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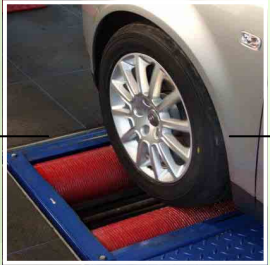
INTERNATIONALE VEREINIGUNG FÜR DIE TECHNISCHE PRÜFUNG VON KRAFTFAHRZEUGEN



AUTOFORE

Report

Study on the Future Options for Roadworthiness Enforcement in the European Union

Consultative Status Category II to the Economic and Social Council of the United Nations
Statut Consultatif Catégorie II auprès du Conseil Economique et Social des Nations Unies
Beratender Status Kategorie II beim Wirtschafts- und Sozialrat der Vereinten Nationen

AUTOFORE

Study on the Future Options for Roadworthiness Enforcement in the European Union

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FOREWORD

The Directorate-General for Transport and Energy (DGTREN) of the European Commission has responsibility for the European Union's common transport policy that includes an objective to improve the roadworthiness of the European road vehicle fleet in order to meet road safety and environmental protection targets.

The International Motor Vehicle Inspection Committee (CITA) represents public and private sector organisations throughout the world that share a common goal of developing and sharing best practice in the vehicle roadworthiness inspections. CITA members in Europe are representative of government authorities and all of the main private organisations within the enlarged European Union with responsibilities for mandatory vehicle inspection.

Soon after the beginning of this millennium, both DGTREN and CITA separately concluded that it was time for a review of roadworthiness enforcement and inspection in Europe. This coincidence of views provided the foundation for the AUTOFORE study.

The study itself was carried out by an international consortium led by CITA and made up of research bodies associated with a number of CITA members, academic institutions and independent consultants. It was steered by a committee of the sponsors, which included the Commission, the partners and a large number of CITA members. CITA took the role of leading the project with a determination for it to be strategic, open minded and innovative; and with a clear objective that its conclusions and recommendations should have widespread acceptance and buy-in.

Achieving consensus for major change is rarely easy. This is particularly challenging when the proposed changes affect a large number of stakeholders with diverse interests and objectives, might be seen as a threat to business interests and are set against a background of significantly different practices and standards throughout the Union.

Going a long way to successfully meeting this challenge, however, greatly strengthens the recommendations and decreases the problems of taking forward and implementing the required changes. DGTREN, as a customer for this report, and other stakeholders, will be the ultimate judges of the success of AUTOFORE, both in this respect and against its wider objectives.

As CITA President, and at a personal level, I would like thank the many people who worked so effectively as a team to meet the objectives of this project, particularly the project management team, the leaders of the various work packages, those who undertook the research and wrote the report, the members of the informal strategy group and the members of the CITA Secretariat, who have each contributed so much to its success. I also thank the CITA members who sponsored over half the cost of the work and who contributed their time and guidance to the work of the Project Steering and Management Groups. Finally, I would like to thank the CITA Bureau Permanent and the members of its AUTOFORE sub-committee for their courage and determination in setting the challenge for the study and for helping overcome the many obstacles encountered during the work.

Ron Oliver - CITA President and Chair of the Project Steering Group

EXECUTIVE SUMMARY

The purpose of the AUTOFORE project is to recommend improvements in roadworthiness enforcement in the European Union to ensure that the benefits accruing from the original design and manufacture of vehicles are retained, where justified, throughout the life of those vehicles.

All vehicles degrade in service. Regrettably, many vehicle owners do not adequately maintain their vehicles so significant numbers of defective vehicles are in use, a matter of concern as poor vehicle condition has an adverse affect on safety and the environment. The level of defects in vehicles in use in Europe remains high and shows no signs of improving with the introduction of new technologies and manufacturing systems.

The need for roadworthiness enforcement is greater than ever because road safety and environmental protection are now more reliant on the correct functioning of technologies that are increasingly taking over aspects of the driver's tasks as a means of eliminating or mitigating the effects of human error. Failure of these technologies in service results in the loss of the benefits they provide. With this increased reliance on advanced technology, the role of vehicle roadworthiness is changing. While preventing the catastrophic consequences of failures of mechanical systems is still important, the role of vehicle roadworthiness enforcement needs to encompass the preservation of the benefits of the new technologies and systems.

Research undertaken by CITA and partly funded by the European Commission (Rompe 2002) has shown that electronically controlled systems on vehicles have failure rates comparable to mechanical systems that are considered important enough to be included in periodic inspections. The failure rates of electronic systems increase both with vehicle age and distance travelled.

The AUTOFORE study reviewed the purpose of roadworthiness enforcement and the potential for improvement of current roadworthiness enforcement measures. A strategy for change is proposed, which is to introduce, where justified:

1. Higher roadworthiness standards.
2. Broadening of the scope of the standards to include items that currently are not included and vehicle types currently not controlled.
3. Improving the level of compliance.

The most promising options for improving roadworthiness enforcement were identified and analysed. Four of them were subjected to a detailed economic analysis, which was undertaken by the Institute for Transport Economics at the University of Cologne.

The options can be grouped under the following seven headings:

1 Improve roadworthiness Directives.
2 Improve type approval requirements and legislative process.
3 Develop the infrastructure required to inspect electronically controlled systems.

4 Promote improved compliance.
5 Develop supporting roadworthiness inspection databases and related items.
6 Improve linkages between forms of roadworthiness enforcement.
7 Support research and development.

Implementation of some of the options can be started immediately, with a view to introduction by 2010 (the 2010 Package). Others require further work before implementation can be initiated. The objective would be to implement them by 2020 (the 2020 Package), at the latest.

The study makes the following **recommendations** -

2010 Package

Recommendation 1 - Amend Directive 96/96/EC to increase the frequency of inspection for older vehicles of categories 5 and 6, as defined in the Directive.

The economic benefit of increased frequency of inspection of older light vehicles would be over 2 billion euros if vehicles of 8 years and over are inspected annually with a benefit-to-cost ratio of over 2. This is the **minimum** change that should be introduced. Although the benefit-to-cost ratio would be slightly reduced, introduction of annual inspection for vehicles 7 year and over would give higher benefits. As such, it should be considered seriously.

Recommendation 2 – Amend Directive 96/96/EC to include the examination of safety relevant electronic systems that are already widely fitted (airbags, ABS and ESC).

The benefit-to-cost ratio of inspecting ESC systems alone is 2.6. Additional benefits will arise from testing other systems, such as ABS and airbag systems. Initially the inspection should include, at a minimum, observational checks on the system's completeness and functionality and for obvious signs of deterioration or deleterious alteration. Additional systems should be added when they become widely fitted. More comprehensive checks should be added when further work described in Recommendation 4 has been completed.

Recommendation 3 - Amend the scope of Directive 96/96/EC to include two-wheeled motor vehicles (international categories L1 and L3).

Although an economic analysis could not be undertaken to quantify the magnitude of the benefits, good accident evidence supports the extension of the Directive to two-wheeled motor vehicles. There may be, however, problems with the inclusion of mopeds, but this objective should be pursued.

Work should start in the near future on the preparation of a regulatory impact statement on these three recommendations.

2020 Package

Recommendation 4 - To be able to develop the options for introduction by 2020, the following 3 projects should be initiated.

1 Undertake a new study ("AUTOFORE 2") to research the magnitude of the contribution of vehicle defects to accidents and to trial new inspection systems suitable for inspecting the functionality of electronically based technologies.

2 Undertake further work to develop methods of improving compliance and the effectiveness and efficiency of vehicle inspection.

3 Undertake further work to develop proposals for further harmonisation of European roadworthiness standards.

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1. Introduction

All vehicles degrade in service. The need for roadworthiness enforcement is greater now than ever before because road safety and environmental protection are more reliant on the correct functioning of technologies that are increasingly taking over aspects of the driver's tasks as a means of eliminating or mitigating the effects of human error. Examples of new technologies and their impact include:

- Electronic Stability Control and Active Cruise Control, which reduce the risk of a crash occurring. Thatcham (2006) has reported that Electronic Stability Control (ESC) reduces the risk of being involved in a crash by between 20% and 40% by applying the brakes to selective wheels if the ESC system senses that the vehicle is about to skid out of control. Baum and Grawenhoff (2006) found that the annual accident and associated congestion reduction benefits of ESC, if it was fitted to all passenger vehicles in Europe, would be €10 billion.
- Advanced braking systems that are leading to major improvements in brake performance and safety.
- Engine management systems, catalytic converters and related technologies that are significantly reducing emission levels through successive introductions of the "Euro" vehicle emission regulations. Malfunction of, or tampering with, these systems result in higher emissions and the loss of the benefits of the vehicle emission regulations.
- Vehicle to vehicle communication (V2V) and crash avoidance systems that can, for example, manage both braking and engine power. Ultimately, these could lead to vehicle platooning and automatic driving.

Figure 1 shows the range of safety related technologies being developed and when they are likely to be introduced. A description of the various technologies, their market introduction, the effect failure will have on safety and emissions, and current inspection options is included in the annex WP300 "Current situation in vehicle technology" [CDlinkCur].

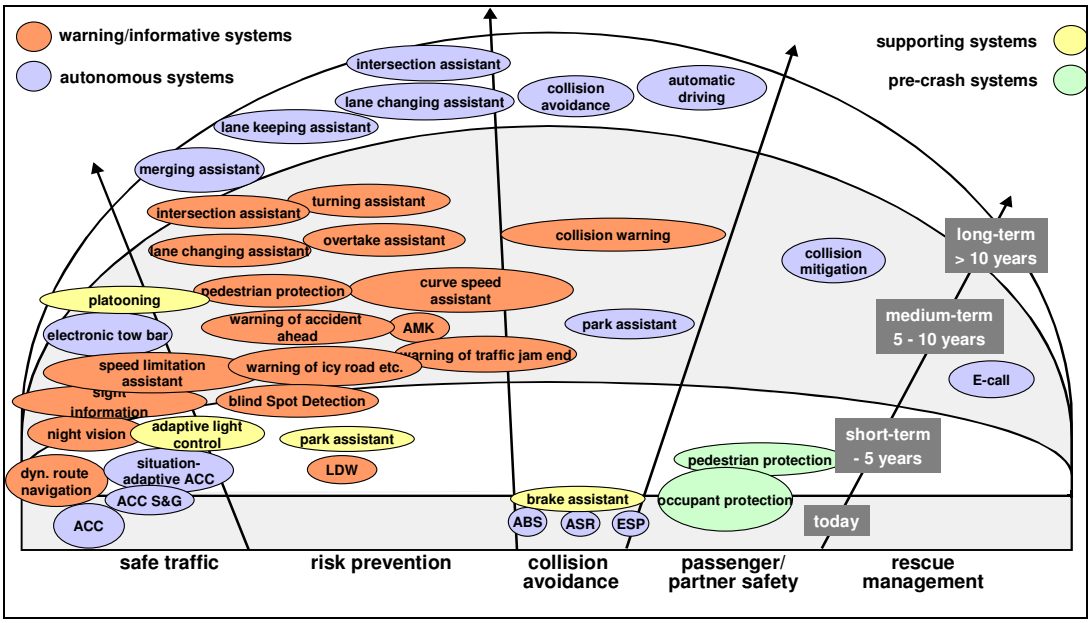

Figure 1: Roadmap for the introduction of advanced driver assistance systems

With this increased reliance on advanced technology, the role of vehicle roadworthiness testing is changing. While preventing catastrophic consequences caused by failure of mechanical systems is still important, the role of vehicle roadworthiness enforcement needs to ensure the benefits of new technologies and system are preserved. Failure of, for example, Electronic Stability Control (ESC) means that the benefits of that new technology are lost. This loss is compounded by drivers increasingly relying on the technology to get them out of difficult situations and their consequent change in driving behaviour. In addition the malfunction of some systems can result in the vehicles being less safe than traditional vehicles. For example, vehicles fitted with airbags in accordance with ECE94 and ECE95 have more rigid dashboards and vehicle interiors than vehicles not fitted with airbags. This means that injuries are likely to be more severe in vehicles fitted with airbags that fail to deploy than vehicles not fitted with this technology.

Unfortunately many vehicle owners do not adequately maintain their vehicles, making roadworthiness enforcement necessary. Defects are often not attended to by the vehicle owner/user because of their lack of technical knowledge and interest. It is easier and cheaper for them to ignore warning lights and other symptoms with the hope that the problem will go away (Stephan 2006).

The purpose of the AUTOFORE project is to recommend improvements in roadworthiness enforcement in the European Union to ensure that the benefits accruing from the original design and manufacture of vehicles are retained, where justified, throughout the life of those vehicles.

In particular, the AUTOFORE project is to recommend future options for roadworthiness enforcement in the EU giving particular attention to:

- Current roadworthiness standards and practices in the EU and other selected countries.
- Current and likely developments in vehicle, diagnostic, measurement and communication technologies.
- The effect of vehicle roadworthiness enforcement on road safety, environmental protection and other outcomes.
- All types of road vehicles ranging from mopeds and cars through to heavy vehicles.
- All forms of vehicle assessment, including periodic technical inspection (PTI) and roadside inspection.

2. Project structure

2.1. Project funding

The AUTOFORE project was funded by the European Commission and 12 co-funding organisations. Those 12 organisations are all members of the International Motor Vehicle Inspection Committee, otherwise known as CITA, which was the lead organisation for the project. The project was undertaken by five organisations working in partnership with CITA together with four subcontractors. Details of the co-funders, research partners, subcontractors and other participants are included in Appendix 1.

2.2. Project governance

The Project Steering Group (PSG) was chaired by the CITA President and had one member from each co-funding organisation and each research partner. The group provided strategic direction to the project. A smaller Project Management Group (PMG) was also formed to manage the operational aspects of the project.

2.3. Work packages

The project was divided into 8 work packages. One was reserved for project management. Three work packages were used to collect, analyse and summarise data on:

- Current situation (legal framework, methods, organization, results, etc.) in member states on all aspects of roadworthiness enforcement (periodic technical inspection, roadside enforcement, operator licensing and performance monitoring, etc).
- Current and likely future trends in vehicle and diagnostic technology including information on the emerging findings of IDELSY project.
- Safety and environmental protection strategies, objectives and priorities of member states, including the justification and details of any other related policy objectives (e.g. reduction of vehicle theft).
- Research and experience worldwide, particularly on alternative approaches;
- Attitudes and views of other stakeholders.
- Options to improve roadworthiness enforcement, e.g. to include other vehicle categories such as motorcycles, light trailers or agricultural tractors and mutual recognition of roadworthiness approvals.

Another work package involved the development of an economic assessment tool that included the categorisation of the benefits of roadworthiness enforcement and the development of an economic assessment tool for the evaluation of all the benefits of roadworthiness enforcement.

Lastly, two work packages involved the identification and analysis of the most promising options for adoption in the EU. The options were divided into those that could be included in a 2010 plan for action and those that required a longer time frame. This later group was included in the vision for 2020. An economic assessment of the options was undertaken and

practical issues and constraints were identified. Consideration was also given to the effect on stakeholders of moving to the alternative arrangements.

2.4. Final report

The final report consists of this report together with all the reports of the other work packages. The structure is shown in figure 2. This report focuses primarily on the identification and analysis of the most promising options and the overall recommendations.

The annexes contain over 20 separate reports that provide valuable background information for the development of roadworthiness enforcement policy options. This report should be read in conjunction with the work package reports.

Hard copy versions of this report have a CD-ROM containing all the annexes. A digital edition of this report, its appendices and annexes is available on the CITA website www.cita-vehicleinspection.org and can be downloaded free of charge. In case of difficulties, please contact the CITA Secretariat on cita.vehicleinspection@skynet.be or tel. +32 (0)2 469 06 70

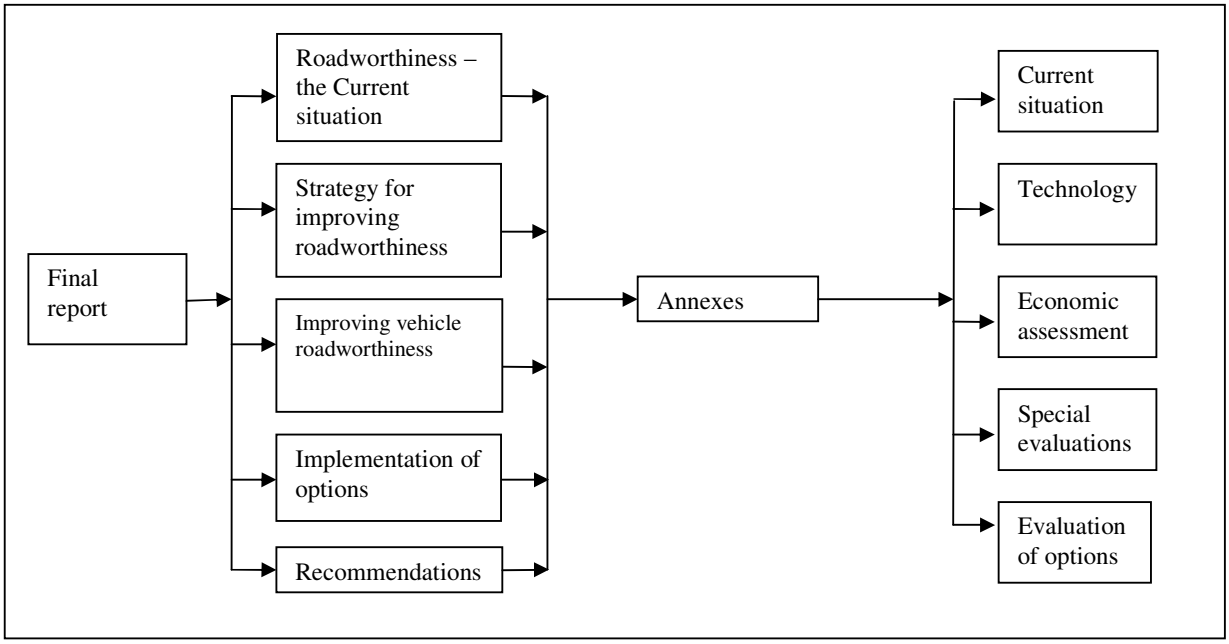

Figure 2: Structure of the report and hotlinks to the annexes (digital versions of the report only)

3. Roadworthiness – Current Situation

This section looks at the available evidence on the roadworthiness condition of vehicles in use in the European Union. It shows that the level of defects remains high and shows no signs of improving with the introduction of new technologies and manufacturing systems. It also sets out the current situation on the inspection of electronic systems and the cost of defects.

3.1. Available evidence

All vehicles deteriorate in service. However, apart from some results from surveys of the roadworthiness condition of randomly selected commercial vehicles in Great Britain, there are no systematic investigations in EU member states into the roadworthiness condition of vehicles in service. A considerable amount of data, such as the results of roadside inspections (most of which are targeted at vehicles most likely to be defective) and of periodic inspections, is available that can be used to infer that the level of defective vehicles in use is high.

The fact that commercial vehicles deteriorate at high rates is well accepted. Figure 3 shows the maintenance inspection intervals for heavy vehicles that are recommended by the British Department for Transport in conjunction with associations representing heavy vehicle operators [HMSO, 2006 #53]. These intervals are similar to those recommended by vehicle manufacturers and the transport industry. The inspection intervals are based on the expected time to failure of this type of vehicle. Many heavy vehicles travel between 50,000 and 200,000km per year and consequently should be inspected every 4 to 8 weeks in addition to mandatory annual periodic technical inspection.

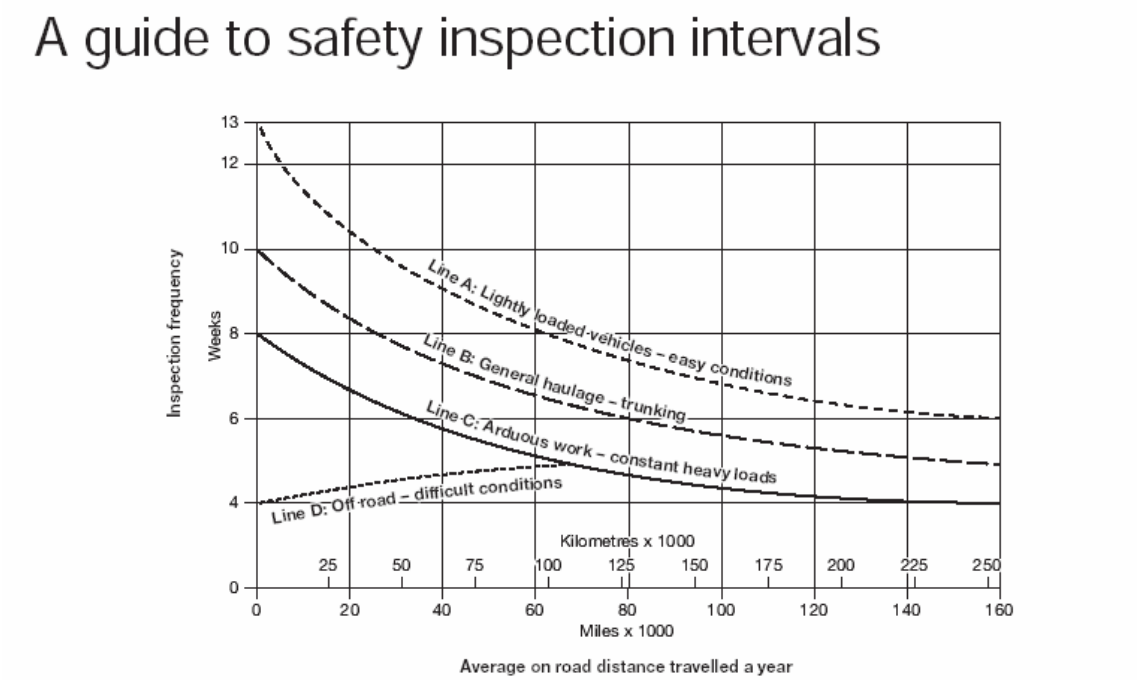

Figure 3: Typical routine maintenance inspection intervals from the British Guide to Maintaining Roadworthiness (reproduced by permission of HMSO, Great Britain)

3.2. Failure rates at periodic technical inspection (PTI)

Figure 4 shows that, for 3 million passenger vehicles inspected in Germany in 2004, more than 10% of the vehicles that were 5 years old at the time of inspection, had serious defects. This increased to over 31% for vehicles older than 9 years. Figure 5 shows the overall rate of serious defects for all vehicle types in Germany from 1987 to 2005. This shows that the average failure rate has not decreased significantly over that time.

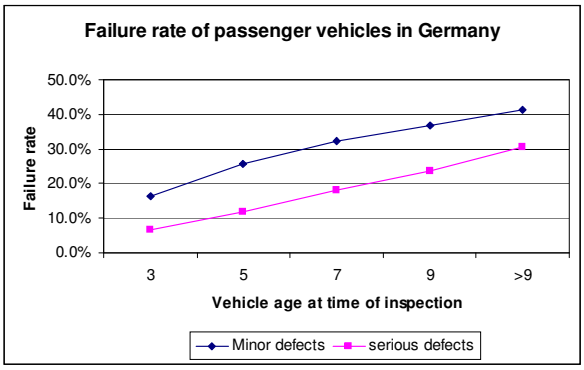

Figure 4: Failure rate of 3 million passenger cars in Germany.

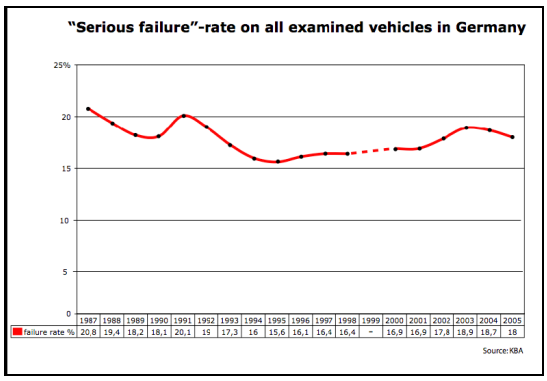

Figure 5: Average failure rate of all vehicle types inspected in Germany from 1987 to 2005.

Light vehicles in Sweden (Figure 6) and heavy vehicles in Great Britain (Figure 7) show very similar trends. Comparisons cannot be made of the failure rates between the different countries because of differences in inspection methods and pass/fail criteria.

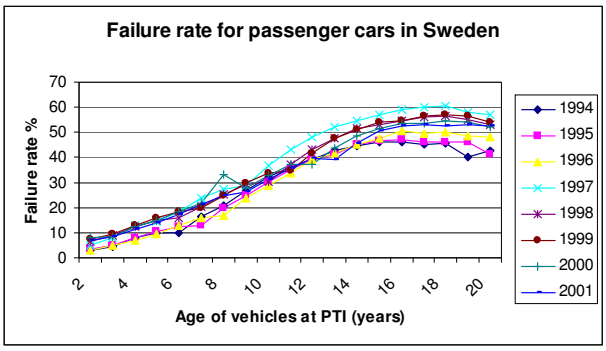

Figure 6: Failure rate of 3 million light passenger vehicles in Sweden during inspections undertaken between 1994 and 2001.

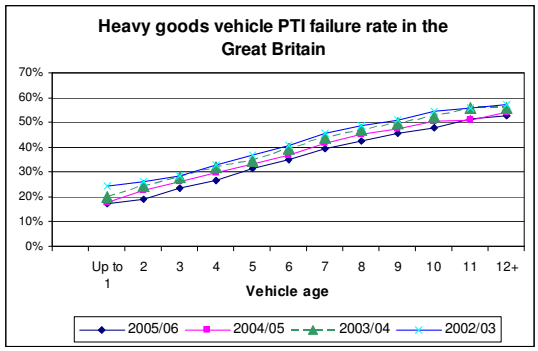

Figure 7 Failure rates of all heavy goods vehicles in Great Britain.

Figure 7 shows that the defect rate at the time of inspection increases to 50% by the time heavy vehicles are 10 years old. Heavy vehicles deteriorate more rapidly and have higher defect rates than light vehicles because of their higher weight and greater distances they travel.

3.3. Failure rates at roadside inspection

Most roadside inspections are targeted at vehicles most likely to be defective. This might be because the inspector can observe a defect, has knowledge that the particular operator is prone to operating defective vehicles or has other intelligence. It may also be on the basis of the age and general condition of the vehicle. Results of such surveys show not just the state of the fleet but also the effectiveness of the targeting.

In Great Britain a survey is conducted annually of the condition of a **randomly** selected sample of goods vehicles and large passenger carrying vehicles and this provides a truer measure of the general state of vehicles in use. In 2004 this survey (VOSA 2005) found that 3.9% of heavy goods motor vehicles and 4.1% of heavy trailers had defects that were sufficiently serious for them to be prohibited **immediately** from any further use. A further 7.4% of heavy goods motor vehicles and 8.8% of heavy trailers had other serious defects. Before any of these vehicles could be used unconditionally again, they had to pass a full periodic inspection. Defects with the braking system and braking components were the most common. Older vehicles were more likely to have defects.

For large passenger vehicles, in the 2004 survey, 3.4% were found to have defects that were so serious that they had to be prohibited **immediately** from further use and a further 5.8% had defects that resulted in restrictions on their further use. Again, before any of these vehicles could be used unconditionally, they had to pass a full periodic inspection. Defects in the braking systems and components were the most common.

There is no reason to think that similar surveys in other countries would find significantly higher rates of compliance.

The results of the checks done by member states on heavy vehicles according to the requirements of Directive 2000/30 have to be reported to the Commission. Their first report, which is due to be issued in early 2007, shows the defect levels up to 72%. However, it is likely that many of these checks are targeted and so cannot be assumed to represent the average condition of vehicles in use.

3.4. Major types of failure

Figure 8 shows that the main areas of failure at periodic inspection for light vehicles are: lights, brakes, tyres and emissions. All these defects show increased rates of failure with vehicle age. This data was for 10,000 vehicle inspections collected over a 4-month period in the Netherlands at large independent testing stations that do not undertake repairs. Of note is the decline in failure rate for vehicles older than 15 years, which is also evident in the Swedish data shown in Figure 6.

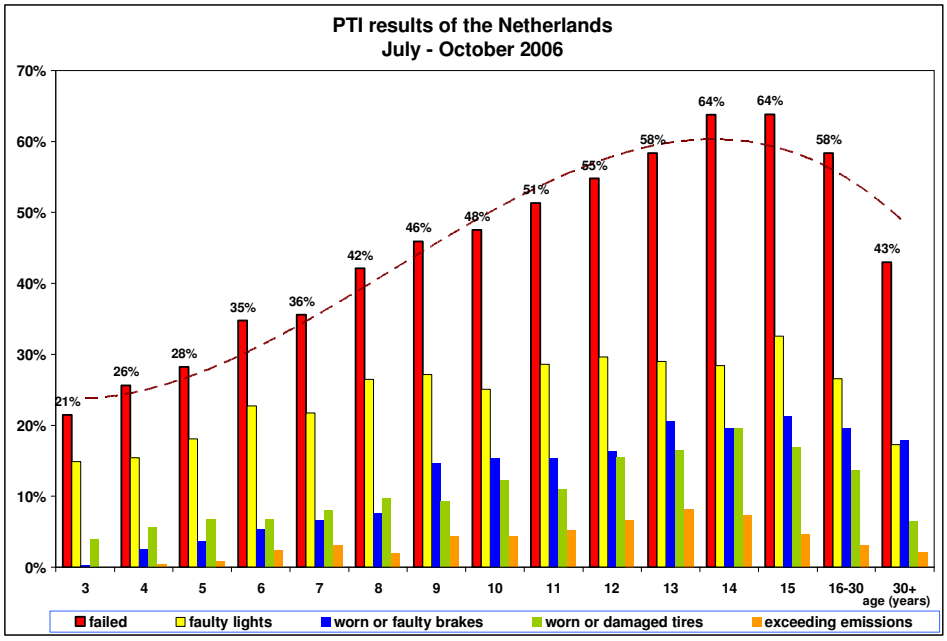

Figure 8: Inspection failure rates for different ages of light vehicles for the Netherlands over a 4-month period in 2006.

3.5. Electronic systems relevant to safety and environmental protection

Research undertaken by CITA and partly funded by the European Commission has shown that electronic systems on vehicles have failure rates comparable to mechanical systems that are considered important enough to be included in periodic inspections (Rompe 2002). The failure rates of electronic systems increase with both vehicle age and distance travelled.

On-board electronic systems typically have built-in diagnostic capabilities that can recognise malfunctions; however their capability is currently limited to the electronically controlled programme, the incoming signals from the sensors, and outgoing pulses. For example, in the

case of ESP systems, without the additional features the diagnosis is not able to detect whether a solenoid valve opens or closes sufficiently to achieve the desired pressure or if the desired brake forces are actually exerted on the wheels. In addition, problems can only be detected through self-diagnosis when they have reached or exceeded pre-defined thresholds.

At present, except for exhaust emission control systems that have been standardised in Europe, there are no agreed standards for on-board diagnostic systems. Each manufacturer has developed its own systems and protocols for communications with the on-board self-diagnostic systems and sensors and defined the failure threshold levels. This makes interrogation of the operational integrity of the systems very difficult and expensive for inspection agencies. Ensuring common inspection standards will require more development work to be undertaken.

3.6. Cost of the effect of defects on accidents and emissions

The European Commission (2001) has noted that the external costs of road transport are as much as €260 billion per year approximately 4% of GDP. Figure 9 shows the proportions of those external costs. In 2002 there were 50,000 fatalities in the EU 25. In the EU-15 alone there were 40,000 fatalities and 1.7 million injuries for which the direct and indirect cost was €160 billion or 2 percent of the EU Gross National Product (annex WP200 "Current Situation and Future trends" [CDlinkFut]). The environmental impact of vehicle use is extensive; contributing to climate change, the production of tropospheric ozone, acidification and degradation of the urban environment and a deterioration of human health. Vehicle defects increase emissions by between 1.2% and 5.7% depending on vehicle and fuel type. Congestion costs caused by vehicle breakdowns in the EU-15 plus Norway and Switzerland are estimated to cost between €1.3 billion and €1.9 billion per year (annex WP400 "Development of an Economic Assessment Tool" [CDlinkDev]).

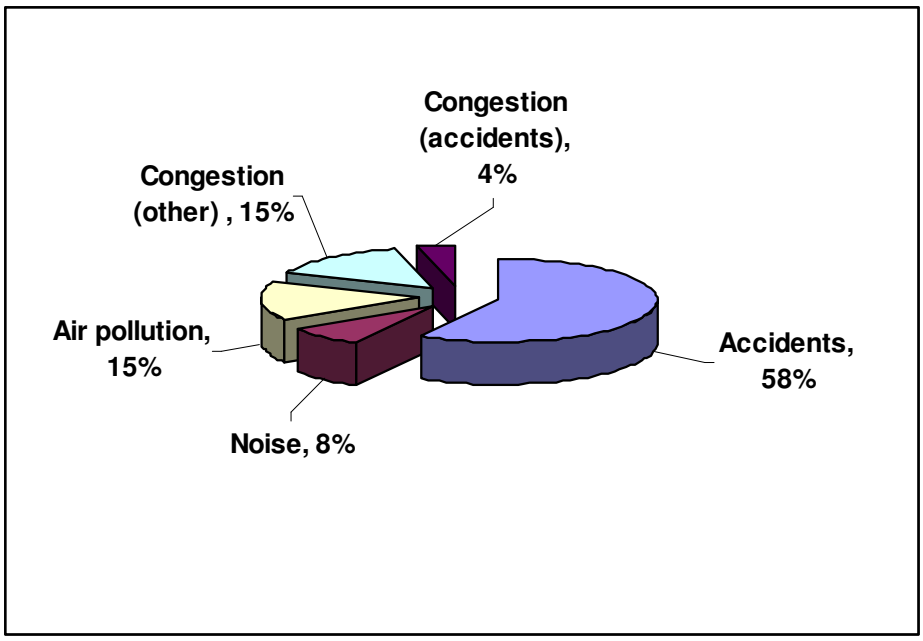

Figure 9: Proportion of the external costs of transport.

4. Strategy for improving vehicle roadworthiness

A conceptual framework is developed that includes definitions of roadworthiness, the purpose of roadworthiness enforcement and the means of improvement. A strategy for change is proposed that will introduce, where justified:

1. Higher roadworthiness standards before a vehicle can be classed as being roadworthy.
2. Broadening the scope of the standards to include items that currently are not included but are worth preserving and to include vehicle types currently not controlled.
3. Methods of improving the level of compliance.

4.1. Background

Vehicle owners and users have the prime responsibility to maintain their vehicle in a roadworthy condition at all times when used on public roads. However, as shown in the section 3, the results of enforcement activities clearly demonstrate that many vehicle owners do not fulfil their obligations. Especially for light vehicles, defects are often not attended to by the vehicle owner/user because of their lack of technical knowledge and interest (Stephan 2006). Roadworthiness enforcement is required to ensure that vehicle owners and users are aware of their obligations and act responsibly.

4.2. Purpose of roadworthiness enforcement

Roadworthiness enforcement *is defined as all activities that are undertaken independently of the owner or operator to verify vehicles remain roadworthy while in use on public roads.*

A vehicle is defined as being "*roadworthy*" when its performance and condition meets or exceeds agreed standards. This includes safety, environmental and other standards. In Europe those standards are currently based on European Communities Council Directive 96/96/EC. The Directive contains minimum standards.

The ***purpose*** *of roadworthiness enforcement is to ensure that the benefits accruing from the original design and manufacture of vehicles are retained, where justified, throughout the life of those vehicles.*

4.3. Developing a strategy for improving enforcement

The diagram in Figure 10 illustrates an example of the levels of roadworthiness that might be achieved by PTI for vehicles that are not fully maintained. Individual vehicles will deteriorate at different rates and often in a stepwise fashion as individual components fail. PTI ensures vehicles are returned to the required standards.

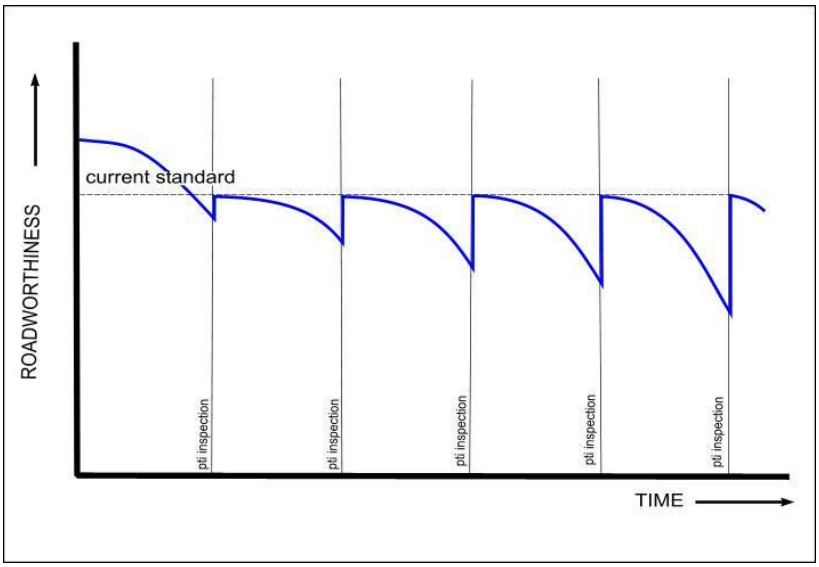

Figure 10: Rate of vehicle deterioration

A number of issues need to be considered when developing future options for roadworthiness enforcement. Those issues include:

- A shift in EU policy towards "sustainability" where all aspects of vehicle use need to be considered; including safety, the environment, mobility, efficiency, productivity and personal security.
- The major advances in vehicle technology that are leading to safer, more environmentally sustainable vehicles and other benefits.
- The increased complexity of vehicles and the need for them to be properly maintained throughout their life.
- The opportunities afforded by advanced on-board and off-board measurement systems to reduce the cost of compliance.
- Increased public expectations that their vehicle will get them to their destination safely and reliably.

To examine the justification for a particular approach to improving roadworthiness enforcement, identifying all the benefits that will be realised is also necessary. The benefits can be divided into two groups: primary and secondary. The primary benefits are identified as:

- Improved road safety by reducing the number and severity of road traffic accidents caused by vehicle malfunction.

- Reduced impact on the environment and public health through reductions in the level of pollutants emitted by vehicles.

The secondary benefits, which are becoming increasingly important, are:

- Reduced traffic congestion caused by vehicle breakdowns and accidents, taking into account the greater impact of incidents involving heavy vehicles.
- Increased personal security and reductions in theft.
- Improved transport efficiency, including optimising energy use and whole-of-life vehicle costs.

Improvements in roadworthiness enforcement will also result in other benefits that are not strictly roadworthiness-related. Those items include checking insurance documents and annual road tax payments.

4.4. Strategy

A number of broad strategic approaches are available that will enhance the benefits of roadworthiness enforcement. The following sections 4.4.1 to 4.4.3 describe the three core approaches that were identified as likely to provide the greatest benefits.

4.4.1 Raising roadworthiness standards

One strategic approach is to raise the standard of vehicle roadworthiness. Although the EU Directives, except for the inspection of brakes and emissions, do not specify standards (only the items to be inspected), the standards adopted nationally are, in most instances quite similar. These were set some time ago when vehicles were largely mechanical devices. Improvements in vehicle design and manufacturing standards plus the extensive use of electronics-based technologies in new vehicles may mean that current pass/fail criteria are no longer optimal.

In addition, raising the standard would provide an increased margin before vehicles degraded to the point where they became a high risk to safety, produced unacceptable levels of emissions and were prone to breakdown. The effect of raising the standards is illustrated in Figure 11. The diagram is purely conceptual because actual levels of roadworthiness will differ considerably from vehicle to vehicle.

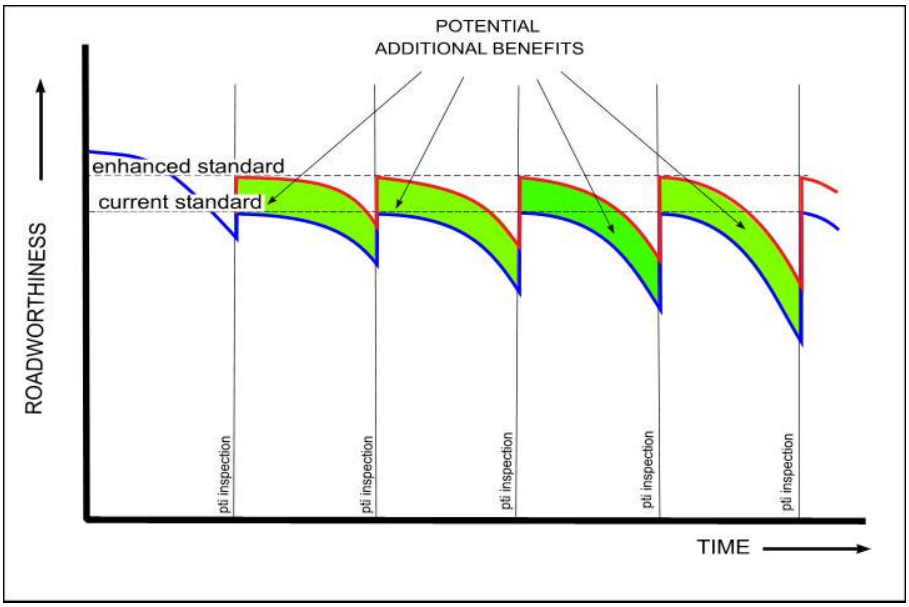

Figure 11: Benefits of raising standards of roadworthiness

4.4.2 Broadening the scope of roadworthiness enforcement

The second strategy is to broaden the scope of the roadworthiness enforcement to include items that currently are not included but are worth preserving and vehicle types not currently covered and where enforcement is justified.

Vehicle technologies are increasingly taking over aspects of the driver's tasks as a means of compensating for human error and reducing driver workload. This includes, for example, controlled application of the brakes if a rollover is imminent, and systems that automatically detect and avoid obstacles. While these systems improve safety and reduce the impact of vehicles on the environment, they add to the number of items on a vehicle that must function correctly if the benefits of the technology are to be retained. As mentioned earlier, new electronics-based technologies have been found to be no more reliable than many safety-critical mechanical systems, such as seat belts and buckles, and when they fail the potential for a disaster are even greater when drivers have learnt to rely on them.

The EU Directives do not cover all vehicles types in use on roads. For instance, Directive 96/96/EC does not cover two-wheeled motor vehicles, light trailers or agricultural tractors while Directive 2000/30/EC covers only commercial vehicles.

4.4.3 Improving levels of compliance

The third broad strategy is to improve the level of compliance with roadworthiness standards. The most obvious approach is to increase the frequency of current enforcement tools (PTI and roadside inspections). The effect of increasing the frequency of PTI is shown in Figure 12.

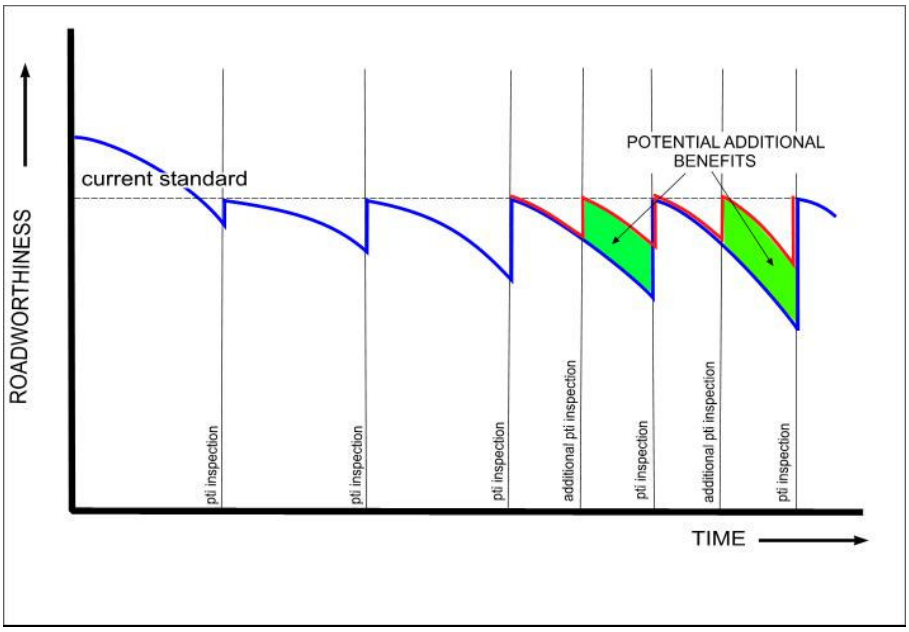

Figure 12: Benefits of increasing PTI inspection frequency

The ideal would be to find ways to get vehicle owners to keep their vehicles continuously in compliance with the roadworthiness standards. The aim would be to ensure vehicles are roadworthy all the time, not just at the time of their PTI inspections. While many vehicle owners regularly maintain their vehicles, the number of defects identified at the time of inspection suggests that a large number do not and that they rely on PTI inspections as their primary maintenance check. Roadside inspections undertaken in accordance with Directive 2000/30/EC contribute towards achieving continuous compliance but the number of roadside inspections that are undertaken is relatively small. A range of measures is required that encourage continuous compliance including the use of targeted enforcement, incentives and disincentives and user education and training. The benefits of continuous compliance are illustrated in Figure 13.

Improved compliance can be achieved by additional measures that include:

- Clarifying and improving the enforcement of legislative and other requirements on commercial vehicle operators to operate roadworthy vehicles and provide an effective incentive for them to have maintenance systems capable of detecting faults between periodic inspections.
- Roadside inspections coupled with suitable deterrents for vehicle operators who use unroadworthy vehicles.
- Improving the reliability of vehicles at the design and manufacturing stage.

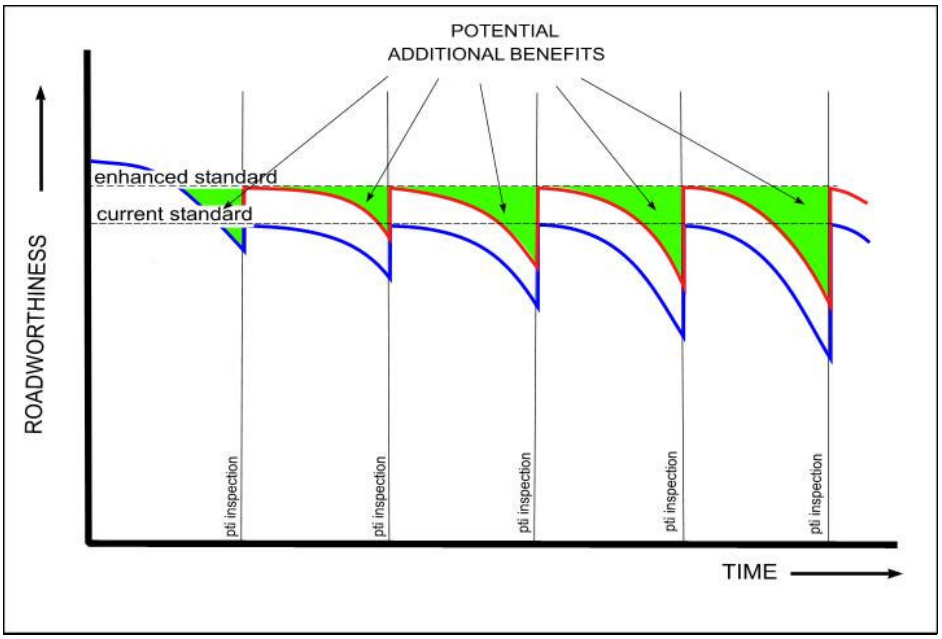

Figure 13: Benefits of continuous compliance over time

4.4.4 Combined effect

The above three strategies are complementary. The diagram in Figure 14 illustrates the benefits of enhanced roadworthiness enforcement if all three strategies are pursued. The red dashed line represents the benefits derived from Directive 96/96/EC. Those benefits will remain largely unchanged if the standards are retained in their current form and level. The blue dotted line shows the benefits of the new technologies that are being introduced provided they are maintained in perfect condition. The green solid line shows the potential benefits of enhanced roadworthiness enforcement taking into account advances in vehicle technology and management practice.

However it is unrealistic to expect all vehicles to be maintained in their “as new” condition throughout their life. The loss of benefits that arise from normal degradation of well maintained vehicles subject to enhanced enforcement is shown by the area between the green and blue lines. The potential gains from improved roadworthiness enforcement are shown by the area between the red and green lines that is shaded green. Virtually no information is available at present that can be used to quantify the benefits and further research is required to obtain such data and to analyse it.

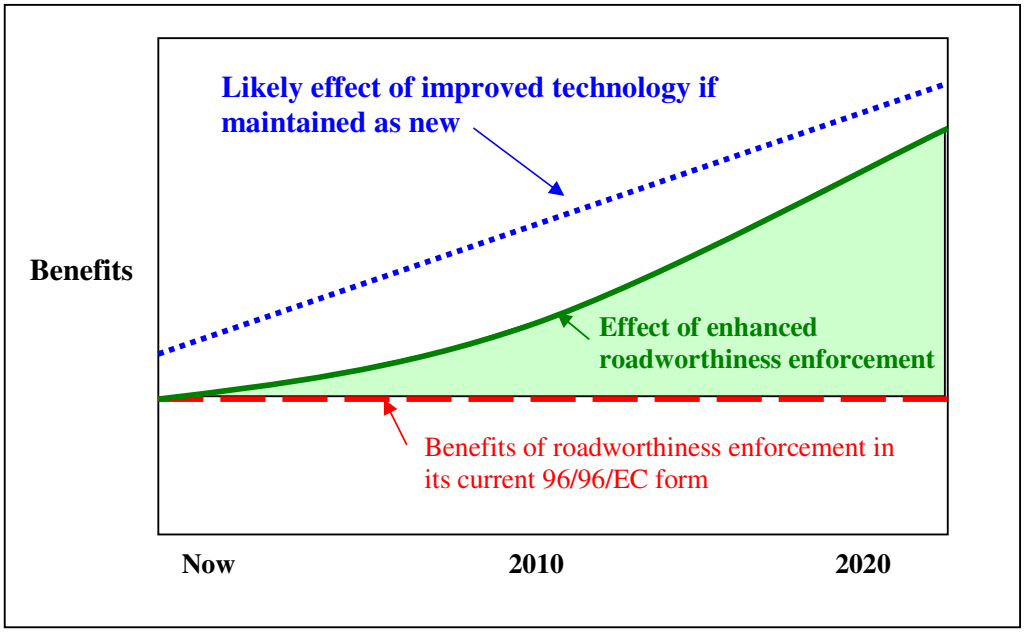

Figure 14: Potential of roadworthiness enforcement to preserve the potential benefits of improved vehicle performance. Benefits include avoidable accidents, injuries, environmental damage and congestion caused by vehicle defects.

5. Improving vehicle roadworthiness

This section describes the process used to identify the options for improving roadworthiness enforcement within the strategy defined in the section 4. That process involved:

1. Identifying and considering the main opportunities for improving roadworthiness enforcement that fit with the strategy (section 5.1).

2. Using a combination of the opportunities to develop a list of the most promising options for improving roadworthiness enforcement (section 5.2). The options are listed under 7 functional headings.

5.1. Opportunities to improve roadworthiness

A wide range of opportunities were identified and investigated as part of the project, and the sixteen most promising ones were identified. Their selection was based on their fit with the strategy, ease of implementation, and whether their introduction was likely to be able to be justified.

These 16 opportunities are summarised in Table 1 and linked to the strategies outlined in the section 4. The different forms of roadworthiness enforcement are described in Appendix 2 of this report.

Table 1: 16 opportunities for improving roadworthiness enforcement and their fit with the strategy.

	Strategy versus Opportunity	**Raise standard of vehicle roadworthiness**	**Broaden scope of roadworthiness enforcement**	**Improve compliance**
1	**Time of first inspection**	**X**		**X**
2	**Frequency of inspection**	**X**		**X**
3	**Inspection failure criteria**	**X**		
4	**Inspection technical database**	**X**		
5	**Standardised database with inspection results**	**X**		
6	**Extension of PTI to other items**		**X**	
7	**Extension to include other**		**X**	

	vehicle categories			
8	**Increased levels of roadside inspection**	**X**		**X**
9	**Remote technical inspections**	**X**	**X**	**X**
10	**Strengthen the maintenance obligations for commercial vehicle operators**	**X**		**X**
11	**Promotion of fleet management systems**			**X**
12	**Rating of heavy vehicle fleets**			**X**
13	**Fleet audits as a targeted supplement to PTI and roadside inspections**			**X**
14	**Vehicle durability rating**			**X**
15	**Inspection at significant milestones**		**X**	**X**
16	**Vehicle and component recalls**		**X**	**X**

5.2. Discussion of opportunities

1 Time of first inspection

The age of the vehicle when first inspected has not been reviewed for some time, despite the major changes that have occurred in vehicle technology. Any review of the time of first inspection needs to take into account the different circumstances in member states, manufacturers' warranties, maintenance requirements and changes in vehicle use. At present, examining the case for a change in the time of the first inspection is difficult because of the lack of good data.

2 Frequency of inspection

Given the evidence presented earlier about the increasing failure rate of older vehicles, clearly an opportunity to improve roadworthiness exists, by increasing the inspection frequency of older vehicles. Currently, private cars and light goods vehicles (classes 5 and 6 in Directive 96/96/EC) have to be inspected every two years (after the first inspection which is at 4 years after first use). Some countries already inspect them annual at all ages after the first inspection which can be either after 1, 3 or 4 years. Some start annual inspection later. Poland starts annual inspection at year 6, Portugal at year 9 and

		Estonia at year 10. As larger commercial vehicles are already required to be inspected annually, the option of higher frequencies for these classes was not investigated although there may be grounds to consider more frequent inspections for high mileage vehicles, such as some heavy commercial vehicles and taxis. Instead of time based frequencies, inspection periods for such vehicles could be mileage-based but that would require the availability and use of tamper-proof odometers.
3	**Inspection failure criteria**	The EU Directives currently only specify standards for emissions and brakes. Some roadworthiness improvement would occur if standards based on best practice in member states were introduced. This option requires considerable further work to identify and agree best practice and to assess the level of improvement that would result. The Directive standards for emissions were updated fairly recently. Further updating is hampered by the lack of cost effective measurement methods for low emission vehicles. The standards for brakes are very old and a strong case exists for their re-examination, particularly for large vehicles but again developing cost effective inspection methods presents problems, although recent improvements introduced into the international braking standards will help for future vehicles. As a first step towards raising standards and achieving harmonisation, the failure criteria could be updated for: A) Vehicles in different age groups built to different standards. B) Vehicles subjected to higher risk; e.g. dangerous goods vehicles. C) Different vehicle types More background work is required before recommendations could be made in this area.
4	**Inspection technical database**	Inspection effectiveness would be enhanced if a European database was available for the collection, storage and distribution of vehicle technical information (annex WP300 “An EU Technical Vehicle Inspection Database” [CDlinkDB]. It would:

		A) Enable inspections to take proper account of relevant vehicles specific information. B) Be essential for intelligent inspection. Some obligation would need to be placed on vehicle manufacturers to provide the data.
5	**Standardised database with inspection results**	A standardised European database of inspection results would be very beneficial in enabling: A) The targeting of roadside inspection to reduce the number of illegal, PTI non-compliant, vehicles on the road. B) Better data to be collected for analysis purposes; e.g. to support changes in the type approval regulations. A key finding of the AUTOFORE project is that very little quality data exists on roadworthiness enforcement. C) Durability rating of different vehicle makes and models. D) The advancement of harmonisation and mutual recognition between member states. E) More effective remote inspections to be undertaken.
6	**Extension of PTI to other items**	The current EU Directives do not cover all safety and environmental systems on vehicles. The inclusion of additional items of inspection must be based on demonstrated need. One general area where there is clearly a case for further items is electronic systems. Evidence is that such systems are no more reliable than mechanical systems already included in the inspections. Many electronic systems are fitted to improve vehicle safety and so their continued correct functioning is essential. To be fully effective, inspection of electronic systems requires agreement on common interfaces and communication protocols. A recent Belgian study found that 18% of a sample of vehicles had trouble codes that could not be interrogated for faults in items such as ABS, and airbags. ABS, ESC and airbags are now widely fitted to vehicles coming into the scope of Directive 96/96/EC. Until harmonised communication interfaces are fitted, at least a visual inspection of the system integrity, safety behaviour and to check that there has not been any obvious manipulation or alterations that would have a deleterious effect on the

		system performance could be introduced. (annex WP300 "Current Situation in Vehicle Technology" [CDlinkCur]) The case for adding the inspection of other electronic systems is also likely to be justified as they become fitted to a significant proportion of the vehicles being inspected. This could be done periodically. Member states could of course add other items earlier but it might be sensible to make this easier. Currently, member states must inform the Commission of any proposed modification and this causes a delay.
7	**Extension to include other vehicle categories**	Analysis of the vehicle categories that are not currently covered by periodic inspections shows the following significant classes might be considered for inclusion (annex WP300 "Extension to other vehicle classes" [CDlinkExt]): A) Motorcycles and mopeds – some member states already require motorcycles to be inspected and some evidence is available to suggest a high incidence of defects on two-wheeled motor vehicles involved in accidents. B) Agricultural tractors –currently insufficient data is available to evaluate this option. C) Light trailers– again, available evidence is insufficient to evaluate this option at present. Further research is necessary.
8	**Increased levels of roadside inspection**	Currently Directive 2000/30/EC does not specify a level of roadside inspections that member states must undertake and inspections are only required on 'commercial vehicles'. While some member states undertake high levels of mainly targeted inspections mainly on heavier vehicles others do very few. The potential to improve roadworthiness by increasing the general level of inspections is considerable, particularly for heavier vehicles.
9	**Remote technical inspections**	Remote technical inspection can include: A) Remote sensing of emissions. This is currently not widely used though possible applications are still being investigated. There are differing views about the usefulness of the results obtained and a lack of suitable roadside inspection sites in many areas. Further work would be required before any recommendations could be made. (annex WP300

		"Actual Situation of Remote Sensing" [CDlinkRS]) B) Weigh-in-motion, which is used extensively and can be very effective. Arguably, such checks are not part of 'vehicle' roadworthiness but part of enforcement of the requirements regarding the way vehicles are used. However, as operators who run overloaded often also ignore their roadworthiness obligations, it is a useful aid to targeting roadside inspections. (annex WP300 "Current situation of Weigh In Motion (WIM) systems" [CDlinkWIM]) C) Number plate recognition and vehicle identification systems are very effective tools to enable remote checks on PTI and vehicle licensing status during roadside and other enforcement checks. They require on remote access being available to reliable centralised databases. Vehicles that are used unlicensed or without a current PTI certificate are very likely to be unroadworthy so these are very useful aids to effective targeting.
10	**Strengthening the maintenance obligations for commercial vehicle operators**	EU legislation (mainly Regulations 881/92, 3118/93, 884/92 and 12/98 and Directive 96/26), already requires member states to ensure that those seeking admission to the occupation of commercial vehicle operator are aware of the roadworthiness requirements. Community permits for access to the international transport market can be withdrawn or not renewed if an operator does not comply with qualitative requirements which include the obligation to operate roadworthy vehicles. However, in practice, these requirements are not implemented in most member states so that they influence on the behaviour of operators significantly. Standardisation and strengthening of the enforcement of these requirements would result in significant benefits. Amendment of the requirements on entry to the occupation of commercial vehicle operator would also have an influence at the national level. Harmonisation of national operator licensing arrangements would be beneficial. For instance, it would provide: A) The ability to link national databases on heavy vehicle operator performance. e.g. number of vehicles, prosecutions, license status and PTI results. B) Better targeting of illegal vehicle operation Europe-wide. C) The opportunity to require new operators to have minimum maintenance systems in place as a

		condition of obtaining a licence. D) The use of graduated sanctions against poor operators including removal of license to operate. E) A means of promoting continuous compliance.
11	**Promotion of fleet maintenance systems**	Current high failure rates found during PTI and roadside inspections suggest that the standard of maintenance of heavy vehicle fleets is low. Promotion of good maintenance management practices is required as a means of ensuring continuous compliance. Adoption can be voluntary or mandatory, and can be linked to operator licensing. Australian research has found that commercial vehicle operators who have good maintenance management systems in place have less than half the number of accidents, irrespective of fault, compared to those that do not have such systems. Incentives and sanctions have been used successfully to encourage compliance. Incentives can include: significant insurance discounts, reduced compliance fees, and preferred status with some clients. Sanctions can include more frequent PTI, the targeting of roadside enforcement, and loss of licence. The use of incentives, including insurance discounts, could be used to encourage the adoption of good maintenance practice for all vehicles, including privately owned light vehicles. In Australia operators who have third party accreditation of their maintenance management systems receive major discounts on their insurance premiums.
12	**Rating of heavy vehicle fleets**	The rating of operators is widely used by the insurance industry for risk management purposes, and in North America as a means of promoting behavioural change through the use of incentives and disincentives. In Europe, the results of PTI inspections and roadside enforcement could provide the basis of the rating of fleets which could be used for targeting enforcement and as an input in to considerations of repute and compliance with obligations under community licenses.
13	**Fleet audits as a targeted supplement to PTI and roadside inspections**	An option for obtaining additional data about the performance of commercial vehicle operators is the use of fleet audits, especially when the condition of

		the vehicles in a particular fleet is of concern.
14	**Vehicle durability rating**	The rating of the durability of vehicles based on the number and nature of the defects found during vehicle inspections would better inform vehicle buyers. It would also act as an incentive for manufacturers to improve vehicle reliability and durability. This would result in improved vehicle roadworthiness and improved levels of compliance.
15	**Additional inspections at significant 'milestones'**	d) Additional inspections could be required at times such as change of ownership, after accidents and after modification. (annex WP500 "Inspection after accidents" [CDlinkAcc], "Inspection after technical modifications" [CDlinkMod], "Inspection after change of vehicle owner" [CDlinkOwn]) Such inspections are already mandated in a number of member states. At first examination, the option for action at the European level that might give the most roadworthiness improvement benefit was inspection after accidents. Currently the evidence available is not enough to undertake a detailed evaluation of the case for additional inspections at significant milestones. In the case of inspections after serious accidents, additional work is also required to establish: A) Accident damage severity that would trigger an inspection. B) The contents of an inspection. C) Enforcement procedures required to ensure repaired vehicles are presented for inspection.
16	**Vehicle and component recalls**	If vehicles that are subject to recall are not brought in and modified there is a loss of roadworthiness improvement. PTI and roadside inspections are important tools that could be used to increase the effectiveness of recall programmes. Their role can include: A) The identification of vehicles and components that may need to be recalled, B) Improving the effectiveness of recall actions, particularly if evidence of a completed repair or modification is made a requirement of PTI. This needs to be coordinated on a European-wide basis to ensure maximum effectiveness.

5.3. Conclusions on the most feasible options for improving roadworthiness

Following further analysis, the following list of actions was developed of the most feasible options to improve roadworthiness. The items have been either derived directly from the opportunities outlined in the previous section or are actions which are necessary to support their implementation. For convenience, they are listed under a number of functional groupings, which means that some occur more than once.

5.3.1 Improve roadworthiness Directives

1. Amend Directive 96/96/EC to include more frequent inspections for older vehicles of categories 5 and 6, as defined in the Directive.
2. Extend Directive 96/96/EC to include other vehicle categories such as motorcycles.
3. Broaden Directives 96/96/EC and 2000/30/EC to include electronics-based technologies, in particular ABS, ESP and airbags.
4. Amend Directive 2000/30/EC to ensure that all member states undertake enough roadside inspections of commercial vehicles to improve operator behaviour.
5. Identify and evaluate further candidate electronic systems for adding to Directives 96/96/EC and 2000/30/EC.
6. Improve European harmonisation and cooperation on roadworthiness enforcement measures.
7. Facilitate the mutual recognition of PTI status across member states by amendment/extension of the Directives.

5.3.2 Improve the type approval requirement and legislative process

8. Update the regulations and Directives governing roadworthiness enforcement as an on-going process.
9. Promote type approval requirements that take into account in-service enforcement.

5.3.3 Develop infrastructure required to inspect electronically controlled systems

10. Develop expanded standard physical interface (OBD) and communication protocols.
11. Include standardised functionality testing of electronic systems in type approval standards.

5.3.4 Promote improved compliance

12. Explore option to including a durability rating of light vehicles in EuroNCAP or equivalent.
13. Promote improved maintenance management of heavy vehicles through clarification and improved enforcement of legal obligations with regard to vehicle maintenance.
14. Promote improved maintenance management of heavy vehicles by voluntary accreditation and by other means.
15. Improve awareness of the importance of roadworthiness and proper maintenance through education and information.

16. Make it easier for vehicle owners to comply by actions such as providing appropriate and timely information, reminders and visible symbols such as windscreen discs and convenient and accessible scheduling systems.
17. Provide fiscal or insurance incentives to improved maintenance.

5.3.5 Develop supporting roadworthiness inspection databases and related items

18. Develop technical database of vehicle make and model specific information for PTI and roadside inspection purposes.
19. Link national databases of PTI results for targeted enforcement purposes.
20. Develop a European vehicle and component recall database and link recall actions to PTI inspections.

5.3.6 Improve linkages between forms of roadworthiness enforcement

21. Improve proof of compliance to demonstrate that a vehicle has been checked for roadworthiness.
22. Develop a Europe-wide vehicle identification system (e.g. smart cards) as a means of positively and efficiently identifying individual vehicles.
23. Link national databases of licensed operators and their in-use performance.

5.3.7 Support research and development

24. Undertake further research to quantify the benefits of the new technologies that are being introduced on vehicles and to quantify the benefits of maintaining vehicles in roadworthy condition throughout their life.
25. Collect accident, emissions and other data for future economic assessment and policy development.
26. Further expand and enhance the economic assessment model developed by this project.

6. Implementation considerations

This section discusses the implementation of the options identified in the previous section.

1. The timescales for possible implementation (section 6.1).
2. Consideration of which options it might be possible to undertake economic analysis (section 6.2)
3. Results of the economic analysis (section 6.3)
4. The views of other stakeholders and likely barriers to implementation (section 6.4)
5. Identification of further work necessary before other options can be implemented (section 6.5)

6.1. Timescales for possible implementation

Proposals for changing roadworthiness enforcement should be justified. Whenever possible, this justification should be based on objective evidence. However, at the present state of knowledge and availability of data, it is not possible to analyse all the options listed in section 5. The implementation of the proposals is therefore divided into two time scales, those where it might be possible to undertake economic analyses on the basis of currently available data and those where more work is required, either to clarify in more detail the option or to collect or obtain sufficient data for a benefit to cost analysis. These two timescales are:

1. **2010 Package:** Options on which implementation work can commence immediately and which might be in force by 2010; and
2. **2020 Package:** Options that require further work and analysis or which require the implementation of other initiatives. The objective should be to achieve full implementation by 2020 at the latest.

6.2. Economic analysis of options

An economic analysis was undertaken by the Institute for Transport Economics team at the University of Cologne on options that were thought to be particularly promising and there appeared to be sufficient data to undertake the analysis. The options analysed were:

- Increase the frequency of inspection for older light vehicles (categories 5 and 6 defined in Directive 96/96/EC).
- Extension of periodic inspection to cover electronically controlled systems.
- Extension of Directive 96/96/EC to cover two-wheeled motor vehicles (International categories L1 and L3).
- Increase the level of roadside inspections as mandated by Directive 2000/30/EC.

6.3. Economic analysis results

6.3.1 Increased inspection frequency for older vehicles

Sufficient empirical data was available to undertake a valid economic analysis. The results show a benefit-to-cost ratio of at least 2:1 for the annual inspection of light vehicles 8 years and older. The economic benefit would be over €2.1 billion. A number of other factors that could not be quantified would enhance these figures.

The benefit-to-cost ratio remains positive for earlier introduction of annual inspections of light vehicles, including starting with vehicles that are 5 years and older. Although the benefit-to-cost ratio progressively reduces as the year of introduction is brought forward, the economic benefit increases. The choice of the year from which to start annual inspection is a matter of judgement. This report does not propose a particular figure but introduction of annual inspection from year 8 is considered to be the latest that should be introduced. An earlier start time would be justified. For instance, a change from bi-annual inspections to annual inspections from year 7 still shows a benefit of €2.2 billion with a benefit-to-cost ratio of about 1.9. It would align better with the current minimum requirements in Directive 96/96/EC which, for countries that test to those requirements already, has an inspection in year 8.

As shown in the annex WP700 "Cost-Benefit Analyses for Roadworthiness Options" [CDlinkCB] covering the detail of the benefit to cost analysis, the robustness of the results is dependent on:

- empirical evidence from Germany that technical defects are contributory factors in somewhere between two and nine per cent of accidents (an average figure has been chosen for the calculations);
- an assumption that the background decline in accidents that is already occurring remains at two per cent;
- The assumption that 60% of technical defect-related accidents would be avoided by inspection.

6.3.2 Inspection of electronic systems

Again sufficient empirical data has been obtained to undertake a valid economic analysis. It is based on one safety system, ESP, and produced a benefit-to-cost ratio of 2.6. Other electronic systems, such as ABS and airbags, which are now widely fitted and have accepted road safety benefits, could also be inspected at little additional cost. In due course, further systems, when widely fitted, such as Lane Departure Warning and Active Cruise Control, could be added.

The analysis is dependent on the assumptions used regarding systems failure rates (Rompe 2002).

6.3.3 Extension of Directive 96/96/EC to two-wheeled motor vehicles

Unfortunately, insufficient empirical and other data is currently available to conduct a full economic analysis on the extension of Directive 96/96/EC to include two-wheeled motor vehicles.

6.3.4 Increased levels of roadside inspection mandated by Directive 2000/30/EC

A proper economic analysis of the affects of increased roadside inspections for commercial vehicles has been thwarted by the lack of empirical data that applies to Europe for the cost/benefit calculations. Positive and quantified evidence for the effectiveness of roadside inspection has been obtained in U.S. studies. While it has not been possible to translate those results to a European setting, they nonetheless demonstrate the need to collect more European data and to investigate this option further.

6.4. Possible obstacles and barriers to implementation

The review of possible barriers and obstacles to implementation of the emerging findings, where a change to current requirements appears to be justified, was undertaken. This included discussions with some of the key stakeholders.

6.4.1 Increased inspection frequency for older vehicles

No overwhelming barriers were identified. However, the following points should be noted –

- Some nations (notably the Netherlands and Great Britain) are already looking at going the other way (i.e. reducing frequency) to save costs. However, no information has emerged from either country that suggests that the economic analysis undertaken as part of Autofore is incorrect.
- Testing capacity may need to be increased in some countries, which has timing implications.
- Public reaction and political consequences will naturally be significant in those countries where PTI would become more frequent.

6.4.2 Inspection of electronic systems

There is likely to be significant opposition to this proposal from the vehicle and component manufacturers. They argue that:

- Only electronic system integrity can be tested, not the functionality of the full system.
- The systems already have malfunction indicators built in.
- Electronic systems are either working or not working, there is no halfway house and consequently do not require periodic inspection.
- Systems are designed and developed using complex simulations and test track experience carried out over many thousands of hours. They have considerable redundancy and over-checking capability built in. A simple test to validate efficacy of the system cannot be relied on.

On the other hand there is strong evidence from trials conducted in Germany that supports the value of the tests. The details of those trials are set out in detail in the report in annex WP500 “Electronic controlled systems” [CDlinkEl].

In addition, there are legal issues related to the fact that systems being proposed for inspection (which will result in vehicles being failed) are not mandated for fitment. This is not thought to be a major issue since there have been many precedents where in-service enforcement decisions have been based solely on the safety or environmentally friendliness of the vehicle at the time of the test.

At the present time, ABS, airbags and ESP systems are fitted to a significant proportion of the fleet. Inspection should start on these systems with others added as they become more widespread. A phased approach is proposed for the testing of electronic systems:

(a) Amend Directive 96/96/EC to include inspection of the most commonly fitted systems, i.e. Antilock, ESP and airbags and specify a minimum visual inspection of the system components for signs of deterioration, malfunction or deleterious alteration and checks on the function of the MIL lamp.

(b) Request urgent amendment of the type approval regulations and/or Directives to require the use of standardised communication protocols. In the meantime manufacturers should be pressed to do this voluntarily.

(c) Add further systems to the Directive as those systems become widely fitted and evidence becomes available to justify their addition.

(d) The inspection methods specified in the Directive should be amended when more information is available on the practicality of inspection methods and the benefits of those inspections.

For further detail see annex "Future Developments and their Implications in Diagnostics Technology for Vehicles" [CDlinkDia].

6.4.3 Extension of Directive 96/96/EC to two-wheeled motor vehicles

A full economic analysis could not be undertaken on the inspection of two-wheeled motor vehicles because of the shortage of data. But two-wheeled motor vehicle riders are more vulnerable than other classes of motor vehicle users and two-wheeled motor vehicles involved in accidents have a relatively high number of defects. The view of the study is that, although there is insufficient data for the cost/benefit analysis, the inspection of motorcycles and mopeds is justified.

In some parts of Europe motorcycles and mopeds are frequently used as a normal means of transport, especially by young people or the lower social classes. The bikes are smaller, less expensive and are generally kept longer. Consequently, the benefits of inspecting two-wheeled motor vehicles are likely to be greater in these countries. Periodic inspection of motorcycles is already mandatory in at least 14 of the EU-27 countries. It has recently been introduced in Italy and is under consideration in France. Mopeds are less widely inspected but some countries, such as UK, have inspected them for many years. Periodic inspection of mopeds has recently been started in Spain

The recently introduced exhaust gas legislation, which will be tightened further over the coming years, and widespread concern about excess noise, add justification for the inspection of two-wheeled motor vehicles. Emission tests for motorcycles have recently been introduced in Germany. Noise tests have been in place for some time.

Mopeds are performance limited by law in order to allow them to be used with less stringent driver licence requirements. A limited, but representative, investigation in the Netherlands found that a very high percentage of the mopeds had been tampered with to increase their performance. Experience in Spain has shown that a high number of vehicles presented for inspection have been modified. Tampering is likely to result in reduced safety and significant increases in exhaust emissions. It is likely that some of the modifications made to increase performance will be reversed just before periodic inspections and random roadside tests may be required to combat tampering. Such modifications can be controlled at roadside inspections but require the use of transportable chassis dynamometers and a high frequency of checks. Periodic inspection would reduce the incidence of other safety related defects, particularly those of which the owner is unaware. The case for testing mopeds is complicated because there is no agreed definition for them and a lack of vehicle licensing requirements in some countries. Nevertheless, consideration needs to be given to how these could be overcome as mopeds have a disproportionately high accident rate and a high level of technical violations.

6.5. Identification of further work

In order to take forward other possible options, additional research and development work needs to be undertaken. This could be grouped into the following 4 projects.

6.5.1 Undertake a new study ("AUTOFORE 2")

The purpose of that study would be twofold:

(1) An innovative study into the effect of vehicle defects on safety and the environment. As discussed earlier in this report, current estimates of the contribution of vehicle defects to accidents range from 2.5% to 9.1% or higher. This is a very broad range and indicates a significant gap in knowledge of the role of vehicle roadworthiness enforcement. It would also appear that vehicle roadworthiness will play an increasingly important role in ensuring safety and environmental protection because aspects of the driver's tasks are being taken over by vehicle technology. This study would include research into the role of the driver, how the driver's task is affected by new technology, and how defects in that technology will affect overall safety and other outcomes such as the level of emissions and congestion. It will draw on the results of other European projects, especially:
- ETAC: European truck accident causation.
- TRACE: Traffic Accident Causation in Europe.
- APROSYS: Advanced Protection Systems (Based on Passive Safety but also containing accidentology).

A brief description of those projects is provided in Appendix 5.

(2) The trialling of new vehicle inspection systems suitable for the inspection of electronically-based technologies. Electronically-based systems often have built-

in diagnostic checks of the electronics but not of the physical functionality of sensors, actuators and other components.

6.5.2 Undertake a study into methods of improving compliance and the effectiveness and efficiency of vehicle inspection

The study would be in three parts:

(1) Continuous compliance of heavy vehicles. This would include operator licensing, and voluntary operator accreditation.
(2) Continuous compliance of all other vehicle categories. This would include: the development of an inspection results database, evaluation of the use of insurance discounts and other incentives and increased training and information as means of encouraging vehicle owners to service their vehicles regularly, the feasibility of a European vehicle recall system linked to PTI, the identification of improved testing methods and methods for targeting enforcement based on PTI results.
(3) The feasibility and trialling of a technical database and a results database.

6.5.3 Further harmonisation of European roadworthiness standards

A study is required that will promote European harmonisation of roadworthiness enforcement. It is expected that this will be limited to practical options that will result in at least minimum levels of harmonisation.

6.5.4 Re-schedule and prioritise CITA work

The work CITA undertakes through its various technical working groups should be re-scheduled and prioritised as a means of furthering the development of options that are not yet at the stage where they can be recommended for regulatory change.

7. Recommendations

On the basis of all the work undertaken during the study, this section sets out:

1. Three recommendations to change European legislation in the immediate future for implementation by 2010 (**2010 Package**).
2. A recommendation to initiate three projects to investigate further and develop other possible actions, with a target of implementation by 2020 (**2020 Package**).

7.1. 2010 Package

Recommendation 1 - Amend Directive 96/96/EC to increase the frequency of inspection for older vehicles of category 5 and 6, as defined in the Directive.

The economic benefit of increased frequency of inspection of older light vehicles would be over 2 billion euros if vehicles of 8 years and over are inspected annually with a benefit-to-cost ratio of over 2. This is the **minimum** change that should be introduced. Although the benefit-to-cost ratio would be slightly reduced, introduction of annual inspection for vehicles 7 year and over would give higher benefits. As such, it should be considered seriously.

Recommendation 2 – Amend Directive 96/96/EC to include the examination of safety relevant electronic systems that are already widely fitted (airbags, ABS and ESP).

The benefit-to-cost ratio of inspecting ESP systems alone is 2.6. Additional benefits will arise from testing other systems, such as ABS and airbag systems. Initially the inspection should include, at a minimum, observational checks on the system completeness and functionality and for obvious signs of deterioration or deleterious alteration. Additional systems should be added when they become widely fitted. More comprehensive checks should be added when further work described below has been completed.

Recommendation 3 - Amend the scope of Directive 96/96/EC to include two-wheeled motor vehicles (international categories L1 and L3).

Although an economic analysis could not be done to quantify the magnitude of the benefits, there is good accident evidence to support the extension of the Directive to two-wheeled motor vehicles. The inspection of two-wheeled motor vehicles should be pursued, especially

the inspection of motorcycles. There may be some problems with the inspection of mopeds that will need to be addressed before inspection of these vehicles could commence.

Work should start in the near future on the preparation of a regulatory impact statement on these three items.

7.2. 2020 Package

Recommendation 4 - In order to be able to develop the options for introduction by 2020, the following 3 projects should be initiated.

1 Undertake a new study ("AUTOFORE 2") to research the magnitude of the contribution of vehicle defects to accidents and to trial new inspection systems suitable for inspecting the functionality of electronically based technologies.

2 Undertake further work to develop proposals of improving compliance and the effectiveness and efficiency of vehicle inspection.

3 Undertake further work to develop proposals for further harmonisation of European roadworthiness standards.

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(2001) 2001 Commission Transport White paper, European transport Policy for 2010 – A time to decide

Appendix 1: Project sponsors, participants and governance

Organisation leading the project

International Motor Vehicle Inspection Committee (CITA)
CITA Secretariat
21-25, rue de la Technologie
B-1082 BRUSSELS
Contact person - LABRO, Wim, e-mail – cita_labro.w@skynet.be
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Primary funding organisation

- European Commission Directorate-General for Energy and Transport (DGTREN)

Co-funding organisations

- A-Inspection Ltd (Finland)
- APPLUS+(Spain)
- Bilprovningen (Sweden)
- DEKRA (Germany)
- Driver and Vehicle Testing Agency (Northern Ireland)
- GOCA (Belgium)
- GPCTA(France)
- National Car Testing (Ireland)
- RDW (Netherlands)
- SNCT (Luxembourg)
- Vehicle and Operator Services Agency (Great Britain)
- Verband der TÜV e.V (Germany)

Partner organisations

- IDIADA Automotive Technology, Spain
- Arbeitsgemeinschaft Technische Prüfstelle für den Kraftfahrzeugverkehr 21 (Argetp21), Germany
- Knibb, Gormezano & Partners (KGP), Great Britain
- Institut für Kraftfahrwesen Aachen (IKA), RWTH Aachen University, Germany
- Transport Engineering Research New Zealand Limited (TERNZ), New Zealand

Sub-contractors

- Institut für Verkehrswissenschaft (IfV), University of Cologne, Germany
- TNO Automotive, Netherlands
- Faculty of Transportation Science, Czech Technical University, Prague, Czech Republic
- J.David Associates Ltd, Great Britain

Project Steering Group

The Project Steering Group (PSG) was chaired by the CITA President and had one member from each co-funding organisation and each partner organisation. The group provided strategic direction to the project. The Project Manager attended the PSG meetings and provided progress reports. The Project Director supported the meetings and acted as secretary.

Project Management Group

The Project Management Group (PMG) was chaired by the CITA President and had four members appointed from the PSG. The members differed from meeting to meeting depending on the issues. This group handled the more operational matters and only met when needed. The Project Manager attended and acted as secretary to the PMG meetings. The Project Director attended the meetings. All PMG papers and reports were copied to all PSG members so that they were informed about what was discussed and what was decided.

Project Director

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Project Manager

DAHL, Göran
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Work Package leaders

WP200	IDIADA	TEJERA, Gonçal
WP300	Argetp21	RICHTER, Axel
WP400	IfV	BAUM, Herbert
WP500	Argetp21	MÄURER, Hans-Jürgen
WP600	CITA	DAVID, Julian
WP700	KGP	KNIBB, Brian

Appendix 2: Roadworthiness enforcement mechanism

A number of roadworthiness enforcement tools are currently used in Europe and overseas that could be enhanced or introduced as a means of improving vehicle roadworthiness. The key measures are listed below.

Periodic technical inspection (PTI)	This is already compulsory throughout Europe and is very effective in ensuring compliance at the time of inspection. Vehicles that are not presented for inspection when required are in breach and need to be found through roadside enforcement.
Compulsory technical inspection not at time-based intervals (Variable PTI)	Similar to PTI but with variable inspection intervals based on an assessment of risk for different vehicle types, uses and operations. Generally only suitable for heavy vehicle fleets. Possible use as an incentive to encourage better maintenance management practices.
Roadside technical inspection	Compulsory technical inspections undertaken at the roadside in accordance with Directive 2000/30. Must be undertaken by organisations that have the legal power to stop vehicles. It is an effective deterrent and a means of detecting illegally operated vehicles.
Roadside non-technical inspection	Includes roadside inspections for overloading, driving hours etc. Although the inspection does not include roadworthiness items, there is often a correlation between poor roadworthiness and other forms of offending. It is also a means of identifying vehicles that do not have a current roadworthiness certificate.
Periodic non-technical inspection	An extension of periodic technical inspection. Can be used to inspect non-technical items such as insurance documents, the payment of fees and taxes and ownership details.
Remote technical inspection	Currently limited to noise and emissions screening. Special sites are required for emissions screening. In time could be extended to include remote access to stored OBD information.
Vehicle operator licensing	Provides a means of ensuring fleet owners take responsibility for the maintenance and operation of the vehicles under their control. Licence conditions can include compliance with specific operational standards, including vehicle maintenance standards.

Operator accreditation	Compulsory or voluntary regimes that assess the maintenance management systems put in place by operators as a means of ensuring vehicles are always roadworthy. Operators are subjected to audits to verify ongoing compliance. A way of encouraging continuous compliance by heavy vehicle fleets.
Operator rating	Compulsory or voluntary heavy vehicle rating schemes that measure the performance of operators in terms of safety, vehicle roadworthiness, on-road compliance etc. A way of encouraging continuous compliance.
More durable vehicles	Legislative or non-legislative means of encouraging manufacturers to produce more durable vehicles. This is a relatively low cost means of improving vehicle roadworthiness and can be very effective as witnessed by the improvements in vehicle crashworthiness achieved by EuroNCAP.

Appendix 3: Supporting annexes

WP200 – Current situation and future trends	
1	Literature research
2	Current situation and Future trends
3	Other Stakeholders Attitudes
4	Overview of worldwide experience
5	Results Governmental Questionnaire + Table1 and 2
6	Results PTI Questionnaire + Table3 and 4
7	Results Other Stakeholders Questionnaire
8	3 XLS-files with answers
9	Governmental body Questionnaire
10	PTI Questionnaire
11	Other Stakeholders Questionnaire
WP300 – Technology	
1	Summary
2	Current situation in vehicle technology
3	Future developments and their implications in Vehicle Technology
4	Function & Technology Matrix
5	Current situation of Weigh In Motion (WIM) systems
6	Actual Situation of Remote Sensing
7	Actual Situation of On Board Diagnosis
8	Future Developments and their Implications in Diagnostics Technology for Vehicles
9	Supplementary Information on Telematics
10	An EU Technical Vehicle Inspection Database
WP400 – Economical model	
1	Development of an Economic Assessement Tool
WP500 – Special evaluations	
1	Mutual Recognition of Roadworthiness Approval
2	Self assessment
3	Extension to other vehicle classes
4	Inspection after accidents
5	Inspection after technical modifications
6	Inspection after change of vehicle owner
7	Pass fail rates and accidents vs PTI frequency
8	Suspension testing
9	Electronic controlled systems
10	Non-legislative measures
WP700 – Economical assessments	
1	Cost-Benefit Analyses for Roadworthiness Options
2	Roadworthiness Testing Evalutaion

Appendix 4: Roadworthiness enforcement in the European Union

a. Today's legislative situation

Member States of the European Community are required to comply with certain minimum roadworthiness enforcement regimes. Until fairly recently, these requirements only covered mandatory periodic testing of vehicles. In 2000, the roadworthiness requirements were extended to introduce mandatory roadside inspection of heavy vehicles throughout the Community.

b. Mandatory Periodic Testing

The Community's Roadworthiness policy was framed over twenty years ago in 1977 (framework Directive 77/143/EEC) and originally only included trucks, buses, taxis and ambulances within its scope. It requires that these vehicles should be tested at least once a year. The Directive included a list of items to be tested and inspected such as brakes and emissions but did not specify how testing and inspection should be carried out or what the pass/failure criterion was. Nevertheless, at the time this Directive established new ground for several Member States: for others it merely confirmed long established procedures.

Up to that time, a number of European countries had been operating mandatory periodic inspection regimes under national legislation. For example, Austria first introduced obligatory periodic vehicle testing with the 1929 Motor Vehicle Decree. In Great Britain mandatory periodic inspection for heavy goods vehicles was introduced in the late 1950s although a less formal regime for passenger vehicles used for fare paying passengers (Passenger Service Vehicles) had been in place since the early 1930s.

Since 1977, the Directive has been modified eight times. Light goods vehicles were included within the scope of the Directive through amending Directive 88/449/EEC. Passenger car roadworthiness testing was introduced through amending Directive 91/338/EEC. The introduction of passenger cars, the vast majority of which are privately owned, established the precedent that the community, in pursuing policies to improve the safety and environmental performance of vehicles on its roads, also needed to take account of privately owned vehicles. The minimum roadworthiness inspection frequency for light goods vehicles and passenger cars is every two years once the vehicle is four years old but many Member States test to higher frequencies.
Further amendments added detailed requirements for the testing of vehicle brakes and exhaust emissions. In 1996, the framework Directive and all its amendments were consolidated (in Directive 96/96/EC) which has been further adapted several times (Directives 1999/52/EC, 2001/9/EC, 2001/11/EC & Directive 2003/27/EC).

Directive 96/96/EC, as amended, prescribes the categories of vehicle, items to be inspected and the periodicity of inspection

CATEGORIES OF VEHICLES SUBJECT TO ROADWORTHINESS TESTS AND FREQUENCY OF THE TESTS

Categories of vehicle	Frequency of tests
1. Motor vehicles used for the carriage of passengers and with more than eight seats, excluding the driver's seat.	One year after the date on which the vehicle was first used, and thereafter annually
2. Motor vehicles used for the carriage of goods and having a maximum permissible mass exceeding 3, 500 kg	One year after the date on which the vehicle was first used, and thereafter annually
3. Trailers and semi-trailers with a maximum permissible mass exceeding 3,500 kg	One year after the date on which the vehicle was first used, and thereafter annually
4. Taxis, ambulances	One year after the date on which the vehicle was first used, and thereafter annually
5. Motor vehicles having at least four wheels, normally used for the road carriage of goods and with a maximum permissible mass not exceeding 3,500 kg, excluding agricultural tractors and machinery	Four years after the date on which the vehicle was first used, and thereafter every two years.
6. Motor vehicles having at least four wheels, used for the carriage of passengers and with not more than eight seats excluding the driver's seat	Four years after the date on which the vehicle was first registered, and thereafter every two years.

c. *Technical adaptation*

Amending Directive 91/225/EEC introduced a "Committee for Technical Adaptation (TAC)" which was necessary in order that the complex technical annex to the Directive could be changed efficiently in line with technological progress. The first technical adaptation on vehicle braking was introduced through Directive 92/54/EEC, and Directive 92/55/EEC introduced detailed testing of vehicle emissions. Both Directives have since been modified, with the latest adaptation (Directive 2003/27/EC) being to add more stringent inspection standards for 'Euro3' petrol and 'Euro 4' diesel driven vehicles.

d. *Two-wheeled motor vehicles (TWMV) testing*

Directive 96/96EC does not include two-wheeled motor vehicles (motorcycles and mopeds) within its scope and therefore there are no procedures specified for testing the safety, exhaust emissions or noise from such vehicles. Earlier proposals to extend the Directive to include two-wheeled motor vehicles did not meet with much support from the member states, particularly those that had only just introduced passenger car testing.

e. Roadside Roadworthiness Inspection

Directive 2000/30/EC extended the scope of mandatory roadworthiness enforcement in the European Union to the mandatory roadside inspection of heavy vehicles circulating in the Community. It requires Member States to undertake a specified minimum number of inspections at the roadside of vehicles in use. It was introduced because the regulated annual roadworthiness test for heavy vehicles was considered not to be sufficient to guarantee the roadworthy condition of these vehicles to the requirements of Directive 96/96/EC. The Directive stipulates that roadside roadworthiness inspections should be carried out without discrimination due to the nationality of the driver or age or country of registration of the heavy vehicle). Targeting of inspection should be based on vehicles most likely to be poorly maintained.

Legislative developments in United Nations Economic Commission for Europe (UN ECE)

f. The World Forum for the Harmonisation of Vehicle Regulations

The World Forum for Harmonization of Vehicle Regulations (WP29), a subsidiary body of the Inland transport Committee of the United Nations Economic Commission for Europe, is responsible for global issues regarding vehicle safety, environmental pollution, energy and anti-theft – both for new vehicles and for those in-service.

WP29 administers three International Agreements: the 1958 Agreement (established to facilitate the adoption of uniform conditions of approval and the reciprocal recognition of approval for motor vehicle equipment and parts); the 1998 Global Agreement and the 1997 Agreement on Periodic Technical Inspection. Subsidiary working parties of experts on Brakes and Running Gear (GRRF), Lighting and Light-Signalling (GRE), Passive Safety (GRSP), General Safety Provisions (GRSG), Noise (GRB) and Pollution and Energy (GRPE) research, analyze and develop requirements for technical regulations in their area of expertise.

The European Commission is currently exploring the possibility of the European Union becoming a signatory to the 1997 Agreement. A proposal to become a signatory is likely to be put to the relevant committee of member states in 2007.

g. The 1997 Vienna Agreement

The 1997 Agreement on Periodic Technical Inspection came into force in 2001 once it had been signed by five countries. It provides for the harmonization requirements for the control of in-service vehicles. Detailed requirements are

set out in "Rules". The first, Rule 1 – Protection of the Environment – was agreed in March 2001 and came into force in early 2002. Work on Rule has been put in abeyance pending possible accession of the European Union as a signatory to the 1997 Agreement.

h. Vehicle inspection arrangements in member States

Although all Member States must comply with the periodic testing requirements of Directive 96/96/EC, arrangements in each country vary significantly. On one extreme, vehicles in Austria, Holland, Great Britain (for cars and light goods vehicles) and Ireland (for heavy goods vehicles) are inspected in private sector testing organizations working in competition (de-centralised testing) and these organizations are permitted to repair and trade in the vehicles they inspect. At the other extreme, countries such as Luxembourg and Sweden have single independent testing organizations. Vehicles are inspected in a smaller number of high volume facilities (centralized testing) which are not permitted to repair or trade in vehicles.

Practices for roadside inspection of heavy vehicles also vary significantly. Some countries use the Police, who are sometimes specialists and some not, while others have special non-police agencies that use specially trained inspectors.

More detail of the roadworthiness arrangements in member states is in the report of the replies to the questionnaires issued at the start of the Autofore project at annex WP200 "Current Situation of Roadworthiness Enforcement on EU" [CDlinkFut].

Appendix 5: European road safety projects

ETAC- European truck accident causation

Project period From: 01.04.2004 To: 31.03.2006 (There has been a delay and the final Database will be available to the public shortly.)
Brief description of project
The main objective is to identify the causes for truck accidents in order to identify actions to improve road safety. The project will develop a common methodology for accident causation research, and expert teams will make in-depth investigations of 600 truck accidents in 7 EU countries.

The results will be recorded in a developed database compatible with other EU projects wishing to harmonise accident registration. The database will give information on accident causes, and the project will give a methodological way of dealing with truck accident registration. Furthermore, the project will come forward with recommendations to reduce the number of accidents involving trucks and ensure that the results are disseminated to relevant parties.

TRACE : Traffic Accident Causation in Europe

Project period From: 01-2006 To: 01-2008

Brief description of project
Objectives

The identification and the assessment (in terms of saved lives and avoided accidents), among possible technology-based safety functions, of the most promising solutions that can assist the driver or any other road users in a normal road situation or in an emergency situation or, as a last resort, mitigate the violence of crashes and protect the vehicle occupants, the pedestrians, and the two-wheelers in case of a crash or a rollover.

The determination and the continuous updating of the metiology, i.e. causes, of road accidents (as well as the causes of injuries) and the assessment of whether the existing technologies or the technologies under current development address the real needs of the road users inferred from the accident and driver behaviour analyses.

http://www.trace-project.org

APROSYS: Advanced Protection Systems

Project full title: Advanced Protection Systems
Coordinator: TNO
Starting Date: April 2004
Ending Date: March 2009

Field: Passive safety

Short Abstract

World-wide, vehicle safety experts agree that significant further reductions in fatalities and injury numbers could be achieved by deploying appropriate passive (or crash) safety strategies. The FP6 APROSYS Integrated Project (IP) answers to this call by development and introduction of critical technologies that improve passive safety for all European road users for priority accident types and levels of crash severity.

The field of passive safety concerns in particular human injury biomechanics, vehicle crashworthiness and protection systems. APROSYS is mobilizing and integrating the European scientific & technological expertise for the development of new technologies for the protection of road users in all relevant accident conditions. Furthermore, this IP aims to increase the level of competitiveness of the European industry by developing new safety technologies.

Appendix 6: Glossary of Terms

Abbreviations and acronyms

ABS	Anti-Lock Braking System
ACC	Active Cruise Control
ACC S&G	Active Cruise Control Stop and Go
AMK	Attention Control
APROSYS	Advanced Protection Systems
ASR	Automatic (or Advanced) Speech Recognition
DfT	Department for Transport
ESC	Electronic Stability Control
ESP	Electronic Stability Program
ETAC	European Truck Accident Causation
EuroNCAP	European New Car Assessment Programme
GDP	Gross Domestic Product
GRE	Working Party of Experts on Lighting
GRPE	Working Party of Experts on Noise and Emissions
GRRF	Working Party of Experts on Brakes
GRSG	Working Party of Experts on General Safety
GRSP	Working Party of Experts on Passive Safety
HMSO	Her Majesty's Stationary Office
IDELSY	Initiative for Diagnosis of Electronic Systems in Motor Vehicles for PTI
IP	Integrated Project
LDW	Lane Departure Warning

MIL	Malfunction Indicator Lamp
OBD	On Board Diagnostics
PMG	Project Management Group
PSG	Project Steering Group
PTI	Periodic Technical Inspection
TRACE	Traffic Accident Causation Europe
TWMV	Two-Wheeled Motor Vehicles
UNECE	United Nations Economic Commission for Europe
V2V	Vehicle to Vehicle
WIM	Weigh In Motion
WP29	Working Party on the Construction of Vehicles, now know as the World Forum for the Harmonization of Vehicle Regulations

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