantify all parameters and variables potentially contributing to the outbreak of fire on various types of vessel. It has produced:

- a database incorporating information on 955 vessels involved in fire-related incidents between 1990 and 1995; the database structure was built on twelve variables, ranging from general data about the ship or the registered flag, to parameters related to the outbreak of fire and the subsequent measures;
- two computer programmes for analysis and prevention of fire on-board ships; FIRST (Fire Simulation Tool) has been developed to simulate fire propagation for a typical ship layout and proved capable of doing so for free fire propagation;
- software-based checklists for ship inspectors that allow the analysis of implemented safety measures for fire prevention; the tool helps to assess pre-accident as well as post-accident conditions on the vessel; and
- a case study on fire propagation in the form of a computer simulation that included a typical compartment set-up with outfitting, furniture and division bulkheads; the outputs were typical fire related parameters like temperature, thermal energy and smoke rate.

POLICY IMPLICATIONS

The study's outputs provide the basis for developing a common European database on fire related ship accidents. Further recommendations include setting up a framework for RTD on specific methods for standardised fire risk evaluation and improved training procedures for fire fighting. In addition, research efforts should focus on the integration of fire emergency tools into control equipment on-board ships. Finally, those safety relevant codes issued by the International Maritime Organisation (IMO) should be adapted to address real user needs.

PROMISING:**Promotion of Mobility and Safety of Vulnerable Road*****KEY RESULTS***

PROMISING has:

- compared mobility patterns and factors influencing mobility for several modes of transport between various European countries, and appraised achieved safety

Project acronym and title**Key results and policy implications****Users**

levels;

- presented an overview of current legislation regarding walking, cycling and the use of powered two-wheelers with respect to traffic regulations, infrastructure design standards and legal limitations to vehicle use for young drivers and riders;
- highlighted best practice examples of innovative traffic concepts from Sweden and the Netherlands, that aim to increase the safety of vulnerable road users;
- summarised design criteria for roads and anticipated traffic management schemes based on the knowledge of the specific mobility needs of pedestrians and cyclists;
- reviewed technical and non-technical accident risk reduction measures targeting young, inexperienced drivers;
- performed cost-benefit analyses for a set of twenty infrastructure (design) and organisational measures, ranging from roundabout design, upgrading of pedestrian crossings, design of dedicated bicycle lanes to e.g. the daytime use of light on vehicles; and
- outlined an implementation strategy that aims at a better balance of the interests of different road users, improved co-operation between local and national traffic authorities, and direct involvement of road users in the planning and design processes.

POLICY IMPLICATIONS

A future, more mode specific transport policy, addressing the particular requirements of pedestrians and cyclists, will have to come up with a set of practical criteria for traffic flow management, right of way regulations and other safety improvements for vulnerable road users. Several national showcases have already provided planning and design guidelines, that need to be adopted and customised for broader usage. Supplementary, cost-benefit analyses evaluating improvements for walking and cycling traffic participants are promoted to avoid further bias towards the dominating motorised traffic.

REMAIN:**Modular system for reliability and maintainability management in European rail transport****KEY RESULTS**

REMAIN has developed practical methods and tools for the evaluation of a Reliability, Availability and Maintainability System (RAMS) for railway operations. The project has produced:

- the framework for a systematic analysis of maintenance needs and organisational requirements using Reliability Centred Maintenance (RCM) and the introduction of Condition monitoring methods (CON-methods);
- a database structure for retrieving railway-specific status, reliability and maintenance data, with the aim to later extend national/local databases with a common global database, that gives railway companies access to anonymous information from other operators;
- an assessment of the suitability of available computer networks and communication channels for data gathering and transmission; recommendations included the use of GSM radio communication technology for RAMS data transmission;
- a life cycle cost (LCC) model for railway applications including the four categories investment, maintenance & operation, delay and hazard;
- an architecture called the REMAIN method for Strategic Maintenance Planning (RESMAP), which additionally has been verified by German Rail on a demonstrator railway line between Dortmund and Hamm; and
- a tool for safety assessment called the REMAIN Change Analysis method (RCAM), which analyses changes in maintenance strategies with respect to safety issues.

The project website can be found at <http://remain.iitb.fhg.de/>

Project acronym and title**Key results and policy implications*****POLICY IMPLICATIONS***

The study concentrated on infrastructure aspects and outlined specific requirements for databases and RAMS tools. In this, it relied on work already undertaken by several railway companies. Subsequent R&D on maintenance in the rail sector is recommended to incorporate all other relevant areas like failure mechanisms, environmental and operational aspects and might include provision of specific application guidelines for railway operators.

RHEA:**Role of the Human in the Evolution of ATM Systems*****KEY RESULTS***

RHEA has produced:

- a review of 20 ATM studies, relevant in the project context, accompanied by a literature survey to identify information sources about automation in ATM, leading to a list of 14 key references;
- an overview of conclusions from literature surveys to be used by a wider audience, such as the operational success of Human Machine Interface (HMI) enhancements and machine aided evaluation, the current testing of co-operative tools and dynamic allocation, and the finding that complete automation happens to fail before complete simulation does;
- an evaluation of 7 selected automation concepts that address the man/machine interface in Air Traffic Control (ATC): controller as supervisor, machine proposal strategy, machine-aided evaluation, dynamic allocation with human delegation, dynamic allocation with machine delegation, dynamic aircraft delegation and cognitive (assistance) tools, which have been found most promising for several ATC environments; and
- requirements on automation of ATM reflecting on the two main dimensions automation related issues, and basic controller functions.

POLICY IMPLICATIONS

The project's results have provided a framework on ATM automation allowing for predictions about the achievable success when implementing particular automation concepts. Further validation of the RHEA framework on the evaluation of automation concepts is necessary. A real time simulation of the four most promising automation concepts – cognitive tools, dynamic allocation with human delegation, machine aided evaluation, and machine proposal – is recommended.

ROSITA:**Road site testing assessment**

The final results of this project were not available when this Thematic Paper was prepared.

SAFECO:**Safety of shipping in coastal waters*****KEY RESULTS***

The goal of SAFECO was to supply policymakers, regulators and actors in the shipping community with a modelling framework to allow the comprehensive evaluation of potential shipping risks. SAFECO has contributed to:

- the development of a radar-based Collision Avoidance Advisory System (CAAS) that has been tested in simulator exercises and on-board vessels during test trials;
- the development of a Simulator Exercise Assessment system (SEA);
- the development of the Marine Accident Risk Calculation System (MARCS) to quantify risk levels and the effect of risk control options in defined geographical areas;
- the development of a risk model for maritime propulsion systems which allows the identification of critical components in the context of enhanced maintenance

Project acronym and title**Key results and policy implications**

strategies;

- the development and analysis of databases for marine casualties which help to understand and model the causes and conditions resulting in ship accidents;
- the further development of structural integrity models for reliability assessment of ship design and maintenance strategies;
- the development and implementation of a risk model for the port of Rotterdam area;
- the development of a numerical model for navigator performance that has been validated in test cases, resulting in the provision of sailing trajectories to defined ports as a function of parameter variations;
- the further development of models and data to quantify the effects of ship manoeuvring capabilities; and
- the development of a model to assess the effects of personal and organisational factors in the light of the International Safety Management Code (ISM).

POLICY IMPLICATIONS

The project has been part of a common international approach to accident and incident reporting in shipping, with a particular focus on risk analysis. The follow-on project SAFECO II aimed to define improved technologies and organisational steps for internal and external communication, and to apply risk analysis methods in order to assess economic benefits and safety improvements for quality operations.

SAFECO II:

Safety of Shipping in Coastal Waters: Demonstration of risk assessment techniques for communication and information exchange

KEY RESULTS

SAFECO II has produced:

- a survey of relevant EU projects on problems of maritime communication and information exchange;
- a structured hazard identification process for the evaluation of risk control options and the development of risk models;
- an intelligent conning display – labelled Collision Avoidance Advisory System (CAAS) – which integrates transponder information into an Electronic Chart Display (ECDIS);
- test runs with maritime simulators to assess and verify risk control options, leading to improved training schemes for crew members;
- fault tree models linked to the Marine Accident Risk Calculation System (MARCS) in order to assess the effectiveness of risk control options and to quantify related implementation costs; and
- an update of MARCS, accompanied by the evaluation of three case studies – the Rotterdam port approach area, the North Sea area, and validation against historical accident statistics.

The project website can be found at <http://research.dnv.no/safeco2/>

POLICY IMPLICATIONS

The project's achievements shall be the basis for further advisory and consulting services to the maritime industry in order to enhance the safety of shipping in coastal waters. In conjunction with initiatives by the International Maritime Organisation (IMO) regulatory matters can be pushed through EC action.

SAFESTAR:

Safety standards for road design and redesign

The final results of this project were not available when this Thematic Paper was prepared.

Project acronym and title**Key results and policy implications****SEALOC:**

Assessing Concepts, Systems and Tools for a Safer, More Efficient and Lower Operational Cost of the Maritime Transport of Dangerous Goods

KEY RESULTS

SEALOC has produced:

- a Safety Assessment Philosophy (SAPh) – elaborated by using the structure of the FSA methodology that was adopted by the International Maritime Organization (IMO) for its own rule-making process – which makes it possible to consider individual ships and installations with the objective to be used as a tool to develop tailored safety management systems, for example within the framework of the ISM Code;
- three case studies, on the "Amoco Cadiz" crude oil tanker accident, on the transport of liquified petroleum gas (LPG) in the Mediterranean Sea, and on the transport of containers in the North Sea, in which the potential hazards during the whole shipping operation from harbour to harbour were identified and evaluated;
- a case study safety assessment for the three above described scenarios comprising activity descriptions, hazard identification, accident event analyses, assessment of frequency and consequences of accidents, and risk control measures addressed by various regulations;
- a model for quantitative risk evaluation in the transport of dangerous goods for the categories crude oil, LPG and container service;
- recommendations in support of the use of safety assessment to actively apply risk control measures, such as:
 - developing an overall systems approach to maritime safety including inland activities (like packaging, container stowage, labelling, or emergency resources),
 - further development and use of telematic solutions for providing information management on dangerous cargoes on board and their instant location,
 - setting quantitative safety targets for maritime transport and quality management systems for inland activities, such as for packing and containerisation or for companies involved in the total supply chain,
 - establishing and maintaining an accident database that includes the cost of accidents in order to enable and facilitate cost-benefit analysis,
 - encouraging the establishment of a maritime safety culture,
 - setting of higher education and training standards, particularly for inland activities,
 - developing and applying measures to reduce the effect of fatigue on maritime safety,
 - researching into human factors,
 - developing state-of-the-art ship to ship and ship to shore communication and ship identification for enhancing emergency response and waterborne traffic management,
 - improving the safety in and around ports and terminals, and
 - sustaining the systematic application of safety assessment techniques to regulations in order to influence optimal design, construction, operation and maintenance of vessels over the entire ship's lifecycle.

POLICY IMPLICATIONS

The project's findings, supported by several other analyses, indicate that with few exceptions adequate regulations are in force, but the problem is however the low compliance. Tools such as FSA and SEALOC's Safety Assessment Philosophy should be systematically used for the assessment of safety regulations and for the development of safety routines, in accordance with the ISM Code, in order to identify technical and safety gaps as well as to contribute supporting regulatory enforcement. SEALOC has highlighted the importance of improving the implementation of safety measures and has recommended a Centralised European Agency with access to all relevant information to accomplish this task.

**Project acronym
and title****Key results and policy implications****STAIRS:****Standardisation of
Accident and Injury
Registration Systems****KEY RESULTS**

STAIRS has:

- analysed three national crash investigation studies from France, Germany and the UK, which focus on accident prevention, legislative support and injury causation, respectively;
- specified a complex set of variables, associated detailed data fields, descriptors, and a glossary of terms to form the basis for a harmonised crash injury database, concentrating on injury prevention, or 'secondary safety';
- analysed and assessed current investigation methods aiming at data collection, highlighting three principal approaches: retrospective studies (one to several days after the accident), on-the-scene/on-time studies (minimum time delay), and hospital based studies (mainly medical information);
- defined a set of quality assurance procedures for data collection (observation and recording), initial data processing (database coding), and comparison/analysis of data from different sources;
- validated the outlined protocol for data collection by performing three national case studies, covering the principal investigation and database modules pedestrian accidents, two-wheeler crashes and car crashes;
- performed feasibility case studies in the aforementioned three countries to prove the linkage of regional accident data to existing in-depth accident data, in order to pave the way for the foreseen extrapolation from in-depth data to national or EU level; and
- disseminated the elaborated methodology and the framework for harmonised accident injury investigation to the automotive industry, universities and research centres, the International Standardisation Organisation (ISO), several road safety conferences, and via the STAIRS project website.

The project website can be found at <http://www.ice.co.uk/stairs/>

POLICY IMPLICATIONS

The STAIRS study is perceived to have triggered a process to ultimately establish a harmonised pan-European accident injury database. The possible realisation of such a database depends on the willingness of national research institutions to co-operate on the issue, which would in fact be well suited to take place in the framework of EC RTD activities. Indeed, the next step should be to further validate the proposed methodology for data acquisition and appraisal, which may be fostered by the inclusion of Central and Eastern European accession countries.

TSM:**Traffic safety model**

The final results of this project were not available when this Thematic Paper was prepared.

WAVE:**Weighing-in-motion
of axles and vehicles
for Europe**

The final results of this project were not available when this Thematic Paper was prepared.

WORKFRET:**Working Cultures in
the Face of
Intermodal Freight
Transport Systems****KEY RESULTS**

WORKFRET has produced:

- reviewed and analysed 'working cultures', and organisational and management structures in current European (intermodal) freight transport;
- identified and assessed the impacts of new technologies in freight transport on the number of employed workers, their working conditions, the quality of jobs (e.g. a shift to more high skill jobs), the time pressure dictated by efficiency

**Project acronym
and title**

Key results and policy implications

- considerations and the membership to trade unions;
- highlighted new logistics and production systems – with respect to reliability, integration, flexibility and cost reduction – and their impacts on the initially defined working cultures;
 - produced a ranking of ten key issues in the development of freight transport systems;
 - analysed five national case studies for the implementation of specific technological and/or organisational developments;
 - identified twelve policy areas addressing the barriers faced by intermodal developments, namely: the size of the freight sector work force, labour regulations, payment; social security, education and training, health and work safety, recruiting, organisational structures, behavioural codes, bargaining, employee and trade union involvement, and the general promotion of intermodal transport;
 - derived a set of ten policy suggestions based on identified problem areas and policy fields.

POLICY IMPLICATIONS

Based on the outlined topics for policy action and the suggestions derived, the implementation of measures needs to be specified in further research studies, in particular focusing on social impacts of organisational and operational changes in the freight transport sector.