**Tyre and Road Surface Optimisation for Skid Resistance and Further Effects**

## Coordination Action FP7-217920

## Seventh Framework Programme

## Theme 7: Transport

# D08

# Recommendations for future harmonised EU policies on skid resistance, rolling resistance and noise emissions


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## Executive Summary

The TYROSAFE Project is a Coordination and Support Action (CSA) under the Seventh EU Framework Programme. The project is examining the possibilities for developing harmonised approaches in Europe to the optimisation and management of the key safety and environmental properties of road surfaces in their interaction with tyres. The assessment of these properties – skid resistance, rolling resistance and noise – are a different stages of development generally and there is widely varying awareness of the issues and practice across Europe.

The three-year project began in July 2008 and is being carried out by a consortium comprising AIT from Austria (formerly known as arsenal research), BASt from Germany, LCPC from France, RWS from the Netherlands, TRL from the United Kingdom and ZAG from Slovenia and FEHRL, the Forum of European Highway Research Laboratories based in Belgium. There are four technical Work Packages (WP):

- WP1 is assessing the current status of policies and approaches to management of the three key topics in the EC.
- WP2 is reviewing the technical issues and proposing strategies for the harmonisation of skid resistance test methods across Europe.
- WP3 is looking in some detail at the road surface properties that influence the three properties and their interdependencies
- WP4 will review the environmental effects of optimising the properties of surfaces and the potential impact of climatic change on a harmonised approach

The measurement and provision of skid resistance has been the subject of research for over 75 years and some individual countries now set standards for skid resistance on their road networks (or parts of them). These are typically based on measurements with specialised devices that may be local (and often unique) to these countries. However, the absence of an accepted common scale for characterizing road surfaces with respect to skid resistance properties is a serious hindrance for developing consistent policies for the provision of adequate skid resistance across Europe that would make the European road network safer.

Greater awareness of environmental aspects of roads and traffic has meant that the noise generation properties of tyres and road surfaces have become a greater focus for research in recent decades. Interest in reducing fuel consumption and vehicle emissions, especially $CO_2$, has led to greater attention being paid to the topic of rolling resistance, particularly by the tyre industry but, from the point of setting standards for road surfaces, work on this subject is still in its infancy. Traffic noise is a major concern within the EC but methods for assessing the noise performance pavements explicitly are not fully established.

This report is concerned primarily with WP1, which provides important background information for the other technical work packages but also gives an opportunity to make recommendations for the development of harmonised policies at a European level.

The research team gathered information using a combination of their own collective expert knowledge, questionnaires sent to EC (and some other) countries enquiring about their practice in relation to the three topics and Expert Workshops in which invited experts and stakeholders from academia, road infrastructure companies, the automotive and tyre industry and road administrations could come together to consider the ongoing findings of the work and contribute from their knowledge and experience.

The first workshop held in October 2008 as part of the World Road Association 6th Symposium on pavement surface characteristics (SURF2008) at Portorož, Slovenia; a second session was held at the FEHRL offices in Brussels in April 2009.

A report on the current status of policies and standards in relation to skid resistance, rolling resistance and noise formed Deliverable D06 was completed in January 2009 [1]. This report is the second deliverable (Deliverable D08), and it draws on the responses to the questionnaires and workshop discussions, as well as the team's expertise, to make recommendations in relation to future harmonised EU policies on skid resistance, rolling resistance and noise emissions.

The report briefly reviews the current situation, summarising current approaches to policies for skid resistance, rolling resistance and noise. Not surprisingly, these vary widely between countries and topics. Skid resistance is the most developed, with a large number of countries making measurements (albeit with a wide range of equipment) and many also having some kind of policy for skid resistance management. However, the scope of such policies varies from sophisticated systems for monitoring and relating levels on the road to accident risk through to making measurements and not using them or no policy at all.

Although there is increasing interest in measuring the rolling resistance of tyres, especially on large drum facilities, the assessment of rolling resistance in relation to road pavements is very much in its infancy. There is already some EC legislation relating to traffic noise but the process of assessing and managing the contribution made by the road surfacing is still developing with test methods remaining to be standardised.

The report also discusses the potential benefits and barriers to a harmonised policy approach for the EU in all three fields. These include both technical issues and "political" aspects, such as recognising the value of a harmonised approach in encouraging more consistent and safer road surfaces across Europe and the difficulties that individual countries might have in introducing or adapting to a harmonised policy.

Chapter 4 of the report provides an in-depth analysis of the requirements and concepts of policies for each of the three topics. Initially, general principles (relevant to all three subject areas) regarding what a policy should include are outlined. This is followed (for each topic in turn) by more detailed discussion of possible approaches that a harmonised policy could take in addressing the various aspects identified. The depth of discussion varies for the different topics because of their different stages of current development.

The TYROSAFE team has considered the various points discussed and arrived at their view of recommended approaches for harmonised policies. For skid resistance it has been

possible to make some quite specific recommendations, including the following broad principles:

- A model policy set at EC level but implemented in detail in each country by their national road authorities.
- General application to Level 1 and Level 2 networks (motorways and principal roads linking major towns) with local options to apply to lower levels.
- Regular monitoring of the skid resistance condition of the road network.
- Recommendations of principles for measurement technique and analysis.
- Threshold levels (determined by each individual country) based on the risk of skidding on different types of site with the overall objective of equalising skidding accident risk across the network.
- Use prioritised investigation to establish whether improvement to the skid resistance at that site would be worthwhile and should be programmed when the investigatory threshold is not met
    - Where a country sets a threshold on a new surface for contractual purposes, individual countries would set their own choice of actions to be followed when the threshold is not met.
- Supporting documentation and advice

However, for rolling resistance and noise, because of their more limited current state of development, the recommended approaches are essentially guidelines for future application and the work that needs to be done to support them.

The final chapter of the report discusses the routes to implementation and the issues that will need to be resolved on the way to harmonised policies for each of the three topics.

# 1 Introduction

The safe passage of road traffic needs a certain amount of grip (friction) between the tyres of the vehicles and the road surface. The road surfacing contributes to this through a property known as skid resistance. Skid resistance is not the only important factor relating to the interaction between tyres and the road surface. A rolling wheel will experience rolling resistance, which can lead to increased fuel consumption, and will also generate noise emissions. These three key properties are all affected by various aspects of the road surface and it is possible that changes to surface characteristics to improve performance of one of these properties might have an adverse influence of one of the others.

The measurement and provision of skid resistance has been the subject of research for over 75 years and some individual countries now set standards for skid resistance on their road networks (or parts of them). These are typically based on measurements with specialised devices that may be local (and often unique) to these countries. The absence of an accepted common scale for characterizing road surfaces with respect to skid resistance properties is a serious hindrance for developing consistent policies for the provision of adequate skid resistance across Europe that would make the European road network safer.

Greater awareness of environmental aspects of roads and traffic has meant that the noise generation properties of tyres and road surfaces have become a greater focus for research in recent decades. Interest in reducing fuel consumption and vehicle emissions, especially $CO_2$, has led to greater attention being paid to the topic of rolling resistance, particularly by the tyre industry but, from the point of setting standards for road surfaces, work on this subject is still in its infancy.

The TYROSAFE Project is a Coordination and Support Action (CSA) under the Seventh EU Framework Programme. It is aimed at coordinating and preparing for European harmonisation and optimisation of the assessment and management of these three essential tyre/road interaction parameters (skid resistance, rolling resistance and noise), to increase safety and support the greening of European road transport. The work began in July 2008 and is being carried out over three years by a consortium that includes six member institutes of the Forum of European national Highway Research Laboratories (FEHRL): AIT from Austria (formerly known as Arsenal Research), BASt from Germany, LCPC from France, RWS from the Netherlands, TRL from the United Kingdom and ZAG from Slovenia. FEHRL itself is the seventh member of the consortium.

There are four technical Work Packages (WP):

- WP1: Policies of EU countries for skid resistance / rolling resistance / noise emissions.
- WP2: Harmonisation of skid-resistance test methods and choice of reference surfaces.
- WP3: Road surfaces properties – skid resistance / rolling resistance / noise emissions.
- WP4: Environmental effects and impact of climatic change – skid resistance / rolling resistance / noise emissions.

Two other work packages support the technical work: WP5 covers dissemination and raising awareness of the subject matter and results of the project, while WP6 covers its management.

This report is concerned primarily with WP1, the goal of which is to assess existing policies and approaches across Europe relating to the management of the three key parameters. This work provides important background information for the other technical work packages but it also gives an opportunity to make recommendations for the development of harmonised policies at a European level.

The work package had a number of specific objectives, looking in parallel at the three main aspects of skid resistance, rolling resistance and noise. For each parameter, the project has:

- Reviewed EU policies and standardisation work.
- Reviewed the current position in EU member states (including those who are non-FEHRL-partners).
- Compared the differences between and advantages/disadvantages of current and alternative approaches.
- Considered the implications for introduction of Europe-wide policies instead of, or alongside, existing national standards.

To meet its objectives, WP1 was structured into four distinct tasks:

- Task 1.1 reviewed regulations, standardization efforts and measurement techniques of skid resistance and existing research work about the safety implications of skid resistance.
- Task 1.2 focused on rolling resistance, which has an effect on fuel consumption. (This also will have a close connection to WP4 which is scheduled to begin in the summer of 2009.)
- Task 1.3 covered the different forms of surface texture that have an influence both on rolling resistance and noise.
- Task 1.4 organised coordinating workshops and expert working groups.

In Tasks 1.1, 1.2 and 1.3, the research team wanted to identify the different approaches to setting policies in the key areas and to investigate the reasons behind the policies that exist. As well as utilising expert knowledge within the research team, the methodology also included literature reviews, questionnaires sent to appropriate organisations in different EU countries (including non-FEHRL member organisations). Task 4 was used to set up workshops in which invited experts and stakeholders from academia, road infrastructure companies, the automotive and tyre industry and road administrations could come together to consider the ongoing findings of the work and contribute from their knowledge and experience.

The first of these workshops was organised in Portorož, Slovenia in October 2008 as part of the World Road Association event SURF 2008, “6th Symposium on pavement surface

characteristics". A second session was held at the FEHRL offices in Brussels in April 2009. The discussions in the workshops attempted to gather knowledge and background not covered in the questionnaires and to identify what barriers might exist to developing policies at a European level, including differences in national practices and gaps in current knowledge. The potential for research that could provide more effective and safe solutions was also included for discussion.

Two major reports were planned as deliverables for WP1, as shown in Table 1.1.

**Table 1.1 Deliverables for Work Package 1**

| Deliverable | Name | Month |
|---|---|---|
| D06 | Report on policies and standards of all EU countries concerning skid resistance, rolling resistance and noise emissions | M8 |
| D08 | Recommendations for future harmonised EU policies on skid resistance, rolling resistance and noise emissions | M12 |

The first of these reports (Deliverable D06) was completed in January 2009 [1]. This report is the second deliverable (Deliverable D08), and its main purpose is to make recommendations in relation to future harmonised EU policies on skid resistance, rolling resistance and noise emissions. In preparing the report, the authors have drawn on the data reported in D06, on the ideas and discussions at the workshops as well as the expert views within the research team. The workshops were videotaped and can be viewed on the internet at http://videolectures.net/tyrosafe/.

Chapter 2 of the report briefly reviews the current situation, summarising current approaches to policies for skid resistance, rolling resistance and noise.

Chapter 3 discusses the potential benefits and barriers to a harmonised policy approach for the EU. This takes account of the views of decision makers of road authorities and road operators on the approach of harmonisation of policies in all three fields.

Chapter 4 is an in-depth analysis of the requirements and concepts of policies for each of the three topics. Initially, general principles (relevant to all three subject areas) regarding what a policy should include are outlined. This is followed (for each topic in turn) by more detailed discussion of possible approaches that a harmonised policy could take in addressing the various aspects identified. The depth of discussion varies for the different topics because of their different stages of current development.

The TYROSAFE team has considered the various points discussed and arrived at their view of recommended approaches for harmonised policies and these are set out Chapters 5, 6 and 7 for skid resistance, rolling resistance and noise respectively.

Finally, Chapter 8 discusses the routes to implementation and the issues that will need to be resolved on the way to harmonised policies.

# 2 Summary of current situation

As part of a process to provide consistent levels of performance in relation to certain road surface parameters, some individual countries have developed some kind of policy for their management. Typically, these set upper levels (in the case of noise, for example) or lower levels (in the case of skid resistance) that should be provided. However, the levels required can vary markedly from one country to another and the strategies developed by road authorities to set, achieve and verify the required performance differ throughout Europe and even within individual countries.

Currently there are no consistent policies relating to the management of skid resistance, rolling resistance or noise at the EC level. This chapter summarises the current state of policies in Europe. The summary is based on the analysis of the responses to questionnaires sent to most EC countries, which is reported in detail in TYROSAFE Deliverable D06 [1]. The views that emerged from the workshops, in which the ideas of policies were discussed with a broader scope, have also been incorporated.

## 2.1 Current approaches to policies for skid resistance

The European Union has not yet implemented a harmonised policy in relation to skid resistance. Four of the European countries responding to the questionnaire do not have any policy regarding skid resistance at all. The others have some kind of policy that applies to at least one specific road category. It is noticeable that the far fewer EU countries have a policy that applies to lower-level networks. Skid resistance policies are mainly set by road authorities, though the road operator or national research institutes are involved in some countries. In the majority of EU countries that have introduced policies or standards for motorways and primary roads, they are legally enforceable.

Countries that have policies (and some that do not), make skid resistance measurements on their roads: the questionnaires listed fifteen different skid resistance measurement devices. (Work in TYROSAFE WP2 has identified 24 different skid resistance measurement devices in use in Europe, including some devices used on airfields and those used primarily for research [2].) The pendulum skid resistance tester (SRT) is mentioned in most policies as a “local” measurement device. It is mainly used as a complement to mobile skid resistance measurement devices and is used for localised investigations or as research tool. SCRIM (Sideway-force Coefficient Routine Investigation Machine) or the similar SKM (Seitenkraftmessverfahren) is used by nine EU countries; the GripTester follows with eight countries using it. Generally, the longitudinal measurement principle (used by twelve EU countries) is more common then the transverse principle (nine EU countries). However, some countries use a combination of devices based on different principles (see [2] for a full discussion of the various devices and measurement principles that they use).

Individual road crashes, routine monitoring programmes or accident cluster analysis can trigger skid resistance measurements. The number of EU countries that carry out routine monitoring relating to skid resistance policies decreases markedly towards the low-level

networks. Fourteen of the seventeen EU countries responding to the questionnaire routinely monitor their motorway and primary road network. The monitoring frequencies vary from twice a year to every fifth year. Mostly, routine monitoring measurements are made between spring and autumn. However, in some northern countries routine monitoring is done in winter, even on icy roads.

Road surfaces are typically classified for skid resistance by defining threshold levels that are based on indices derived from the measured skid resistance. Currently across Europe there are many differences in the number of levels, the values set and their dependencies on measurement speed, weather and road type. Nevertheless, it is common practice to set standardised thresholds in some form for high-level road networks.

On new road surfacings, many EU countries verify that sufficient skid resistance has been provided by carrying out acceptance tests. These measurements are mainly done a few weeks after opening to traffic. If the acceptance test fails, most countries take measures to improve the skid resistance. Additional measures such as placing warning signs, deducting money and imposing speed limits are common.

While warranty periods are very common in other fields, this issue does not have a high importance in skid resistance policies. Less than fifty percent of all EU countries require warranty tests, perhaps because routine monitoring is carried out anyway.

The important conclusion from this analysis is that at present there is a wide variety of practice in relation to skid resistance across the EU. If safety standards are to be improved in a consistent manner, particularly on the strategic pan-European network, then a harmonised approach to the of managing skid resistance is needed.

## 2.2 Current approaches to policies for rolling resistance

Rolling resistance, is one of the environmental related aspects of tyre/pavement interaction. It is directly linked with fuel consumption and therefore with the $CO_2$-emission of a vehicle driving on a road surface.

The literature review and questionnaire found that, at present, there are no policies or standardised measurement methods throughout Europe for tyre rolling resistance on roads.

However, the road characteristics influencing rolling resistance have been investigated. Macro-texture, mega-texture and evenness have been identified as the most important but to date research has not agreed on their share of influence.

A number of different devices have been developed and are used to measure rolling resistance but, it is quite difficult to compare the results from the different techniques. Generally, measurements fall into one of two distinct groups: static units (rotating drums) and dynamic (usually trailers).

At present, before harmonisation of policies can be considered, considerable work is needed both to understand the factors influencing rolling resistance and to develop reliable standard measuring techniques that can be used on in-service roads .

## 2.3 Current approaches to policies for noise

Noise generation is the second environmental aspect of tyre/pavement interaction. It has been recognised as a significant nuisance for a long time and in recent years considerable effort has been devoted to setting legal rules. The European Directive 2002/49/CE relating to the assessment and management of environmental noise gives a legal framework for road noise mitigation. In parallel, two Directives specify the type approval tests of vehicles and tyres, and set legal limits for their noise emission. These regulations are completed by a set of international standards describing methods for measuring noise emission or its contributors.

Because tyre-road noise is the dominant source of noise for vehicles above relatively low speeds (around 30 km/h for passenger cars and 50 km/h for trucks), road surface characteristics play a principal part in road noise emission. Low noise road surfaces significantly and beneficially reduce road traffic noise in addition to other abatement measures, such as speed reduction and noise barriers. However, the is a lack of legal rules or common procedures for the classification and the assessment of noise properties of road surfaces. This is considered to be a serious barrier to further development of low noise road surfaces at the European scale.

A literature review and survey conducted during the project has shown that procedures for road surface type testing (or labelling) and for the check of Conformity of Production (COP) are active in some EU countries or are under consideration in several others, but they are not comparable with one another.

Although a significant effort has been made over the last ten years to develop standardised methods for road noise measurements, more has to be done to make them more reliable and easier to use.

A harmonised system of characterisation of noise properties of road surfaces is necessary for the promotion of low noise road surfaces, an important part of the process of mitigating road traffic noise. Ongoing research is showing that it is possible to design road surfacings with characteristics that give low-noise properties but are also compatible with the provision of good skid resistance. It is likely that these characteristics will also relate favourably to rolling resistance characteristics of the road.

# 3 Potential benefits of and barriers to a harmonised policy approach for the EU

This chapter summarises the various potential benefits from and barriers to introducing harmonised policies for the three key parameters that were identified during the various workshops and other discussions. In Section 3.1, general considerations relevant to all three topics are listed and Sections 3.2, 3.3 and 3.4 then highlight issues of specific relevance to skid resistance, rolling resistance and noise policy respectively.

## 3.1 General discussion

### 3.1.1 (Potential) Benefits

**Encouraging innovation**

Standardised methods for specification / Conformity of Production / monitoring are necessary to encourage and ease innovation.

**Comparison and benchmarking**

The main advantage of harmonisation is comparability (of products, of requirements, of analysis…), ultimately resulting in a unified quality of roads through Europe. Therefore a consistent, cross-national approach is necessary.

**A tool for political decision**

Politicians benefit from harmonised policies, as they will provide them with a tool to allow for cost/benefit analysis helpful for political decisions.

**Breaking barriers**

The EU is breaking barriers and opening markets, with potential for increased cross-border travel of people and goods. Harmonisation of policy for key properties would make the situation on the road more predictable for the user and ease comparison of safety levels between countries.

**Sharing information**

Harmonisation is essential for authorities with smaller budgets (such as regional or local authorities) as they may not be able to invest in policy development. It is easier to learn from larger authorities or countries and use their findings as a basis.

Small countries try to achieve social benefits and road safety while having little resources. A harmonised policy would make it easier take a balanced approach between safety, budget, and comfort.

**Awareness about the problem**

The implementation of policies and their legal implications could raise awareness between authorities and contractors and lead to improved quality of performance of the network.

### 3.1.2 (Potential) Barriers

**Implementing policy as a law**

Some countries may not agree to be bound by or be liable because of thresholds or procedures set in a mandatory harmonised policy.

**Reasonably safe level and achievable harmonised policy**

A harmonised policy should be both practical and politically acceptable. If the demands of a policy are set too high or seem difficult or very expensive to achieve it might not be successful.

**Lack of existing common measuring methods and procedures**

Any harmonised policy would need to use measurements of the road condition and so should contain a definition of the measurement methods. Currently, with all three topics, there is a wide range of measurement techniques that are not easily related to one another. Consequently, there is a need for a either harmonised measurement system that allows the different measurements to be related to one another through a common scale or for a standard measurement technique that all countries adopt. The absence of such a scale is a potential barrier to widespread adoption of a harmonised approach, as would be the need for countries to procure new test equipment if they currently do not make measurements or their current devices were incompatible with the proposed standard or a common scale[1].

Further, where routine monitoring were to be used, detailed procedures for making the measurements, relating them to the network and methods of analysis could present a level of complexity that might be a barrier to countries with little or no experience of them.

[1] For skid resistance, where measurement techniques are more advanced and numerous, the issue of developing a common scale that would allow measurements to be harmonised is a major component of TYROSAFE Work Package 2. The concepts of standard and common scales are discussed in detail in Deliverable D05 [3] and Deliverable D09 (currently in preparation) will make recommendations for a route towards harmonisation for skid resistance measurements.

## Lack of references

All three properties are “concepts” rather than fixed physical properties of the road. Skid resistance is measured using specialised friction measurement techniques, noise with microphones mounted at the roadside or attached to vehicles in an enclosed space around a tyre. Rolling resistance measurement techniques are still developing. At present, there is no established standard, (for reference devices, reference surfaces, reference indicators and reference calculations) against which measurements can be compared for any of the three properties. While this need not prohibit developing harmonised policies, it is a potential barrier to achieving or verifying that consistency of performance and standards are being maintained.

## Preventing innovation

Harmonisation might prevent innovation because products would develop to just meet the requirements.

## Wrong topic to harmonise

Another potential barrier is misunderstanding of what is to be harmonised. It is important to harmonise the objectives of the policy and the methods to be used and but not necessarily the threshold levels. To avoid this barrier, the harmonisation should lead to a common framework with the same set of rules but setting thresholds should be left to individual countries.

## Regional diversity

Different countries use different pavement types and materials which can make comparison difficult Further, there are specific issues related to the climate that cannot be ignored: pavement behaviour varies across Europe due to climate differences and prevailing weather conditions can lead to differing pavement requirements and materials. For example, surfacings need to be heat resistant in southern countries and resistant to winter maintenance actions in northern countries. Such differences could be perceived as a potential barrier, particularly with delivering the requirements set by a harmonised policy and will need to be taken into account.

## Political feasibility

Governments are often reluctant to set regulations relating to public property because of the risk of litigation if standards are set but then are not met. The argument is sometimes made that if there was no policy, nobody could be blamed for not following it. Moreover, sometimes authorities might prefer not to know whether they had a problem and, for this reason, do not make measurements. Such reluctance to be prepared to set standards and maintain them represents a significant barrier to establishing harmonised policies.

A further barrier comes from lack of confidence: it is perceived as difficult to implement a new concept from somewhere else or to apply research results not obtained in the home country.

### Data accessibility

Availability and accessibility of measurement results might be an issue that presents a barrier. The extent to which data that undergoes complex processing should be publicly available in response to freedom of information legislation will need to be addressed.

### Approval body

Another potential barrier is lack of clarity on how policies are interpreted and applied in different countries. It must not happen that a harmonised policy is interpreted differently in different countries. How the policy is defined and who will set it, together with the status of any document will be important, for example, whether a policy should be set as an EU directive, through CEN standards some other formal written document.

### No clear benefits

If the benefits of a harmonised policy are not clear to national administrations, there might be a lack of acceptance. This is potential obstacle so all benefits must be defined to clarify why the policy should be adopted.

### Costs

For countries that currently have no policy, or only limited policies the costs of implementation (which may include costs for upgrading parts of the network) could be a significant barrier. Willingness to apply a harmonised policy could be dampened by comparing it to alternatives that might be perceived as cheaper, such as speed limit reductions, although such measures could be incorporated within an extensive policy.

### Contractual issues

Concerns about how to deal with contractual issues relating to the building of new surfaces could be a potential barrier. Strictly, a policy is about network performance rather than the mechanics of how that is achieved. Nevertheless, it is argued that a good building contract supports policies and it is consistent with it. Countries that set requirements for contractual measurements will need to ensure that these are linked appropriately to the requirements of the policy.

## 3.2 Specific issues for skid resistance policy

### 3.2.1 (Potential) Benefits

**Awareness about the problem**

In the various discussions, countries with well established policies recognised clear benefits in reduced numbers of accidents and, because their standards are well defined and consistently followed, reduced risks of litigation. Examples were cited where improved skid resistance, especially at high risk locations, had markedly reduced the number of crashes. In some countries, the relevance of this aspect was considered more important than in other countries.

**Sustainability**

Sustainability is also an issue of increasing importance and workshop discussions indicated that skid resistance policies can have an impact on the tyre industry as the levels of grip to be maintained become clearer and road surfacings become more consistent in their properties. This could allow tyres to have longer lives, for example, reducing the problems of disposal.

### 3.2.2 (Potential) Barriers

**No action after measurements**

A significant barrier to a harmonised policy would be to state a requirement but without any indication of what actions are to be taken to achieve it. If no action plan is included in the policy, the policy would not achieve its goal. Currently, some countries make skid resistance measurements but do nothing with them.

Another key component is the definition of measures to be taken if it is determined that skid resistance should be improved. When preliminary measures like speed limits or the erection of warning signs are being considered the circumstances of their use should be clear. There is a cost associated with such measures and this could be a further barrier in relation to a harmonised skid resistance policy.

**Regional diversity in terms of friction**

Across Europe, environmental conditions and hence road friction differs from country to country. The friction situation in Northern countries cannot be compared to Southern countries. It is not possible to adopt a policy between such countries without considering the differences.

**Comparability of devices**

The discussions indicated that a significant barrier to a harmonised policy for skid resistance could be the choice of measurement device. Were a single standardized skid resistance measurement device specified in the policy, there would be several obstacles on the path to that approach to harmonisation.

The choice of measurement technique would generate different issues for various types of users, for example, those having no device and wanting to choose one, those having many devices and wishing to correlate one to the other, those wishing to propose services to their neighbouring countries. Clearly there is a need to establish a common scale against which various measurements or threshold level requirements can be compared and understood.

Although the process of finding a solution to this problem is ongoing (and will be discussed further in Deliverable D09), it is likely to be some time before it is resolved. However, even in the absence of an accepted standard method or a harmonised measurement scale, it would still be possible to adopt a harmonised policy that sets out clear principles but uses a local device for measurements with locally-designed threshold levels that are approximately comparable with those used elsewhere.

### Feasibility

A potential barrier of particular significance to skid resistance policy is that of the wide variation in environmental conditions and likely requirements in different countries. The question arises as to how feasible it would be to to find a skid resistance policy for different countries, which can be applied by all authorities involved. For example, Nordic countries have very different requirements concerning skid resistance on roads to deal with their more extreme winter conditions. Obviously, it is senseless to apply a policy adapted for the influence of winter conditions in southern regions and vice versa.

Again, setting a harmonised approach to general principles that allows for local setting of specific thresholds (which might include separate requirements for winter and summer where necessary) could help to overcome such issues.

### Precision

The advantages of using one device (or one carefully-controlled type of device) might be lost with a common scale approach that allows different devices to be used.

Using more than one device poses a challenge when the results of different devices are to be compared. Calculation to a common scale would possibly lead to a loss in precision. It is clear that the issue of precision would need to be satisfactorily answered before a harmonised approach would find wide acceptance among countries that already have well-established policies based on a single type of device.

## 3.3 Specific issues for rolling resistance policy

### 3.3.1 (Potential) Benefits

**Environmental contribution**

The main benefits from a rolling resistance policy will be found in the design of actual pavement surfaces that reduce the rolling resistance of tyres, with a consequent expected reduction in $CO_2$ emissions.

### 3.3.2 (Potential) Barriers

**Lack of awareness**

At present, influence of road pavements on rolling resistance has only recently begun to be discussed. Although research on rolling resistance by the tyre industry has been done for a while now, research on the contribution of the pavement is in its starting phase.

## 3.4 Specific issues for noise policy

### 3.4.1 (Potential) Benefits

**A coherent tool for noise mitigation**

A common policy will provide a coherent tool for politicians and road authorities for their concern about noise reduction in the environment, especially with regard to the Noise Action Plans defined in the European Noise Directive 2002/43/EC. At a final stage, this will result in a quieter environment for people living in noisy areas.

**Awareness about the problem**

In some countries, road authorities are still reluctant in using low noise road surface. A harmonised policy may stimulate the request for such surfaces and low noise surfaces may be more widely used.

Inclusion of common noise requirements for low noise pavements would help road authorities to promote the use of low noise pavements, road engineers to design, check and monitor low noise pavements and encourage the road industry to develop and disseminate optimised products.

**Development of improved products**

Although noise reduction is sometimes presented as a marketing argument for the road construction industry, the industry sometimes claims that the market for low noise surfaces is actually very small. A harmonised EC policy would help to clarify this discussion and stimulate the development of improved products throughout Europe.

### 3.4.2 (Potential) Barriers

**Lack of existing common measuring methods and procedures**

A harmonisation of policies is not possible without common measuring methods. In terms of noise performance, currently there are two measurement methods:

- The statistical pass-by method (SPB) which it is standardised at ISO and CEN.
- The close proximity method (CPX) which is not yet standardised but is currently an ISO draft.

The situation is therefore rather more favourable for noise performance than it is for skid resistance since there are only two methods to compare, although there is no clearly established link between the two methods at present.

**Lack of references**

Although there are only two measurement methods, for harmonisation, agreement on references has yet to be reached:

- Some countries relate acoustic performance to a *reference surface* but its definition is different from one country to another. Some other countries define absolute noise levels and do not need any reference surfaces
- *Reference indicators*: this is linked with the previous point. The difference in reference indicators in Member States makes the comparison between products and their performances difficult.
- *Reference calculation* schemes where the road performances are introduced are needed.

**Performance durability**

It would be necessary to incorporate the durability of noise performance into a harmonised policy. This is still a scientific challenge. Not only does the noise performance of pavements deteriorate over time, it declines in relation to traffic as well.

## Awareness about the problem

A point raised in discussions is that road authorities are not used to specifying noise performance in tendering procedures, and probably they do not know how to specify (legal noise requirements are often specified at façade of buildings, not in the vicinity of the road pavement).

However, where a classification system exists (e.g. in the Netherlands), awareness is rising, on both the contractor's and the road authority sides.

While there obvious safety benefit to road users from providing adequate skidding resistance, for noise, the benefits (or the people who will benefit) are less clear. This seems to be more a political matter. Of course, local residents will benefit from noise reduction measures but the benefits become less clear on roads where few residents are affected.

## Awareness about low noise pavements

There are several regulations or international standards regarding noise in the environment: European requirements exist for vehicle noise emission and tyre noise emission; there is a European standard for noise barrier performance. However, there is no common policy or regulation regarding the use of low noise road pavements.

Road authorities are not always convinced that using a low noise pavement could be a significant noise reduction measure. A change of mind-set is needed to overcome this kind of resistance.

## Lack of common approach

At present a major barrier to establishing a harmonised policy for road pavement noise is the lack of a common approach to choosing low noise surfaces.

Two examples are presented here to illustrate two different approaches to the problem. In the Netherlands, several classes of road surfaces have been defined by a noise reduction relative to a fixed reference. This noise reduction, defined not only for these classes but also for individual products, is used as an input in calculations of noise emission from the road. It corresponds to initial noise reduction. Decrease in noise reduction over time is not taken into account at the moment but research on this subject is being carried out.

In the UK, local authorities typically specify small particle sizes for noise-reducing surfaces. The Highways Agency (responsible for motorways and trunk roads in England) is committed to the specification of materials and no real choice is left to the contractor. The Agency usually specifies thin surfacings (these are similar to SMA but are proprietary materials that must be certified). They all have built-in noise attenuation and this is one of the reasons that their use is preferred.

## Trade-offs

Some potential barriers to a developing a harmonised policy come from the need for trade-offs between different issues.

Participants in the workshops commented that very low noise pavements may be so quiet that people do not hear vehicles coming, thus creating potentially hazardous situations.

It was also noted that interactions between road surface characteristics and different types of tyres can differ:

- Truck tyres should also be considered because best performing pavements for passenger car tyres may not be the best performing pavements for truck tyres.
- Tyres with smaller sidewalls may reduce the influence of mega texture on noise but increase the effect of macro and micro texture on noise.

# 4 What should a harmonised policy include?

## 4.1 General principles

Any policy designed to provide a consistent, harmonised approach to the management of skid resistance, rolling resistance or noise on European roads should contain certain key components. These provide general principles common to each of the three parameters. However, there may be a number of possible approaches for each component and some of the detail will naturally be different for each topic.

Eight main components have been identified that should be included in a harmonised policy and they are summarised in the list below. Different approaches that might be followed for some of these are discussed in more detail in Section 4.2 for skid resistance, Section 4.3 for rolling resistance and Section 4.4 for noise.

**Responsibility for setting and implementing the policy**

With any policy, it is essential that responsibilities for setting and managing it are clearly defined. This is important for future application of the policy, particularly when (as will inevitably occur) there is some kind of legal challenge, perhaps after a serious crash or when a new road surface generates noise levels that are unacceptable to local residents. In this context, two issues are important for the introduction and application of a harmonised policy across Europe:

- Definition of where overall responsibility lies for setting, maintaining and reviewing the policy framework at a European level.
- Definition of which organisation(s) have responsibility for practical implementation of that policy in each country.

It will also be necessary for each country to define where responsibilities lie within its own organisation(s) for the different practical aspects of policy implementation. However, this need not be part of a European policy, other than to state that this should be done.

**A statement of objectives and principles on which the policy is based**

One reason for adopting a harmonised policy is to provide clarity and consistency of approach in relation to the management of the various factors across national boundaries within the EC. To support this, the policy should state what its broad objectives are and the principles on which it is based. For example, a skid resistance policy might have the broad objectives of reducing the risk of skidding accidents and be designed on the principle that the risk should be broadly equal across the networks to which it applies.

It is important for the policy to make these points clear so that what the policy is intended to do (and what it does not do) is understood, particularly if questions are raised later regarding

either the threshold levels that may have been set or the interpretation and application of the policy in practice.

### The network level(s) to which the policy will apply

It will be impractical or uneconomic to implement policies which apply to the entire road network for any of the three topics. An essential part of any harmonised policy, therefore, is to define the "reach" of the policy. Primarily, this means defining the network level or levels that will be included. For many countries this is likely to be the highest level of the network, but there should also be some kind of statement as to what alternative approaches might be taken for other road classes where the full policy will not be applied.

### The stages in the life of a surfacing with which the policy will deal

The three main factors (skid resistance, rolling resistance and noise) all change over time, primarily as the result of trafficking. Consequently, the performance of a road surfacing after two or three years in service can be noticeably different from when it was first laid. A harmonised policy should therefore take account not only of the network level but also the stages in the life of the surfacing to which the policy relates, with defined different approaches if appropriate for different stages. Typically, a policy will apply to "in-service" roads, but there must be clarity as to what "in-service" means, possibly with special provisions for assessing roads when they are new.

### The need for an established measurement technique

It is important that policies to manage the three key parameters should be evidence led. Therefore, it will be necessary to measure the condition of the road in order to provide the data that any trigger actions or support decisions that the policy requires. For this purpose, a measurement technique that will be used to gather data to support the policy must be established and this should be defined within the policy documentation.

Ideally, this would be a harmonised test method that could be applied in all countries. However, it is currently the case for all three parameters there are a number of different measurement techniques that have yet to be fully harmonised. Initially, therefore, it may not be possible or realistic to use the same measurement technique in every EC country and a transition period will be needed in which different techniques are used. In this situation the policy should still use a harmonised approach but should set out how the issues relating to measurement should be resolved.

### Measurement strategy and data analysis

As well as defining what measurement technique(s) are to be used, the policy needs to define how measurements are to be programmed (including when and how often they are made). There will need to be some variations in detail from one country to another to take

account of different climatic conditions but a policy will need to define the characteristic value that will be used for comparison with threshold levels and how this is determined from the measurements.

### Approach to setting appropriate threshold levels

Any policy will be based upon measurements providing evidence of road conditions and then set out actions to be taken based upon characteristic values determined from these measurements. Typically the characteristic values will be compared with pre-determined threshold levels for the relevant section of road. This component of a policy should define the form that the thresholds will take (for example, investigation levels or fixed limits) and how the values for a particular stretch of road are to be set.

*It is important to stress that, although a common approach to setting thresholds would be used, the actual values to be applied should not be included in an EC-wide policy.* These will need to be determined locally depending on local road conditions and the measurement technique used. In the longer term, as experience is gained and measurement techniques are harmonised or standardised, common threshold values might become a possibility.

### Actions to be taken when the thresholds are not met

This is an important part of any policy since it governs what occurs when the measured characteristic value falls to or below the threshold level. The nature of the actions will be different for the three topics. However, as a general principle, the harmonised policy should state clearly the approach that will be followed, even though the details of how this is worked out may vary.

## 4.2 Possible approaches for skid resistance policy

Currently there are a number of different approaches to dealing with skid resistance across the EU ranging from very sophisticated systems to no policy at all. In this Section, different possibilities for approaching each of the main aspects outlined in Section 4.1 are discussed.

### Responsibility for setting and implementing the policy

For a harmonised policy for skid resistance across the EU, the general policy should be set at a European level even though it will need to be worked out in detail in individual countries. The EC (or some organisation that it appoints) should be responsible for monitoring its implementation.

Two possible broad approaches have been identified.

i) *A centrally defined detailed policy*

With this approach, the EU would define and implement a full policy which would then be adopted into national regulations. This approach has the advantage of defining explicitly

the approach that every country must follow. However, it would be very difficult to draft given the level of detail that would then be required and the range of different local circumstances that it would need to cover.

*ii) A centrally defined model policy with local application*

With this approach, the EU would set out a model policy that individual Member States would then apply locally. They would prepare their own national policies that fit with their local practice and administrative structures but are consistent with the model policy principles. This approach would be the easiest to implement and allow for any necessary regional variations, such as the implications of differences in climatic conditions between north and south.

In many countries, the top level networks are administered and operated at national level but lower-level routes are typically managed by local administrations. Some routes may have similar status or character but are managed by different organisations and some strategic routes may be operated on behalf of central government by private concessions. This situation has to be recognised in assigning responsibilities. Using a model EU policy approach will enable the application of consistent policies by each Member State requiring the appropriate organisations within their country to develop their own policies to follow the EU model. If necessary, national guidelines can be set to ensure consistency within that country.

Countries that already operate established policies for skid resistance should be able to adapt their current practice where this is necessary so that it complies with the model. Countries that are introducing a formal policy for the first time will be able to design a system that suits their situation but that is consistent with the model, working with, or drawing on the experience of other countries with similar circumstances.

## A statement of objectives and principles on which the policy is based

At its heart, a harmonised policy for skid resistance will have the overall aim of reducing accidents due to skidding by providing a framework for setting and maintaining appropriate levels of skid resistance on the road network. The objectives of a policy would therefore express this concept. However, the objectives will also be influenced by the fundamental principles on which the policy is based. Three possible approaches are discussed here.

i) *Achieve maximum friction possible*

This approach is based on the simple idea that as much grip as possible should be provided to drivers. However, the fundamental difficulty with this approach is that it fails to take account of the practical realities of skid resistance and the many factors that influence it. It is difficult to determine what the maximum friction might be in any given situation or to judge whether that has or has not been achieved. There will be some places where local aggregates cannot achieve or maintain high friction levels and although the maximum possible locally might have been provided, it may still be too low

for safety. Very high levels of friction can be achieved with specialist surfaces but it would be very expensive indeed to apply these to the whole network even if it were possible.

It is considered that this general approach is both impractical and uneconomic.

*Minimise stopping distance or maximise cornering speed*

There are those who consider that the main problem with skid resistance is that, if it is too low, vehicles faced with a conflict may not be able to stop in time to avoid a collision. Stopping distance (after allowing for thinking and reaction time) depends not only on the available friction but also on vehicle speed. However, because it is not possible to predict the actual speed of any individual vehicle (and, of course, friction itself varies with speed), some generalisations have to be made. Using this approach often results in higher friction levels being required for higher-speed roads with the speed limit being the deciding parameter.

However, while this approach can be applied reasonably confidently to locations where there is a fixed stopping point (such as approaching a junction or other fixed hazard) it does not take any account of other road characteristics or the fact that many accidents, especially on roads where there are no “events” such as junctions, are the result of a number of unpredictable random factors that might occur anywhere. A tendency of this approach would be for target levels of skid resistance to be set unnecessarily high in many places, increasing the costs of achieving and maintaining the requirements.

The corollary of minimising stopping distance in a straight line is maximising the speed at which a curve can be safely negotiated. This has similar disadvantages to the stopping distance approach since it cannot take account of the full range of circumstances in which vehicles are driven. Research has shown, for example, that most car drivers tend to drive through curves at speeds which keep the side forces acting on the vehicle to less than about 0.3g for their own and their passengers’ comfort but this might be inadequate for drivers who take a less cautious approach. In any case, problems might be more likely in transitions where vehicles approach a curve at high speed and then try to both corner and decelerate at the same time.

ii) *Equalised risk of skidding*

Research in many countries has demonstrated that as skid resistance decreases, accidents tend to increase. However, behind that broad conclusion is a wide range of actual levels of risk, a fact identified in some of the earliest research in this field. It is therefore important to recognise a number of important concepts:

- Low skid resistance of itself does not cause skidding accidents; however, it can become a significant contributory factor when other factors combine to make it necessary for the driver to brake hard or corner sharply.
- The risk of skidding varies according to circumstances, particularly road layout. For example, there are likely to be greater risks where traffic conflicts and braking regularly occur. Conversely, risk will generally be lower on well-designed roads

where high volumes of traffic generally move at uniform speeds in the same direction.

- Speed will be an important factor influencing risk but it is not the only factor.
- Risk can never be zero – there will always be situations where no amount of grip on the road will prevent an accident occurring.

The approach discussed in this section is based on the concept that although all risk cannot be eliminated, it can be reduced and broadly equalised on the road network. Thus, greater levels of skid resistance may be called for where risks are higher and relatively low levels of skid resistance may be acceptable in locations where skidding risk is low. With this approach, a consistent level of risk can be maintained across a network (and, in principle, across borders between networks) even though the actual levels of skid resistance vary from place to place.

The approach allows concentration of resources in those areas where they are most needed. At any time there will always be more areas needing improvement than can be funded and a further benefit of this approach is that it provides a rationale for prioritising treatments to increase skid resistance that may also provide a defence against litigation. Also, by focusing on risk rather than friction levels, it encourages a more holistic approach, in which engineers consider alternative approaches such as signing, re-engineering a junction layout or altered speed limits as ways to reduce accident risk.

### The network level(s) to which the policy will apply

As pointed out under this heading in Section 4.1, it is necessary for the policy to clearly define the networks to which it applies. From a European perspective, there are essentially two options.

i) *Apply the policy to the whole European road network*.

It is probably unrealistic, uneconomic and unnecessary, to include the whole network in a European policy. For example, extremes such as quiet country lanes or urban residential streets might not carry enough traffic or vehicles might not travel at high enough speeds for skid resistance to be a significant issue. Also, in such situations, it is relatively easy to provide and maintain reasonable friction levels so regular monitoring is of limited value.

ii) *Apply the policy to selected parts of the network where the greatest safety benefits are likely to be realised*.

The greatest gains from a European harmonised policy are likely to be achieved by applying it to higher network levels such as motorways and main inter-urban highways. These tend to form a smaller proportion of the network as a whole but carry a high proportion of traffic (particularly cross-border traffic) and are generally maintained by, or on behalf of national authorities.

A further issue to consider is that, the greater the network to be covered, the greater the amount of data collection and analysis is required to support the policy. For countries that are

already well equipped with fleets of skid resistance measuring devices to cover large networks frequently, this will not be a problem. However, for those countries with only one or two devices available or which do not make network-level measurements at present, this will be an important consideration.

The idea of a harmonised policy across Europe will probably gain greater support if it is confined to higher-level strategic networks. Nevertheless, in many countries there may be significant gains to be made by applying the policy at some of the lower network levels. There is no reason why individual countries should not decide to apply the main policy to such routes, keeping its principles but adapting the detailed requirements through local highway authorities where appropriate.

For those levels of the network that are not covered, options include the use of aggregates that will not polish significantly under the traffic loading on those routes and assuming that skid resistance will be adequate. Approaches such as monitoring accident rates to identify accident black spots (so-called “cluster analysis”), supplemented by local measurement might also be used. It needs to be recognised that this is a reactive rather than preventative approach that is used because full-scale monitoring would be impractical and probably uneconomic.

## The stages in the life of a surfacing with which the policy will deal

There are two stages in the life of a surfacing. These are:

- The initial phase soon after it has been laid, when the aggregate has yet to be polished by traffic.
- The rest of the road’s life when skid resistance is generally at an equilibrium.

It is necessary to consider how a harmonised policy might deal with both of them. Also, the issue of using skid resistance measurements as part of contractual requirements that are important in some countries and how these relate to a harmonised policy must also be considered.

i) *In-service roads*

Generally, a harmonised skid resistance policy would apply to in-service roads, meaning roads that have been open to traffic for some time – a year or more, say. The policy would manage skid resistance by combining regular monitoring with appropriate remedial action when skid resistance falls too low in specific locations.

The expectation would be that, after an initial period as network standards are gradually improved to meet the policy requirements, the majority of the networks would remain in an acceptable condition until the surfacing becomes worn out for other reasons. The purpose of the policy is to provide a preventative framework for detecting the localised situations where the standards are not being achieved and risks of skidding accidents might increase to an unacceptable level.

*Newly-laid surfacings*.

Many countries currently have requirements for checking the skid resistance of new roads in order to give confidence that the new surfacing is delivering adequate grip at the outset. Other countries currently take the view that a new road will automatically provide good skid resistance and that it is not until the surfacing is a year or so old that it will have begun to polish and checks on skid resistance may be necessary. This is an important issue to consider, especially in situations where routine monitoring may not be carried out for some time after the surfacing has been in use.

It can be argued that immediately a surface is opened to traffic it is "in service" and therefore, logically, a harmonised skid resistance policy should apply immediately. However, to cover the issue regarding monitoring frequency, there could be a specific requirement within the policy that the surfacing should be measured within the first six months after it has been laid.

In principle, a new surface should meet the requirements of the policy for that location at any time in its life and so there is no need for special threshold levels. The results from this initial test would therefore be treated in the same way as for routine surveys elsewhere on the network. It if was known that a routine survey was already scheduled on that length of route in the initial period, then no special action would be needed (provided that measurements are actually made). However, if a survey was not due for a year or more, an initial test would need to be programmed.

ii) *Contractual compliance of newly-laid surfacings*.

As well as a check that adequate grip is being provided, some countries also use skid resistance measurements on the new (or nearly-new) road as a contractual compliance tool. However, there are potential difficulties with this in the context of a harmonised policy that is primarily targeted at in-service roads. These are mainly associated with the threshold levels that might be chosen and the rapid rate at which skid resistance can change in the first few months of service.

A new surfacing should have been specified and designed with ingredients (particularly the coarse aggregate) that, in normal circumstances, can be expected to provide skid resistance above any threshold set by the policy for that location for a reasonable working life. However, to achieve this, the new surfacing will begin at a relatively high level and then reduce over time.

For testing for contractual compliance purposes, therefore, a further question is raised. Should the acceptance threshold for the new surface be the same as the normal in-service level set by the policy requirements, or should it be higher in order to provide a margin of safety and allow for subsequent polishing? A surfacing which complies with the policy levels when new but then fails after a few months is unlikely to be acceptable.

To deal with this situation it may be better not to include contractual testing specifically within the policy in order to keep the issues distinct. Nevertheless, those countries that wish to do so could include a requirement that contractual testing should be carried out within a certain period and that the level to be achieved should be at least a certain

amount above the threshold level for that location. The differential would need to be decided within-country to reflect expected performance of the materials used locally, another reason for keeping this aspect separate from the main policy. Such a test would, of course, serve as the initial survey within six months required by the policy if that requirement is included. Similarly, results from a routinely scheduled survey that passes over the new section could be used for contractual assessment.

## The need for an established measurement technique

As indicated in Section 4.1, in an ideal world, a harmonised European policy for skid resistance would be supported by harmonised measurement method from its implementation. However, the reality is that currently there is no harmonised test method for skid resistance (or a common scale with acceptable precision) that can be applied immediately in all countries. Resolving this issue is a matter being considered in some detail through Work Package 2 of the TYROSAFE project and it is likely to take some time before this will be achieved.

The main purpose of a harmonised policy is to introduce a *consistent approach* to managing skid resistance on European roads, ultimately improving safety. In this context, important though it is, the measurement technique is secondary. The absence of a harmonised measurement method need not be an impenetrable barrier to introducing a European harmonised skid resistance policy; indeed, introducing such a policy could provide further incentive to resolve the technical problems.

Theoretically, it would be possible to impose the measurement technique centrally, specifying an existing device but this would probably be regarded as unacceptable at present, especially by countries that use a different device from that specified. The alternative is for individual countries to use an existing established device. This could be one which they already operate and with which they are familiar or, for those without a suitable device, an appropriate new machine could be purchased. The threshold levels to be applied in that country (discussed further below) would need to be set in terms of measurements made with the chosen device.

Initially therefore, rather than specify the measurement device, the policy will need to set out some broad requirements.

i) *Continuous measurement capability*

Because the policy will generally apply to the whole length of roads on a network, the primary requirement for the measurement device is that it should be able to make continuous measurements. It should be able to record data at short enough intervals to allow reasonably detailed examination of the results locally where necessary while aggregating data over longer lengths for comparison with threshold levels. Ten metres is a typical length for an individual reading for many devices and has been found to be acceptable in many countries that already operate skid resistance management policies.

Devices that essentially make spot-checks such as the static and locked-wheel devices are inherently unsuitable for use in a routine monitoring context, although they could have a support role.

ii) *Near traffic-speed operation*

To carry out routine monitoring it is necessary for the device to be able to operate in traffic, largely without the need for additional traffic management. The device will therefore need to be able to maintain a target operating speed that is broadly consistent with traffic levels on a particular road – 50 km/h in urban areas and 80 km/h on higher-speed routes for example. Static devices or those that are operated by pedestrians are inherently unsuitable.

iii) *Practical working range*

Many measurements will be made on what are predominantly long-distance routes, potentially with considerable distances between junctions. The measurement device will therefore need to be able to cover appropriate distances before it needs to re-fill with water. Of course, this relates to survey efficiency rather than the measurements themselves and is not strictly an issue for the harmonised policy. It is mentioned here as a practical matter to be considered. The choice of device in any situation will involve a balance between equipment capital and maintenance costs and survey efficiency, which will also be affected by survey frequency and network length.

## Measurement strategy and data analysis

As explained above, whatever device is used for the measurements, the policy needs to define how the measurements are to be programmed, the test conditions to be used and the main principles of how the data will be analysed. There are a number of specific issues that will need to be considered.

i) *Operating conditions and choice of reference speed*

The operating conditions, such as water depth will be governed to some extent by the device chosen and should be defined in the specifications for the use of that device (for example, in a CEN Technical Specification).

However, a key factor influencing skid resistance measurements is speed. For this reason a constant speed should be maintained during testing where this is possible. So long as different devices are used in different countries, it is not realistic for the harmonised policy to define what the operating speed should be. That will have to be determined locally in the context of the device used and the governing circumstances on the national networks (ruling speed limits, for example).

However, the harmonised policy can and should provide guidelines:

- The policy should indicate that there should be one reference speed that will be used within each country for comparison with thresholds and to which all

measurements will be adjusted. This need not necessarily be the same as the operating speed.

- Where possible, the reference speed should be the same in countries that use the same or similar devices in order to provide a first level of harmonisation.
- Operating speeds will need to reflect the roads being surveyed, with higher speeds being needed on high-speed routes for safety reasons. For example, a country could use a reference speed of 50 km/h and make that the target operating speed for most roads but have a target operating speed of 80 km/h on high-speed roads.

ii) *Test lane and line*

It is common practice when measuring skid resistance on in-service roads to measure one of the wheel paths, typically the “nearside” path. This is the right side of the lane in right-hand drive countries and the left side in left-hand drive countries. There is no reason for a harmonised policy to change this general practice.

The policy should also indicate which lane should normally be tested to characterise the route on multi-lane or dual carriageway roads. Again, it is normal practice to measure in Lane 1 (the lane carrying most of the heavy traffic) on the basis that this will normally exhibit the lowest skid resistance. A harmonised policy should continue to follow this general practice.

There will be some occasions, such as on very congested routes or where there are several lanes carrying heavy traffic, where the choice of lane may need to be altered or additional measurements made. This will be a decision for individual countries to make depending on their network layout and local circumstances but the harmonised policy should indicate that it may be appropriate to add such tests.

iii) *Direction of survey*

Another important point that needs to be included is the direction in which a road is tested, that is, should measurements be made in both directions on single carriageways and both carriageways on dual carriageway sections? This raises practical and economic issues in relation to the amount of survey required and the number of devices available to cover the network.

In considering this aspect, a number of points must be borne in mind:

- Accident risks may vary depending on the direction of travel (the approaches to junctions will be in different places, for example) skid resistance requirements might be different on opposite sides of a road.
- Traffic levels in the two directions may be different so skid resistance levels may also be different.
- Surfacing materials may be different so skid resistance levels may be different.

Alternative approaches might be:

- Measure the whole network in both directions. This is probably the most rigorous approach.
- Test in one direction only: this is probably least satisfactory in terms of the overall objectives of a harmonised policy. A policy based on this approach should recommend testing a section of route on the side that generally carries the heaviest traffic but without alternating test directions if traffic distribution changes.
- Test in one direction generally but test both directions where there are clearly identifiable differences in surfacing, traffic or other factors affecting either skid resistance or accident risk. This could be a compromise approach but the planning and logistics of getting test vehicles to cover both sides of a road may involve as much work as testing both sides routinely would have done.
- Test in opposite directions in alternate surveys so that over time both directions are covered routinely. This would be a reasonable compromise provided that survey intervals are not too great.

iv) *Timing and frequency of measurements and dealing with seasonal variation*

For skid resistance measurements on new surfaces, either as an initial test or for contractual purposes, the timing of the tests will be dictated by when the surfaces are laid.

For assessing the in-service condition, however, the purpose of the surveys is to assess the underlying general condition of the road network. It is usually the case that a surfacing has high skid resistance when it is new (apart from a short period very early in the life of asphalt surfacings when bitumen covers the aggregate and can affect friction levels). As traffic polishes the surface, however, the skid resistance gradually decreases until it reaches an equilibrium level. It is this equilibrium level that needs to be assessed for older roads.

Apart from in the first few months, the skid resistance usually changes quite slowly and equilibrium is typically reached between one and three years after the surface course was laid. However, on some very lightly-trafficked roads, the equilibrium level may take many years to be established. Conversely, if a poor quality aggregate is used with heavy traffic the skid resistance may worsen very quickly. Changes in traffic after some years in

service can lead to changes in equilibrium level, with increased traffic perhaps leading to lower skid resistance and lighter traffic leading to an increase in skid resistance.

Superimposed on this process is the influence of “seasonal variation” in which skid resistance decreases during the summer and increases to some extent during the winter and the extent to which this occurs can vary from year to year and from region to region. Countries that use studded tyres during the winter months may not have a problem with aggregate polishing because the surface is automatically “retextured” every winter. However, with the trend away from studded tyres these countries are beginning to experience reduced skid resistance in summer.

There is also the added effect of the build-up of oil and dust deposits on the surface during long dry spells, especially in summer. Not only do these deposits contribute to the polishing process, they also create a slippery, contaminating mixture that forms on the surface in the first rainfall after the dry spell, causing a marked reduction in friction until it has been washed off. This effect is technically independent of a skid resistance policy but it can influence skid resistance measurements so must be borne in mind.

All these factors must be taken into account when determining timing of routine measurements and dealing with seasonal variation. It is typical practice to make measurements during the summer months when skid resistance is at its lowest. The objective is to obtain a characteristic measurement that is as close as practicable to the long-term equilibrium summer value of the surface, so that interventions are not made as a result of “freak” conditions occurring in individual years.

Some options for timing are set out in Table 4.1. and

Table 4.2 shows some options for dealing with seasonal effects. These vary in complexity and many require careful survey planning. The seasonal correction strategy needs to be considered in the context of the strategy for survey frequency; it is not appropriate to discuss this in detail here. Both tables assume a generally temperate climate and that measurements are made in summer. However, Nordic countries may need a different (or additional) strategy to deal with winter conditions. Countries with long summers and relatively short winter periods, or with wide climatic variation may also need to develop different approaches.

**Table 4.1 Options for survey timing**

| Option | Advantages | Disadvantages |
|---|---|---|
| Survey whole network every year. | Measures skid resistance when at its lowest during the year. Allows between-year variations to be detected and taken into account. | Potentially the most expensive option. |
| Survey whole network in alternate years. | Reduces survey and processing costs. | Some risk of not detecting sites which fall below thresholds between surveys. |
| Survey whole network every three years. | Reduces survey and processing costs. | Greater risk of not detecting sites which fall below thresholds between surveys. |
| Survey a different part of network each year so that whole network is covered over two or three years | Reduces survey and processing costs. | Risk of not detecting sites which fall below thresholds between surveys. |
| Survey over longer intervals than 3 years | Better than nothing at all | Allows significant deterioration to pass undetected for long periods. |

**Table 4.2 Options for dealing with seasonal variation**

| Option | Advantages | Disadvantages |
|---|---|---|
| Survey whole network three times during the summer and use average value. | Provides a good estimate of average summer conditions in that year. | An expensive option. Does not take account of year-to-year variation. |
| Survey main network once but measure selected “benchmark sites” three times in summer to determine a correction factor | Provides a reasonable estimate of average summer conditions in that year. | Depends on behaviour on benchmark sites being typical of whole network. May need different sets of sites in different regions.<br>Does not take account of year –to-year variation |
| Use average value over a series of surveys. | Provides an estimate of equilibrium level from year to year. | Needs previous data to work with. Does not deal with “in-year” variations. |
| Use average value over a series of surveys, adjusting values in current year with a factor to take account of within-year variation on the network | Takes full account of both within-year and between-year variation | Requires complex annual survey pattern or combination with regular benchmark site measurements to assess average changes within a test season. |

v) *Determination of a characteristic value for comparison with thresholds*

This is at the heart of the measurement strategy. It is unlikely that data straight from the measurement device will be used and that some processing of the data will be necessary to arrive at a characteristic value that can be compared with thresholds that are set.

The actual calculations will depend on the device used but will need to include, for example:

- Adjustments to correct measurements to the reference speed.
- Adjustments for temperature conditions during the survey.
- Application of calibration factors (where a machine is part of a fleet of similar devices)
- Adjustments to take account of seasonal variation.
- Lengths of road to be summarised for analysis (see below).

## Approach to setting appropriate threshold levels

There are a number of possible approaches that might be used to set threshold levels. The threshold levels are the values that will be compared to the skid resistance characteristic values and will trigger some kind of action when the skid resistance falls to the threshold level. These also relate to the broad principle that is to be used for the policy.

There are two types of threshold value:

- A fixed threshold: if skid resistance falls below this value, then action to improve the surface must be taken. This is a “go/no-go” decision. Although simple in concept, the difficulty with this approach for in-service roads is that it does not allow flexibility to take account of local conditions or unusual circumstances. It also imposes a need for a very high level of precision on the measurement technique. It might be used for contractual acceptance tests and also has a potential value to set an underpinning limit below which skid resistance will not be allowed to fall in any circumstances (effectively an “emergency” threshold).
- An “investigation” or “warning” level: if skid resistance falls below this level it provides a warning that accident risk may be increasing and therefore an investigation should be made to assess whether treatment is necessary or appropriate. This type of threshold has greater flexibility in setting levels that relate to accident risk. It also provides protection in case of litigation since this type of threshold does not compel a treatment but, provided there are records of the investigation having been carried out, an authority can show that it has acted appropriately. The investigation process might also show that an alternative to surface treatment, such as altering a junction layout slightly, would be more effective as a means of reducing the accident risk.

As has been explained, it is anticipated that actual threshold values would be set by individual countries, but a harmonised policy could indicate recommended approaches for the way in which this might be done. Essentially, there are three approaches to establishing the threshold values:

i) *Set levels based on theoretical calculations*

In the absence of any other data, it is possible to use factors such as assumed speed, gradient, curvature and required stopping distances in a particular situation to calculate a value for road/tyre friction that would be considered appropriate for the type of road or location being considered.

This process would need to reflect the general approach determined for the policy. For instance, a “maximise grip” approach might consider the most extreme situation likely. A risk-based approach might consider a range of circumstances that present different levels of accident risk and arrive at different threshold values for these.

Having arrived at a coefficient of friction, this must then be converted somehow into a value for the measured skid resistance using the device in that country.

ii) *Set levels based on accident analysis*

Where a country has good accident records, accident analysis, in combination with a special skid resistance survey (or historic data) can be used to provide an indication of the level of accident risk in relation to skid resistance as it will be measured, on different types of road and in different categories of site. It is then possible do decide upon the level of risk that will be acceptable and to set thresholds that equate to that risk.

This approach will allow ranges of risk to be taken into account and adjustments to be made as experience is gained of actual conditions in individual locations.

iii) *Set levels based on established practice*

Countries considering introducing a policy for the first time may not have the data or resources to gather it to use one of the fundamental two approaches. In such cases, it might be better to follow the practice in another country which has networks with similar characteristics. This approach may also be used within a country, for example, when a local authority sets thresholds for its roads based on practice on the higher-level networks. However, in this case care is needed to make sure that the conditions are equivalent and some adaptation may be required.

As well as setting the thresholds, an important aspect is to regularly review them and this should be a requirement of any harmonised policy. Road networks change as new routes are built, roads are upgraded from single to dual carriageway or junction layouts are changed, for example. Introduction of a new facility might alter traffic flows in a particular area. All of these could influence accident risk and therefore, potentially, the threshold levels required.

A further aspect of thresholds is not just the numerical value but the length of road to which it applies. Experience has shown that in some situations skid resistance can vary markedly over short distances but remain essentially constant over longer lengths of road. Some areas

of high risk may only be relatively short in length (the approach to a junction, for example) whereas long lengths of motorway may have levels of risk (and of skid resistance) that hardly change. It is important, therefore, that the policy should indicate the lengths over which the characteristic skid resistance value should be calculated for comparison with the threshold value.

Typically, 100 m might be used as a general averaging length, reducing this to 50 m in higher-risk locations where the areas of conflict can be clearly identified. The policy could also allow for the identification of short lengths that might present a particular hazard, for example a localised low-friction patch that could be of especial risk to motorcyclists but is not sufficiently low to reduce the average for the 100 m length of which it is part below the threshold. However, this would add complexity and potentially increase costs.

Another approach is to use statistical techniques to identify areas where the average skid resistance changes and divide the route according to the levels of skid resistance that occur. This has the advantage of allowing the length of site used to define the threshold to vary and makes it easier to detect localised areas below the threshold without the constraint of artificially imposed 100 m or other boundaries.

### Actions to be taken when the thresholds are not met

The harmonised policy must indicate what action will be taken when the threshold is not met. This is dictated by the type of threshold that has been set.

A fixed threshold would require immediate action: this could be immediate treatment to improve skid resistance or it might be the erection of warning signs to alert drivers to potential risks until the appropriate measures have been carried out.

Investigation levels may not require immediate action to increase skid resistance but would nevertheless require some action to be taken. There are two stages that need to be covered:

i) *Carry out an investigation to determine whether treatment might be required*.

This will include a number of components, for example

- Prioritise investigations, for example so that sites with the greatest potential accident risks or with the greatest differences between the measured value and the threshold are investigated first.
- Inspect the site to identify any particular local conditions that might be giving rise to the low skid resistance or accident risks.
- Assess the accident record for the location and any other evidence that might indicate increased skidding accident risk, such as damage to roadside furniture or comments from police or local residents.
- Consider whether the problem really is the road surface or whether another engineering solution might be more appropriate.

- Consider whether the threshold level itself is too low, and is triggering investigations that are not justified by other evidence.

*ii) Remedial actions to be followed*

If the investigation establishes that treatment is necessary, the harmonised policy should also set out the sequence of actions that would follow the investigation. These could include:

- Defining what the action should be and recording the decision
- Prioritise the surface treatment or other measures for inclusion in the maintenance programme (this might include immediate emergency action if the problem is severe)
- Determine any intermediate measures, such as erection of warning signs or temporary speed limits pending the final treatment, depending on the severity and nature of the risks.
- Verifying that the action has been taken.
- Reviewing the threshold levels for future surveys

These processes can be clearly summarised in a flow diagram for inclusion in any model policy. Figure 4.1 is an example of how the approach using risk-based “investigation” threshold levels with an underpinning “emergency” fixed threshold might be presented.

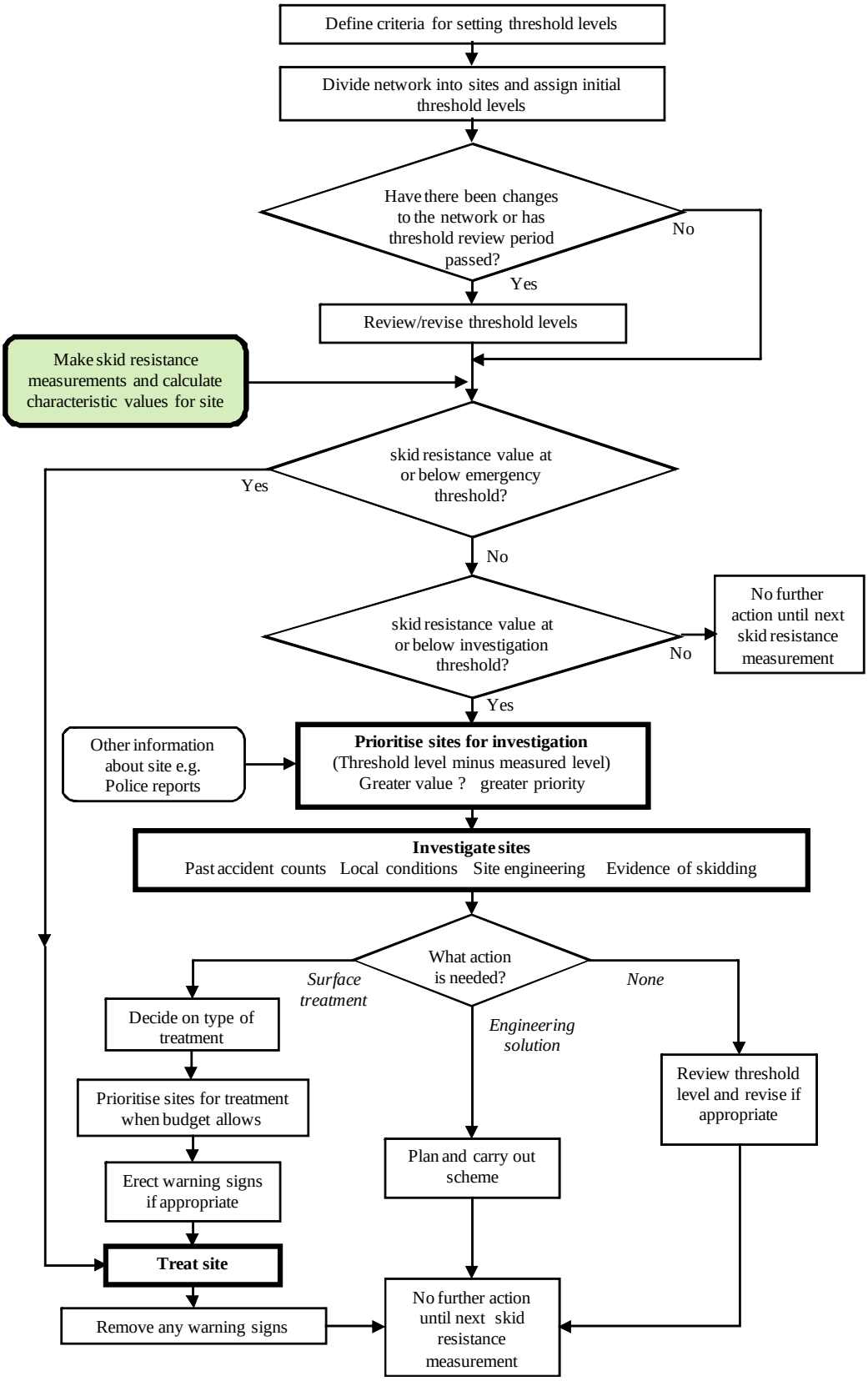


**Figure 4.1 Flow diagram illustrating how a risk-based "investigation" threshold levels with an "emergency" fixed threshold might be presented in a skid resistance policy document**

## 4.3 Possible approaches for rolling resistance policy

Currently, the discussion of the contribution that road surfaces make to tyre rolling resistance is in its early stages. Therefore, there are no policies at present that deal with this aspect of road surfacings. For this reason, knowledge that would be necessary and yet tools needed to design and implement a harmonised policy for rolling resistance on in-service roads have yet to be obtained.

From the point of view of harmonisation, this could be regarded as an advantage since there are no prior polices that need harmonising and it should be easier to implement a European-wide policy (with associated measurement systems) if a more unified approach is taken at the outset than has been possible with skid resistance or, to a lesser extent, with noise.

This section, therefore, discusses briefly some of the aspects that a harmonised policy would need to consider in due course.

### Responsibility for setting and implementing the policy

For a harmonised policy for rolling resistance across the EU, the general policy should be set at a European level even though it will need to be worked out in detail in individual countries. The EC (or some organisation that it appoints) should be responsible for monitoring its implementation.

Two possible broad approaches to setting policies were identified for skid resistance (described in detail in Section 4.2 (see page 28) and similar approaches could be used for rolling resistance.

i) *A centrally defined detailed policy*

With this approach, the EU would define and implement a full policy which would then be adopted into national regulations. This approach has the advantage of defining explicitly the approach that every country must follow but would be very difficult to draft to cover the necessary detail and range of different local circumstances.

*ii) A centrally defined model policy with local application*

With this approach, the EU would set out a model policy. Individual Member States would prepare their own national policies to fit local circumstances consistent with the model policy principles. This approach would be the easiest to implement and allow for any necessary significant regional variations.

### The network level(s) to which the policy will apply

A harmonised approach needs to define the “reach” of the policy. This includes the level(s) of the network to be covered (which could be the whole road network, be confined to certain categories of road). This, in turn, influences both the level of detail at which measurements need to be performed and the frequency of measurements. Depending on the network levels covered, different authorities may be responsible fo implementation of a policy in some

countries (e.g. a national authority for motorways and major roads, local authorities for others). In general, there is likely to be a better chance of adopting a harmonised policy across the EC, at least initially, if it applies to higher road network levels.

## The stages in the life of the surfacing with which the policy deals

The policy will need to define stages in the life of the surfacing with which the policy deals. It is likely that slightly different requirements may be needed for newly-laid surfaces and for in-service conditions.

## The need for an established measurement technique

Unlike skid resistance, for which there are many different measurement techniques, currently, there are no well-established or standardised methods for measuring rolling resistance on “real” road surfacings. So long as this situation continues, harmonisation of measurements is not an issue since there are no established tests to harmonise. However, a harmonised policy needs to make it clear how the property is to be measured in order to provide supporting data on which decisions relating to the condition of the road can be based. Therefore, common measurement method needs to be defined before a policy can be implemented.

A possible approach could be to base a measurement procedure for roads on an existing measurement standard for tyres, e.g. ISO 28580 (Passenger car, truck and bus tyres – Methods of measuring rolling resistance – Single point test and correlation of measurement results). This measurement standard describes the measurement rolling resistance of tyres using drum test facilities. According to this international standard, the warm-up phases, tyre/wheel loads, tyre pressure and test velocities could be used to tests tyre rolling resistance on real road surfaces (using sample surfacings fitted to the drum machine).

Further, this international standard describes the parameters of different measurement methods and two of these might be suitable to be adapted for use to assess road surfaces:

- Force method (force measured at tyre spindle)
- Torque method (torque at tyre axis)

The best solution for standardised measurement equipment would probably be a trailer for passenger car tyres and a separate trailer for truck tyres, using the operating principle of the force method described in ISO 28580.

However, any measurement technique for real road surfacings on which a harmonised policy is to be based is likely to need a reference tyre and reference test track. Possibilities for a reference test tyre might be the SRTT, AV4, as already used for CPX (close proximity noise) measurements. Alternatively, a smooth tyre with a defined hardness could be chosen, which might be more sensitive, or provide a more consistent response, to road surface characteristics than a patterned tyre. The reference tyre will need to be of a type that will be available for several years.

The optimum requirements for a reference test track would be a minimum length of 500 m, even, straight and level, perhaps enclosed to avoid influences caused by weather changes. Of course, the pavement construction and surfacing of this test track would need to be clearly defined, including whether the surfacing(s) are of asphalt or concrete and what specific types of material should be used (perhjpas as defined in ISO 10844). The benefits of such a test track include:

- Opportunities to calibrate different measurement systems on a consistent surface with the reference tyre.
- Opportunities to measure rolling resistance of different tyres on that test track with a rolling resistance coefficient defined by the reference tyre. This, in turn, could be used to help define suitable thresholds measured with the reference tyre.
- Opportunities to make comparative measurements of rolling resistance coefficients and ranking of different road surfaces.

As well as establishing a measurement technique that can be used to provide a reference rolling resistance coefficient, the coefficient should be compared with the performance of in-service roads with as many different kinds of pavement types as possible. Simultaneous measurement of texture and unevenness measurements of the test tracks should be recorded. This will enable an analysis of the texture and rolling resistance data that might establish a link between the texture characteristics and rolling coefficient of tyres on in-service roads. This could provide an alternative strategy, using texture data, with appropriate thresholds, as a surrogate for rolling resistance and thus avoid the need for direct rolling resistance measurements on in-service roads.

### Measurement strategy and data analysis

The policy needs to define how measurements are to be programmed and the principles of how data will be analysed, including:

- *Timing and frequency of measurements.* (On newly-laid surfaces, after a period of months, annually, etc). Climatic and seasonal variation may require differences between different countries and further research may be needed to understand these issues once an established test method is available.
- *Methodology for dealing with special factors* (such as seasonal variation or other effects that may be identified once measurement techniques are established)
- *Lengths of road to be summarised.*

### Approach to setting appropriate threshold levels

This part of a policy covers how the threshold levels against which measurements will be compared are to be set. A number of different approaches were discussed for skid resistance

(Section 4.2, pages 29 and 30) but, at this stage of development of the subject, it is not possible to specify the basis on which thresholds should be set for rolling resistance.

One possibility approach to setting thresholds could be to make a life cycle assessment of the pavement type that will be measured. A maximum rolling resistance coefficient, measured with reference tyre(s), could be adopted depending on the expected traffic volume using the road. This would follow the premise that high level, high-speed, high traffic-volume roads should have a relatively low rolling resistance coefficient.

Different classifications might be needed in different regions of Europe to take into account climatic and seasonal variations of surface properties affecting rolling resistance.

### Actions to be taken when the thresholds are not met

Whatever principle is chosen to set the threshold, the policy will also need to describe what will be done when the measurements indicate that the threshold is not being met on the road. This will need to include:

- *Investigations to determine whether treatment might be required.* Dealing with rolling resistance problems could be difficult and it will be important to understand what the key issues are that affect a particular site. Investigations will need to include looking at what is causing the excessive rolling resistance coefficient, considering what maintenance measures might be appropriate to deal with the problem and reviewing these in the light of the economics of any treatment. Different actions might be proposed for different road categories.
- *What remedial actions will be followed;* The policy should indicate what remedial actions will be taken the investigations indicate that this is necessary and appropriate. It would set out how treatments in different situations should be prioritised and included in any ongoing maintenance plans. For new roads there might need to be specific requirements to ensure that the surface enters service with an appropriate performance level.

## 4.4 Possible approaches for road/tyre noise policy

### Responsibility for setting and implementing the policy

As with skid resistance and rolling resistance, a general harmonised policy for noise should be set at a European level, even though it will need to be worked out in detail in individual countries, with the EC (or some organisation that it appoints) responsible for monitoring its implementation.

The two possible broad approaches to setting policies that were identified for skid resistance (described in detail in Section 4.2 (see page 28) would be appropriate for noise.

i) *A centrally defined detailed policy*

With this approach, the EU would define and implement a full policy which would then be adopted into national regulations. This approach has the advantage of defining explicitly the approach that every country must follow but it would be very difficult to draft to cover the necessary detail and range of different local circumstances.

*ii) A centrally defined model policy with local application*

With this approach, the EU would set out a model policy. Individual Member States would prepare their own national policies to fit local circumstances consistent with the model policy principles. This approach would be the easiest to implement and allow for any necessary significant regional variations.

## The network level(s) to which the policy will apply

A harmonised approach needs to define the "reach" of the policy. This includes the level(s) of the network to be covered, which could be the whole road network, be restricted to top category roads only, or any other option between these two. However, for noise, priority would need to be given to the roads within the chosen categories that are responsible for higher noise exposure (noise maps in the frame of European Noise Directive (2002/49/EC) will help identifying them).

Most commonly these would be medium speed *urban* roads, high and medium speed *suburban* roads, *inter-urban* roads in the vicinity of built areas. As with skid resistance and rolling resistance, depending on the network level covered by the policy, in some countries different authorities may be responsible for implementing a policy to cover the roads in their charge.). In general, there probably is a better chance of adopting a harmonised policy across Europe if it applies to the higher road network levels. However, most disturbances tend to be related to inter-urban roads in the vicinity of populated areas which may not be directly on the top-level networks.

## The stage(s) in the life of the surfacing with which the policy deals

The stage(s) in the life of the surfacing with which the policy deals should be defined, in particular how it relates to new surfacings and in-service requirements.

## The need for an established measurement technique

The important issue is that the policy needs to be evidence-led and therefore measurements are going to be necessary. Currently there is a limited number of different methods for assessing vehicle/road noise emissions. These are in various stages of standardisation but are not yet harmonised.

Nevertheless, measurements made using one of the following techniques could be utilised to support a harmonised policy approach:

- Pass-by method for characterisation of road noise performance in the environment.
- Close-proximity method for on-site check of road noise performance.
- Simplified close-proximity method for regular monitoring.

There would need to be a transition stage in which some kind of assessment between techniques is made so that there is reasonable commonality across national boundaries.

Ultimately, a standard measurement method (not device) could be established (as is envisaged at some point in future with further support) that could become the recognised technique. The combined use of these methods can be defined e.g. in a EU (or CEN) standard.

Tyre-road noise is highly dependent on speed and the speed relation is not linear. Thorough research will therefore be essential to establish an appropriate reference speed for the measurements, either for mobile test equipment (CPX) or passing traffic (SPB). It is likely that two or three reference speeds will have to be defined in order to cover the variety of roads on which each type of pavement will be laid.

### Measurement strategy and data analysis

The policy needs to define how measurements are to be programmed and the principles of how data will be analysed. The detail will vary but a policy will need to include:

- *Timing and frequency of measurements* (for example, on new road pavement surfaces, after a fixed period, at annual intervals etc). Timing may need to be different in different countries because of climatic conditions and seasonal variation of surface properties affecting noise. Therefore, it could be left open to national authorities to decide when to perform measurements
- *Lengths of road to be summarised* (10m, 100m, homogeneous sections or spot checks, etc.) and to which the thresholds will apply.

### Approach to setting appropriate threshold levels

This part of a policy covers how the threshold levels against which measurements are to be compared should be set. Setting thresholds could be done by one of the following approaches:

- In relation to an existing database (absolute levels)
- In relation to noise reduction (before/after noise level difference)

Within either approach, the following will need to be taken into account:

- The duration for which the threshold will apply should be specified.
- Possible evolution of performance over time should be allowed for.

- Possible seasonal variation of factors that influence noise should be taken into account.
- Different classifications might be needed in different regions of Europe to take into account climatic and seasonal variations of surface properties affecting noise.

## Actions to be taken when the thresholds are not met

The policy will need to make clear what actions are to be taken when measurements indicate that the road performance does not meet the required threshold. For noise, there may be a number of alternative treatments that could be applied, ranging from some kind of treatment to the existing surface to replacing it completely.

The policy should indicate the process that will be followed to determine what the most appropriate sequence of actions should be. It may be necessary to apply tolerances to the measurements in relation to the thresholds set that allow for site to site variation and the inherent variability of the measurement techniques (reproducibility).

# 5 Recommended approach for a harmonised skid resistance policy

Skid resistance measurement is well established, albeit with a wide range of measurement techniques, and practice for using the data obtained across Europe. Having considered the various aspects of policies and the important components, the TYROSAFE team makes the following recommendations for the approach to be taken for a harmonised skid resistance policy. These are recommendations on the general principles to be applied: much more work will be required to develop a suitable model document.

**The harmonised policy should be a model policy set at EC level (through CEDR, CEN or other appropriate organisation) that will be implemented in detail in each country by their national road authorities.**

- The model policy will be a high-level document that sets out the key objectives, principles and fundamental requirements and for the harmonised policy.
    - It may be supported by advice documents indicating how to implement some of the detailed aspects.
- The national authorities will each be responsible for defining a policy in their country based on the model policy incorporating the proposed principles.
- The national authorities will also be responsible for determining actual threshold levels, measurement techniques and co-ordinating monitoring and application of the policy.

**The harmonised policy should apply to Level 1 and Level 2 networks (motorways and principal roads linking major towns).**

- The policy and associated thresholds are intended to support maintenance planning and asset management) and should apply to all in-service roads on those networks.
    - If necessary, separate but consistent policies may be prepared to take account of any divisions in administrative responsibility for the different parts of the network(s) concerned.
- Where countries require tests on new surfaces for initial acceptance purposes, separate thresholds consistent with the overall policy may be set. These may be set at a slightly higher level than for in-service roads to provide a safety margin against subsequent polishing by traffic.
- Individual countries may choose to extend the principles to lower network levels, adapting specific requirements in a manner appropriate to local circumstances where necessary
- This policy does not apply to new asphalt surfacings in their very early life when skid resistance may affected by surplus bitumen on the surface. Separate arrangements should be made to cover these specific circumstances.

**The policy will be supported by regular monitoring of the skid resistance condition of the road network.**

- Measurements of skid resistance will be made on the network at regular intervals.
- The objective of the measurements is to assess the underling long-term equilibrium skid resistance of the road surface and not instantaneous values.
- Measurements will normally be made in the summer months when skid resistance is generally at its lowest.
    - Some countries (Nordic countries, for example) may wish to have two measurement seasons and matching standards to take account of widely varying winter and summer conditions.
- In countries where there is significant seasonal variation within or between years, survey planning and subsequent analysis should be designed to take this into account.
- Ideally, the whole network should be surveyed every year. Where this is not possible, the maximum interval between surveys should be three years.
    - New road surfacings should be assessed as part of the policy before they are six months old.
    - Measurements made for contractual compliance purposes should be made not less than two months and not more than six months after the surfacing has been laid.
- Single carriageway roads should normally be assessed in both directions. Both carriageways of dual carriageways should be assessed.
    - If necessary, this may be achieved by testing opposite sites in alternate surveys provided the maximum survey interval is respected.
    - Exceptionally, where surfacing materials, traffic loading, road layouts and accident risks can be shown to be similar, measurements may be on one side only.
- The measurements will normally be made in the wheel path closest to the edge of the road and in Lane 1 on multi-lane roads. Exceptionally, where the heaviest traffic is in a different lane or on diverging routes, other lanes may also be surveyed.

**The measurement technique will be defined based on the following principles:**

- The measurement device should be capable of continuous measurement and be able to record skid resistance values for at least every ten successive metre of road.
- There should be an established standard covering the specification and operation of the device, for example a CEN Technical Specification or formal National Standard.

- The device should be able to record its location on the network with sufficient accuracy to enable data to be related to relevant lengths of road.
    - This may be by means of: the operator inserting a code into the data stream as a fixed reference point is passed; by an automated system such as transponders or sensors detecting fixed markers; through a Global Positioning System linked to a digitised network.

**For comparison with thresholds, characteristic values for skid resistance will be determined from the measurements.**

- The characteristic values will take account of:
    - Appropriate variables that may have influenced the measurements.
    - The effects of seasonal variation.
- A single reference speed should be defined that will be used in deriving the characteristic values for comparison with thresholds.
- As far as is safe and practical, all measurements should be made at the same speed.
    - A target operating speed should be defined that is appropriate to the device and safe operation on the network.
    - Ideally this will be as close as possible to the reference speed but for safety it may be appropriate to use different target speeds for different types of road.
- Appropriate correction formulae should be established for the device that will allow measurements to be adjusted from the target speed to the reference speed.
    - Minimum or maximum tolerances may be applied to define speeds below which data become invalid.

**For network assessment purposes measurements will normally be averaged over not more than 100m for comparison with thresholds.**

- An analysis technique that uses statistical methods to identify significant changes in skid resistance level may also be used to identify appropriate lengths for comparison.
- Analysis should make provision for identifying localised short lengths of low skid resistance that might present an additional accident risk.

**For normal maintenance management, threshold levels will be based on the risk of skidding on different types of site with the overall objective of equalising skidding accident risk across the network.**

- Appropriate threshold levels will be determined in each country.

- Thresholds will normally be in the form of an investigation level which is set to indicate a potential increase in accident risk. This will trigger an investigation of the site and its circumstances to determine whether and what treatment or other measures might be necessary.
- Some countries may set underpinning minimum fixed threshold values lower than the investigation level that automatically trigger remedial treatment to improve skid resistance for some types of location.
- The thresholds will reflect the different levels of accident risk in different locations on the network. They may be based on:
    - A direct analysis of accident and skid resistance data where this information is available
    - From a similar analysis in another EC country with similar traffic and road conditions.
    - Theoretical considerations.
- The threshold level assigned to the different locations on the network should be regularly reviewed, at least every three years.

**When the investigatory threshold is not met, prioritised investigation will be used to establish whether improvement to the skid resistance at that site would be worthwhile and should be programmed.**

- It is recommended that on completion of a measurement survey and calculation of the characteristic skid resistance values, all locations at which the characteristic value is equal to or less than the investigatory level should be identified.
- Sites requiring investigation should be prioritised on a clearly defined basis.
    - Countries may wish to prioritise investigations so that sites which are significantly below the threshold are assessed first.
- The investigation should take account of accident records in relation to other sites of a similar character and other evidence that may indicate increased accident risk.
- If it is established that surface treatment to increase skid resistance would be worthwhile, the site should be added to an ongoing maintenance programme in a prioritised manner.
- Alternatives to surface treatment that would reduce accident risk at the site should also be considered, e.g. posting warning signs, reduction of speed limit.
- If the characteristic value is lower than any underpinning minimum fixed threshold value that may have been set, arrangements to carry out appropriate remedial treatment will be put in place as soon as it is practicable without the need for investigation.

- If there is likely to be a significant delay before remedial work can be completed, appropriate warning signs may be erected. If this action is taken, the signs should be removed once the treatment has been satisfactorily completed.

**Where a country sets a threshold on a new surface for contractual purposes, individual countries will set their own choice of actions to be followed when the threshold is not met**

- The reinstated surface should be capable of delivering the required in-service thresholds for a reasonable working life.

**Supporting documentation and advice**

- National policies should be accompanied by appropriate supporting documents, specifications or standards that provide more detailed advice. These should include, for example:
    - Identification of the measurement device and its operating conditions.
    - The reference speed.
    - Details of how seasonal variation is to be managed.
    - How the characteristic values are to be calculated, including any correction formulae and how they should be applied.
    - Advice on how to carry out the assignment of thresholds and investigations.
    - Advice on materials or specifications for acceptable surface treatments that will provide surfacings that can deliver the required level of skid resistance for a reasonable working life.

# 6 Recommended approach for a harmonised rolling resistance policy

Given that at present there are no existing policies or established measurement techniques relating to tyre rolling resistance on on real road surfaces, it is premature to make specific recommendations for a harmonised European-wide policy for road surface rolling resistance. This section therefore makes some basic suggestions that can be regarded as a guide-line for a future approach.

**The harmonised policy should be a model policy set at EC level ( through CEDR, CEN or other appropriate organisation) that will be implemented in detail in each country by their national road authorities.**

- Each of the national authorities will be responsible for defining a policy in their country based on these proposed principles. They would also be responsible for determining actual threshold levels based on measurement devices developed in the light of measurement techniques set by ISO standards.
- There are some key activities that should be carried out before a harmonised policy can be recommended:
    - A reference surface and a reference tyre will have to be defined. The ISO 10844 surface is a possibility for the reference surface. The reference tyre will need to be of a type that will be available for several years. Possible candidates include the SRTT (used for noise measurements by the CPX-method) or a smooth tyre with a defined hardness could be chosen.
    - Preliminary research using measurements with the reference tyre on the reference surface will be necessary (performed according the ISO 28580 measurement procedure) to establish a reference rolling resistance coefficient. This coefficient should be compared with the performance of in-service roads with different kinds of pavement types to establish appropriate thresholds.
    - Parallel research using simultaneous measurement of texture and unevenness measurements of the test surfaces may allow texture parameters (with appropriate thresholds) to be used as an alternative to direct routine monitoring of rolling resistance on in-service networks.

**The harmonised policy should apply to Level 1 and Level 2 networks (motorways and principal roads linking major towns).**

- The greatest benefits and acceptance of a policy are likely to be achieved on routes that carry most traffic and hence the greatest overall improvement in fuel consumption.

- Individual countries may choose to extend the principles to lower network levels, adapting specific requirements in a manner appropriate to local circumstances where necessary.
- Separate standards will be set for new road surfacing (for initial acceptance purposes) and for in-service roads (for maintenance planning and asset management).

**The measurement technique will be defined based on the following principles:**

- Measurement using a device for which there is an established standard (e.g. ISO).
- A defined test speed should be used appropriate to the device and safe operation on the network.

**Measurements for assessing new surfaces for contractual purposes should be made**

- As with skid resistance tests for new surfaces, the rolling resistance coefficient of the reference tyre on the test surface might be measured between 4 and 8 weeks after opening to traffic.

**For in-service roads, the network will be monitored at intervals (yet to be defined)**

- As long as rolling resistance is regarded as an environmental influence and not a topic relating to traffic safety, routine monitoring might not be necessary.
- It may be possible to define materials specifications such that rolling resistance performance is generally acceptable
- Therefore, it might be adequate to limit measurements of rolling resistance to defined times such as after maintenance operations that include renewing the road surface to verify that performance is acceptable.

**For new roads**

- Special requirements might be set in individual countries for new roads as part of contractual control arrangements.

**Measurements will be adjusted to a standard reference speed**

- If the policy is based on ISO 28580, the suggested test velocity in the measurement standard should be accepted.

**On new road surfaces: where a threshold is set for contractual purposes on a new surface, when the threshold is not met individual countries will set their own choice of actions.**

- The reinstated surface should be capable of delivering the required in-service thresholds for a reasonable working life.

# 7 Recommended approach for a harmonised noise policy

Although much further forward than rolling resistance, the process of assessing and dealing with traffic noise is still in development. Practice varies across Europe and test methods have yet to be fully standardised. Important issues such as reference speeds for measurements had yet to be resolved. Some EC legislation exists in relation to noise and any policy for road surfacings will need to fit in with that. The approach proposed here provides a guideline towards developing a future harmonised policy for European roads.

**The harmonised policy should be a model policy set at EC level ( through CEDR, CEN or other appropriate organisation) that will be implemented in detail in each country by their Road Authorities (national, regional, urban or private company) including definition of thresholds.**

- The road authorities will each be responsible for defining a policy on their network based on the proposed principles.
- They should also be responsible for determining actual threshold levels, controlling the performance after works and co-ordinating monitoring.
- They will have to use the recommended (standardised) measurements techniques

**The harmonised policy should apply to all kinds of networks but concentrate on areas exposed to road noise.**

- Priority will be given to the roads responsible for higher noise exposure: noise maps in the frame of European Noise Directive (2002/49/EC) will help identifying them.
- Medium speed urban roads, high and medium speed suburban roads, inter-urban roads in the vicinity of built-up areas are of primary concern.
- This policy should apply initially to new road surfacings but will include a monitoring scheme for in-service roads over time.

**The measurement technique will be defined based on the following principles:**

- A clear distinction must be made between
    - Road surface classification (labelling),
    - Assessment of a new surface (conformity of production)
    - Monitoring of networks over time.
- Benefits from both SPB and CPX measuring methods must be integrated in the recommended methodology.

- Standardisation of the CPX method must be completed before it can be fully integrated.

**A classification method will be defined.**

- This information will be useful to be introduced in noise prediction models. The link with END (2002/49/EC) must be clearly specified. This will also help the road authorities to require low noise road surfaces in tender documents.
- Road surfaces could be defined not in terms of products but in terms of performance; this will make harmonisation easier.

**Measurements for assessing new surfaces for contractual purposes will be required.**

- The results of measurements must be related to the performance specified in the classification of the road surface.
- Special care must be taken to clearly define the reference speed.
- The policy should state the “window” in which contractual control measurements may be made. There will be an initial period that must elapse to allow the surface to “settle down” before measurements should be made, together with a latest date after which results are not acceptable for contractual control.

**For in-service roads, the network can be monitored annually.**

- Monitoring should be left optional as an informative first step, unless a contract has specified in terms of long term performance.
- It is unlikely that road surfaces will be replaced for noise reasons alone but monitoring can help road authorities in planning their strategy for road surface renewals.
- The time of year at which measurements are made will depend on local climate conditions and seasonal influences.
- Some countries may wish to have two measurement seasons and matching standards to take account of widely varying winter and summer conditions.

**Measurements will be adjusted to a standard reference speed.**

- Thorough research is essential to determine what reference speed(s) should be used for the measurements, whether for mobile test equipment (CPX) or passing traffic (SPB).
- It is likely that two or three reference speeds will have to be defined in order to cover the variety of roads on which each type of pavement will be laid.

## On new road surfaces

- Where a threshold is set for contractual purposes on a new surface and when the threshold is not met, individual countries should set their own choice of actions.
- Actions may range from a financial penalty (on contractual decisions) to resurfacing. The decision to take action will depend on how far from the threshold the noise emissions are and the length of the section that does not fulfil the requirements.

# 8 Routes to implementation

This section of the report summarises the implications of this part of the TYROSAFE project by discussing the routes to implementation of the proposed harmonised policies.

Although recommendations or guidelines for general content have been made in Chapters 5, 6 and 7, it is important to recognise the issues that are raised when a harmonised policy is to be implemented in individual countries. A clear finding of the study is that different countries have different levels of policies implemented at present. Consequently, the route to implementation to apply the recommended principles will look different for each country.

## 8.1 Skid resistance

This chapter focuses on the national implementation of the harmonised skid resistance policy.

After a harmonised policy has been issued by the EC, there will be several steps that a country has to take to implement it. The amount of work involved will vary widely between countries depending on the current status of skid resistance management in the country concerned. Where a sophisticated skid resistance policy is already in place, only small modifications will be necessary. In countries without policies, all the steps outlined below will need to be followed.

### Definition of network

As a first step, the network(s) covered by the harmonised policy will have to be defined. As there may be different road authorities involved, an initial agreement on network coverage should be reached. It has to be borne in mind that these networks need constant attention with respect to skid resistance and therefore need regular monitoring. Networks change as road alignments are altered or new roads are built, so regular review of the network covered by the policy is also needed.

Countries that already use well-developed computerised pavement management systems (PMS) with digital representations of their networks will find this easiest. However, (particularly for smaller countries or networks) suitable strategies can be established even where such technology is not immediately available: the early systems for skid resistance management in countries such as the UK were introduced many years before fully-developed PMS software became available.

### Decide on measurement principle

Here, there is a distinction between countries that make measurements but have no policy and countries that simply do not measure skid resistance. Those in the latter category would have to decide on the measurement principle and on the type of device to use. This fact emphasizes the need of for harmonised measurement method in Europe to simplify that

decision and encourage consistency of measurements from one country to another. Test speed and any necessary corrections (for example, for speed, temperature and season) should also be defined. Seasonal adjustments may involve localised research to establish how these factors influence measurements in the country concerned. Issues such as test speed and speed corrections can be determined by reference to practice in countries with similar road and traffic conditions using the same measurement technique.

### Initial measurement of network

Currently, some countries only make static measurements (with the pendulum) or no measurements at all. These countries would have to carry out an initial measurement of the whole of their defined network(s) to obtain an overview of their situation. This would also serve as a basis for the risk assessment that will need to follow.

### Risk assessment of network

The next step is to make initial risk assessment of the defined networks. To do that, accident data (where it is available) need to be brought together with skid resistance and geometric data. Both skid resistance and accident data need to be spatially referenced to allow the comparison of accident sites and skid resistance; experience has shown that this can be difficult since it depends on the reliability of accident reporting in particular. Where reliable accident data are not available, other characteristics such as geometry may need to be used as indicators of increased accident risk initially. It may be necessary to make reference to established practice in other countries.

### Definition of thresholds

From the risk assessment, thresholds should be derived following the principle of equalising the risk of skidding in the whole network. If an initial risk assessment is not possible (because of a lack of accident data, for example), the adoption of thresholds from other countries (with similar network characteristics, climate etc. would be a possibility.

### Definition of intervention plan for sites where thresholds are not met

Having set the threshold levels, an intervention plan for sites with skid resistance below thresholds should be defined. The plan will need to be supported by appropriate computer programmes (which could be part of a PMS) to process the large quantities of data that will be obtained and to carry out the initial analysis to identify sites that require investigation or early treatment.

Here again, the road operators of the affected network must be heavily involved to ensure a workable policy. The intervention plans should be legally binding for the road operator and include “step-by-step” procedures and advice on what has to be done (see Figure 4.1), with

details of records that must be kept for future reference in the event of legal challenge following an accident.

However, it should be borne in mind that the process of "intervention" recommended in Chapter 5 involves a process of prioritised investigation and review rather than immediate intervention on the network. This means that is not possible to set out precisely what should be done in every possible situation: engineers will be required to "think" about the decisions that they make rather than simply "tick the boxes".

**Set up measurement plan**

Finally, a plan for managing the regular monitoring of the defined network must be set up. This will include details of measurement intervals, measurement season, the number of lanes target speeds and test direction. This will need to be supported by appropriate arrangements with the operators of the test equipment for actually carrying out the measurements and incorporating the data into the analysis process.

## 8.2 Rolling resistance

At the moment, there are no policies or any measurement standards for the determination of effect that real road pavements have on rolling resistance. Therefore, appropriate standards will have to be defined before any policy can be established. For this reason, the following suggested route to implementation should be regarded as tentative.

**Interdependency**

- Definition of the interdependency between road texture characteristics and tyres' rolling resistance for both passenger car tyres and truck tyres.
- Some further research is needed (2010-2013).

**Measurement procedure**

- Definition of a basic measurement procedure (by 2012).
- This could follow ISO 28580 using the same tyre classifications, same tyre/wheel loads, inflation pressures, warm-up procedures, measurement method (e.g. force method).

**Reference test track**

- Definition of a reference test track; length should be more than 500 m, with surface possibly according to ISO 10844 (2010 – 2012).

#### Reference tyre

- Definition of a reference tyre, possibly SRTT or a smooth tyre (2010-2012).

#### Relation between texture wave-lengths and rolling resistance coefficient

- Gathering the relation between texture wave-lengths and rolling resistance coefficient.

#### Pre-investigation

- Definition of some test tracks with as wide a range of surface types as possible
    - Testing these test tracks for rolling resistance according ISO 28580.
    - Gathering knowledge of the ancillary conditions and disturbing factors.
    - Definition of correcting factors.
    - Approach for first rolling resistance thresholds for pavements.

#### Relationship

- After the analysis of test data the relation between rolling resistance and texture can be defined.

#### Setting thresholds

- New thresholds for rolling resistance by texture-measurements can be defined.

## 8.3 Noise emissions

As with skid resistance, after a harmonised policy has been issued by the EC, the work to do in each country will differ markedly between countries, depending on their current practice.

#### Types of network

A first step will be to define where this harmonised policy must apply. This could be defined as in END (2002/49/EC) according to the traffic flow.

#### Indicator of performance

As a first step, a common indicator of the noise performance of a road surface should be defined. Some countries refer to absolute noise value, others to noise level difference; some

countries refer to SPB measurements, others to CPX and others to both. By defining one common indicator, relations between this indicator and other existing indicators in some countries will have to be determined in order to preserve existing knowledge and data base.

### Decide on an integrated scheme

Once the reference noise measurement methods are standardised, the way to use these methods in order to classify, assess or monitor the surfaces will need to be defined. This will lead to a common system specifying which method to use for which purpose and in which conditions. This scheme will have to take into account the problem of evolution of noise performances over time.

### Noise classification or labelling of road pavements

The problem of product repeatability will have to be taken into account without promoting a too detailed a classification procedure (for instance by multiplying the test sites unnecessarily).

### Specification and assessment of noise performance

The specification of noise performance must be consistent with general environmental noise policy. Furthermore, it must accord with the noise classification system. This means that a relationship between specified values that will be assessed after works and classification of noise performance must have been established. In this relationship, care will have to be taken on the correspondence between reference speeds.

### Long term performance

This is the most difficult part of the policy, affecting both the planning of what should be monitored and promoting the development of new products. At the moment there are no tests or models to predict the evolution of the performance of a new product over time. Research on and accelerated test method for performance prediction should be supported.

# 9 Conclusions

Following a widespread review of current practice and the state of development of measurement techniques, it has been possible to make recommendations for general approaches to introducing a harmonised approach to policies for the management of skid resistance, rolling resistance and noise across Europe.

Skid resistance is the most developed of the three areas, although measurement techniques have yet to be harmonised to common scale, a subject receiving detailed attention in WP2 of TYROSAFE. Management practice varies widely across the EC at present but it is considered that there is sufficient knowledge to move towards a harmonised policy for skid resistance in Europe, initially using current measurment techniques within individual countries with approximate comparisons across borders as developments to full harmonisation of measurements proceed in parallel.

Important broad principles that such policies should follow have been recommended, including:

- A model policy set at EC level but implemented in detail in each country by their national road authorities.
- General application to Level 1 and Level 2 networks (motorways and principal roads linking major towns) with local options to apply to lower levels.
- Regular monitoring of the skid resistance condition of the road network.
- Recommendations of principles for measurement technique and analysis.
- Threshold levels (determined by each individual country) based on the risk of skidding on different types of site with the overall objective of equalising skidding accident risk across the network.
- Use prioritised investigation to establish whether improvement to the skid resistance at that site would be worthwhile and should be programmed when the investigatory threshold is not met
    - Where a country sets a threshold on a new surface for contractual purposes, individual countries would set their own choice of actions to be followed when the threshold is not met.
- Supporting documentation and advice

However, rolling resistance and noise are at a much more limited current state of development. Research is needed to establish standardised measurement techniques that can be widely adopted for both parameters.

For rolling resistance, the influence of real pavements on the property has yet to be fully assessed. It may be that standardised measurements using reference tyres can be used to provide relationships that allow other routinely monitored characteristics such as road surface texture to be used as rolling resistance predictors for in-service roads. For noise,

ways of classifying and measuring the contribution of the pavement itself to traffic noise need to be established before a harmonised policy can be introduced. The issue of when surfaces should be assessed and what interventions might be appropriate is also uncertain at the moment.

For these reasons, the recommended approaches for harmonised policies for rolling resistance and noise are essentially guidelines for future application and the work that needs to be done to support them.

For each case, the routes to implementation of the recommended approaches and the issues that will need to be resolved on the way to harmonised policies have been summarised.

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