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Road Safety Inspections: best practice and implementation plan

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List of abbreviations

AADT	Average Annual Daily Traffic
EB	Empirical Bayes method
EU	European Union
NSM	Network Safety Management
RIPCORD-iSEREST	Road infrastructure safety protection – core-research and development for road safety in Europe; Increasing safety and reliability of secondary roads for a sustainable surface transport
RSI	Road safety inspections
WP5	RIPCORD-iSEREST Workpackage 5 – Road Safety Inspections

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EXECUTIVE SUMMARY

The main objective of RIPCORD-iSEREST Workpackage 5 (WP5) was to formulate good practice guidelines for implementing road safety inspections (RSI) in the European context. Conclusions from activities carried out to this end are presented in this report, with an overview on relevant issues for the implementation of RSI in any country where such tool is not yet applied.

According to the common understanding agreed by RIPCORD-iSEREST WP5 participants, **RSI is** defined as **a preventive tool for detecting safety issues, consisting of a regular, systematic, on-site inspection of existing roads, covering the whole road network, carried out by trained safety expert teams. Road hazards and safety issues detected with this activity are described in a written report, for which a formal response by the relevant road authority is required**.

The responses to a questionnaire sent to European countries showed that RSI is recognized as a relevant infrastructure safety management tool in several countries; however, procedures for its practical implementation differ from country to country. It was also concluded that the designation RSI is not extensively associated with the concept outlined above; rather, descriptions of current RSI activities consisted of a mixture of road safety audit, ordinary road maintenance inspection and black spot intervention.

Due to the administrative, regulatory legal and policy specificities of each country, detailed procedures for RSI are better defined by national road authorities. However, some general items are presented as an overall background for the definition of good practice to national procedures for each country's RSI.

The elements to be addressed in RSI should be known risk factors for accidents or injuries. Inspections should be standardised and designed to ensure that all elements included are assessed in an objective manner. The RSI report should be standardized; its contents should include a description of detected safety issues and of proposed corrective measures. Follow-up activities should be carried out to check if the proposed measures are implemented. Check lists for RSI should include the following core important elements: the quality of traffic signs, road markings and road surface characteristics, the adequacy of sight distances, the presence of roadside traffic hazards and consistency between road function and key aspects of traffic operation (ex. speeds). Furthermore, inspectors should be formally qualified for their job.

The proposed good practice guidelines were benchmarked against current practice in Austria, Portugal and Norway, by the execution of four pilot RSI tests. Six of the seven proposed items for best RSI practice are partially fulfilled. Only the requirement for a standardized formal report is completely fulfilled. Follow-up of RSI is the best practice item least fulfilled in the tested procedures; nevertheless, there are no factual indications that this occurs because it would be impractical to fulfil.

Relevant administrative, regulatory, technical, legal and financial issues related to RSI implementation are also discussed in this report.

1 Introduction

Road authorities must guarantee adequate levels of safety on existing roads. To reach this goal, advanced road safety management considers not only traditional corrective measures due to analyses of high risk sites but also the whole infrastructure life cycle itself. This includes interventions to reduce the influence of hazards using general quantitative knowledge on factors affecting the safety of road facilities.

At the planning stage, a Road Safety Impact Assessment (RIA) is performed to assess the impact of plans on safety. This can be a new bridge that may or may not be intended to raise the safety level; or the assessment of a wider scheme i.e. the plans for upgrading the safety level of a total network or area (Eenink, *et al*, 2007).

At the design stage, a Road Safety Audit (RSA) is carried out to ensure that a new road schemes operate as safely as possible for all road user groups. RSA consist of the examination of road schemes at the different stages of project development (starting with the preliminary design), before or shortly after a road is opened to traffic (Matena, *et al*, 2007).

Once fully operational, the safety level of an existing road may be improved through several types of procedures: Black Spot Management, Network Safety Management and Road Safety Inspections.

Black Spot Management (BSM) consists of identification, analysis and treatment of black spots. In RIPCORD-iSEREST, black spots are defined as any location that has a higher expected number of accidents than other similar locations as a result of local risk factors. Network Safety Management (NSM) is the identification, analysis and treatment of hazardous road sections. In RIPCORD-iSEREST, hazardous road section is any section that has a higher expected number and severity of accidents than other similar road sections, as a result of local and section based accident and injury factors (Sørensen, *et al*, 2007).

NSM differs from BSM by focusing on longer road sections of normally two to 10 kilometres, while the black spots seldom are longer the 0.5 kilometres.

The above mentioned procedures (RIA, RSA, BSM, NSM and RSI) are complimentary, rather than alternative.

Road Safety Inspections (RSI) are carried out to identify traffic hazards related to the road environment characteristics and propose interventions to mitigate the detected hazards.

Developments in the road network may create a conflict between the current function of a road and its intended use, along with the inadequacy of equipment and design characteristics to the current use of the road. Furthermore, improvements in road standards may result in discrepancies between characteristics of newly built or reconstructed roads and existing ones, interfering with the establishment of common *a priori* expectations concerning road use. Due to technological developments and new technical standards, existing road equipment may become obsolete, its replacement being necessary. Once open to traffic, the road environment is likely to be affected by interference due to developments not decided upon by road authorities (Figure 1); this is especially relevant concerning roadside characteristics.

Figure 1 - Safety intervention by changes in the road environment

These and others are hazardous factors emerging during the lifecycle of a road itinerary and unforeseen in its early stages, i.e. the planning and design stages. Tackling these hazards in order to raise the safety level of existing roads and bring their standards to adequate consistency with the rest of the road network is the main objective of RSI. A secondary, complementary, objective may also be achieved by RSI: to maintain or restore the original safety level of an existing road. However, it is recognized that several issues related to this secondary objective are mainly achieved by means of regular road maintenance inspections.

The main objective of RIPCORD-iSEREST Workpackage 5 (WP5) was to formulate best practice guidelines for RSI. To meet this objective, a questionnaire was sent to 14 European countries in order to obtain an appropriate description of the current European practice of RSI (Lutschounig, S., *et al*, 2005). A common understanding of the RSI concept was thereafter defined, as agreed by the participants (Mocsari, T., *et al*, 2006), and compared with the responses obtained in the questionnaire. The results are shown in Figure 2 (Nadler, H. *et al*, 2006). Best practice guidelines were defined (Elvik, 2006) and their practicability was tested by means of pilot tests carried out on selected roads in Austria, Portugal and Norway. Relevant national road administrations representatives were involved in these pilot tests.

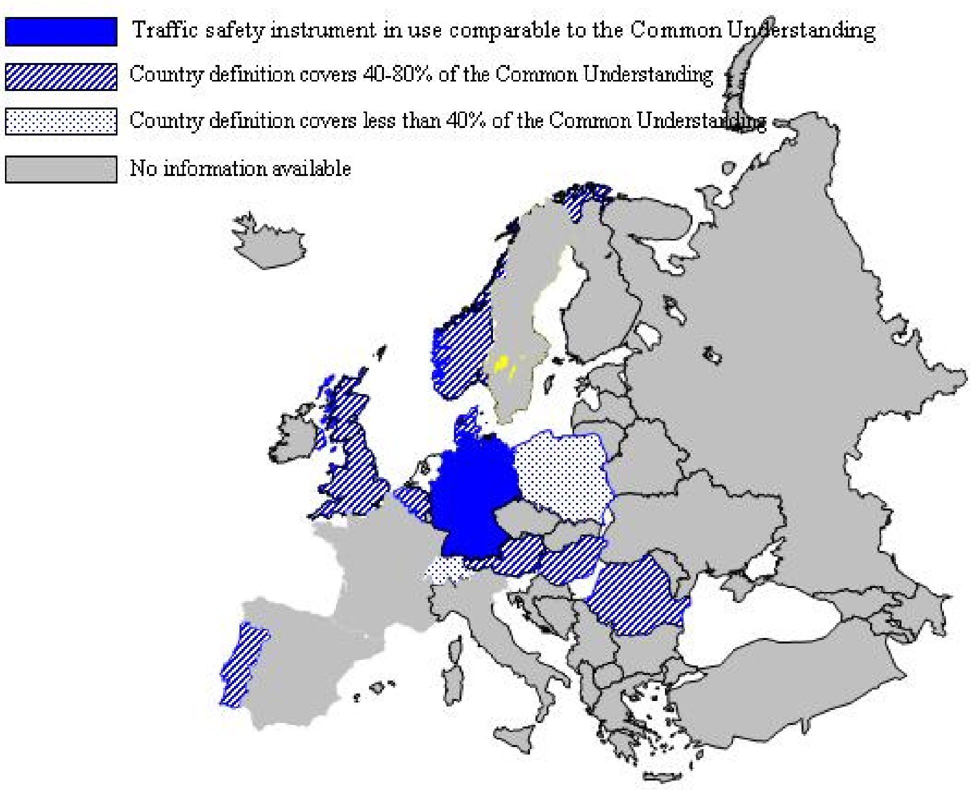


Figure 2 - Compatibility between RSI *Common Understanding* and currente practice (Source: Nadler, et al, 2006)

This report is intended to present the conclusions from these activities and give an overview on relevant issues for the implementation of RSI in any country where such tool is not yet applied. In the next chapter, RSI are defined according to the common understanding agreed by RIPCORD-iSEREST WP5 participants; in Chapter 3, best practice guidelines for RSI are presented, with the results of the benchmarking of the pilot RSI against these guidelines. In the last chapter (Chapter 4) relevant administrative, regulatory, technical, legal and financial issues related to RSI are discussed.

2 Definition

According to the common understanding [Mocsari, T. *et al*, 2006], Road Safety Inspection is defined as:

a. a preventive tool,

b. consisting of a regular, systematic, on-site inspection of existing roads, covering the whole road network,

c. carried out by trained safety expert teams,

d. resulting in a formal report on detected road hazards and safety issues,

e. requiring a formal response by the relevant road authority.

RSI are considered as a preventive tool because its application to an itinerary or road section is not dependent on knowledge concerning its specific safety level. In fact, neither the decision for the initiation of a RSI nor the procedures for its execution require knowledge on the registered safety record of the relevant itinerary. To carry out a RSI, only general knowledge on road hazards, on safety issues related to the road environment and effective infrastructure interventions are needed.

Nevertheless, in some EU countries accident data are used either as an inspection triggering criteria or as complementary information used for setting suitable interventions. Most probably this deviance from the mentioned common understanding does not seriously affect the application of the RSI concept, provided that the required accident data is readily available and meets quality requirements; however, caution should be taken, to ensure that RSI does not become too similar to other safety management tools, such as “Network Safety Management” and “Black Spot Management” (as defined in RIPCORD-iSEREST Workpackage 6) [RIPCORD-iSEREST, 2007].

One important feature of RSI is that this activity should cover the whole network. Furthermore, to be fully effective, some regularity in RSI should be defined, to ensure that there is a periodic systematic evaluation of safety hazards throughout the entire road network.

RSI are an activity that is performed on-site, at least partially, even though experience shows that it is possible to carry out some inspecting tasks at office, provided that adequate inventory and reporting techniques are used. Some of the selected safety interventions will be proposed for implementation, which involves the possible investment of an important amount of funds.

Differences detected in RSI practice at the analysed EU countries may arise also from costs. Various time spans between inspections (1 to 5 years) and a mixture of eligible aspects to analyse (daylight or night time conditions, roadside only, incidence on pedestrian issues, etc.) were reported in the questionnaire. In several analysed countries, priority rules for carrying out RSI were set or are envisaged; most frequently criteria used for selecting road sections include their safety level or their hierarchical category in the network.

To be efficient, on-site inspections and the selection of possible safety interventions should be the task of a team of trained traffic safety experts, familiar with the analysed traffic system. Qualification and experience of the involved experts are critical for RSI. They must: detect possible problematic sites upon preliminary analysis of the selected road section; identify hazards while moving through a road; evaluate their importance and decide upon the need to collect additional detailed information; assess each detected hazard and recommend the application of cost-effective safety interventions that may mitigate the hazard while not creating additional hazards. Most probably all these tasks are better performed by a team than by a single inspector, due to the possibility to exchange technical opinions on the detected issues. Additionally, rotating team compositions also enables the long term development of harmonized practices.

The preparation of a formal report is important to adequately inform road authority decision makers on the detected safety issues and on the general guidelines for diminishing their expected consequences.

To fully obtain the potential effectiveness of RSI, road authorities should add to the mentioned report a description of safety interventions addressing the detected issues; explanations for not acting on some issues should be provided, as well.

Responsible units or persons for each RSI stage should be identified in order to allow for subsequent efficiency control of the procedure.

3 Best practice guidelines

3.1 Current RSI practice in the countries participating in WP5

Within WP5 activities, the state of current RSI practice in several European countries was collected, by means of a questionnaire. Answers were collected from 11 countries: Austria, Belgium, Czech Republic, Germany, Hungary, Italy, Netherlands, Norway, Portugal, Switzerland, and Turkey. The quality of the returned questionnaires varied considerably and several questions were only answered by a few countries. Additionally, bibliographic references to activities comparable to RSI in other countries (United Kingdom, Sweden, Denmark, Poland, Romania, Australia, New Zealand and USA) were analysed. Selected results are summarized in Table 1 (Lutschounig, S., *et al*, 2005).

Table 1: Selected results from the questionnaire

Country	Legal basis	Compulsory	Standardized approach	Applicability	Frequency	Ordering	Report	Cost
Austria	No	No	Yes	Motorways	No	Road authority	Yes	10000€/km
Belgium	No	No	Yes	On demand	No	Road administration	-	1 man-day/10 km
Germany	Yes	Yes	Yes*	Whole network	Every 2 years	Traffic authority	Yes	-
Hungary	Yes	Yes	No	State roads	Every 5 years	Road administration	Yes	-
Netherlands	No	No	No	State roads	-	Road authority; Emergency services	-	-
Norway	No	Yes	Yes	Highest accident record	-	Road administration	Yes	Less than 50000€/km **
Portugal	No	Yes	Yes	State roads	Every 5 years	Road administration	Yes	3 man-day/40 km
Switzerland	No	No	Yes	Where safety level is assessed	-	Road operator	Yes	-

* with implementation of the new procedure. ** includes construction costs of interventions

Several differences in the way RSI are carried out in Europe were detected. First of all, RSI are not even executed in all countries. RSI or similar procedures are performed in eight European countries (Austria, Belgium, Germany, Hungary, Netherlands, Norway, Portugal and Switzerland); in three respondent countries (Czech Republic, Italy and Turkey) no comparable procedure is performed. From the responses obtained it was concluded that the designation RSI is not extensively associated with the concept or definition as outlined in Chapter 2; rather, descriptions of current road safety inspection activities consisted of a mixture of road safety audit, current road maintenance inspection and black spot analysis and intervention.

Two countries (Germany and Hungary) do have a legal basis for RSI; in four countries (Germany, Hungary, Norway and Portugal) RSI are compulsory. In general RSI is carried out by National Road Administrations as part of, or in addition to, general maintenance inspections. In Austria, Belgium, Norway, Portugal and Switzerland a standardised approach exists for RSI; the newly revised German RSI procedure will fulfil such standards.

In six countries (Austria, Belgium, Norway, Portugal, Switzerland and The Netherlands) inspectors use a standardised list of deficiencies to check. In The Netherlands the checklist is based on the guidelines for Road Safety Audit and Design Guidelines for Motorways. In Portugal the checklist is an internal document of the Portuguese Road Administration (*Estradas de Portugal, EP-SA)* containing recommendations for the implementation of inspections and a list of the most frequently detected hazards on main roads of the National Road Network.

No country had distinct RSI procedures for each road category. Germany was the only country where RSI are carried out in the entire road network. In The Netherlands, Hungary and Portugal RSI are performed exclusively on state main roads. In Switzerland, Belgium and Norway RSI are executed only if the safety level of a specific section or junction needs to be assessed.

Only three countries responded that they have specifications for RSI frequency: once every two years in Germany, and once every five years in Portugal and Hungary. Generally the periodical execution of RSI is hindered by the lack of legal obligation to inspect roads.

In most cases the road operator is responsible for initiating, performing, financing and implementing RSI activities, which are carried out internally, without outsourcing.

Not all countries have requirements concerning the composition of inspecting teams and formal qualification of the inspectors. This may be explained by the fact that RSI are mostly performed by selected agents from road authorities' technical staff.

Usually selected sites to be inspected consist of an entire section of road. In Germany RSI may involve the complete network of a municipality. Most frequently, main criteria for the selection of inspection sites include the accident rate (Netherlands, Belgium, Portugal, Hungary and Switzerland) or requests from public or police (Hungary and Switzerland). Independent, automatic, periodical inspections are implemented, or at least recommended, in Germany, Hungary and Austria.

In several countries (Austria, Hungary, Norway and Portugal) a report is written, containing the deficiencies and indicating responsibilities for implementation of safety measures. However, this does not appear to be a general practice in other countries.

In most countries there are no stated consequences if RSI recommendations are not fully implemented.

Information about costs of RSI is scarce, mainly due to the fact that the corresponding activities are carried out by road authorities, being part of the normal activities of the inspectors. In Austria, the overall estimate is 1000 € per kilometre, excluding the corrective measures; in Norway the average cost is 50000 € per kilometre of inspected road, including the execution of cost efficient safety interventions. Portuguese experience shows that an inspection team can examine 20 to 40 km in one single day, followed by a one to two days of office work to draft the corresponding report. These numbers depend on the number of safety hazards detected in the inspection.

In summary, RSI is recognized as a relevant infrastructure safety management tool in several countries; however, procedures for its practical implementation differ from country to country.

3.2 Guidelines for RSI

Following the analysis of the questionnaire answers (see 3.1) and the results of the analysis of expected safety effects of RSI, guidelines for good RSI practice were suggested by Elvik (2006), consisting of seven items:

1. The elements included in road safety inspections should stand as risk factors for accidents or injuries.

2. Inspections should be standardised and designed to ensure that all elements included are covered and are assessed in an objective manner. In initial stages of implementation, check lists may be helpful.

3. Check lists for RSI should include the following core of recognised important elements:

a. The quality of traffic signs, with respect to their need and to whether they are correctly placed or legible in the dark.

b. The quality of road markings, in particular whether they are visible or are consistent with traffic signs.

c. The quality of the road surface characteristics, in particular with respect to friction (macro and micro-texture) and evenness.

d. The adequacy of sight distances and the absence of permanent or temporary obstacles that prevent timely observation of the road or other road users.

e. The presence of roadside traffic hazards, near the carriageway, such as trees, exposed rocks, drainage pipes and culverts, steep high embankment slopes, etc.

f. Aspects of traffic operation, in particular if drivers' speeds are adequate to local conditions and to the function of the road. This also includes items such as the suitability of the road to its function and the adequacy of space for current traffic and separation between motorized and vulnerable road users.

4. For each element included in an inspection, a standardised assessment should be made by applying the following categories:

a. The item represents a traffic hazard that should be treated immediately. A specific treatment should then be proposed.

b. The item is not in a perfectly good condition or deviates slightly from current standards, but no short term action is needed to correct it. Further observations are recommended.

c. The item is in good condition and in accordance with current standards.

5. RSI should state their findings and propose safety measures by means of standardised reports.

6. Inspectors should be formally qualified for their job. They should meet in a regular basis, to exchange experiences and to ensure a uniform application of safety main principles in the inspections.

7. There should be a follow-up of RSI after some time, to check if the proposed measures have been implemented or not.

These general statements are intended as a background for the definition of national procedures for each country's RSI. In fact, due to the administrative, regulatory legal and policy specificities of each country, detailed procedures are better defined by national road authorities.

4 Benchmarking of the guidelines

4.1 Pilot RSI tests

Within the scope of WP 5 the practicality of the suggested guidelines for good RSI practice were tested through the execution of pilot RSI at selected roads in two participating countries (Austria and Portugal) and the critical analysis of reports from RSI already performed by the Norwegian Public Roads Administration.

Austrian pilot RSI were performed on a 4 km length dual carriageway expressway section and on a 7 km motorway section. Both road sections are operated by ASFINAG. The RSI involved test drives by staff from the road operator and KfV, and discussions with officers from the local traffic police force.

Norwegian RSI reports carried out by the Norwegian Public Roads Administration were collected and reviewed. The Norwegian handbook “Road Safety Audits and Inspections” (Statens Vegvesen, 2006) was also analysed.

The Portuguese RSI was carried out on a 15 km length single carriageway interurban road section operated by the EP-SA. The RSI involved test drives by staff from both EP-SA and LNEC.

In Annex I, the pilot RSI reports and results of the guideline tests are presented.

4.2 Benchmark of pilot RSI procedures with the guideline statements.

4.2.1 Pilot RSI included the practicability evaluation of the proposed guidelines. The results of this evaluation are discussed in this chapter.

For each guideline item, a comparative assessment of compliance of the three RSI protocols and an evaluation of viable improvement towards the item requirements were performed. Results of this activity are summarized in Table 2, using the following simplified scoring system:

0 – the procedure does not comply with the guideline item;

1 – the procedure partly satisfies the guideline item content;

2 – the procedure fully matches the recommended item.

Table 2: Benchmark results of pilot RSI procedures

Guideline item	Austria	Norway	Portugal
1 Elements should be risk factors for accidents and victims	1	2	1
2 Standardized procedure	1	2	1
3 Important elements should be analysed	2	2	1
4 Standardized assessment of potential hazard effects	1	2	2
5 Standardized formal report	2	2	2
6 Qualification of inspectors	1	2	1
7 Follow-up of RSI, to check implementation of proposed measures	0	1	1

4.2.2 All tested RSI comply, at least partially, with the requirement for consideration of known risk factors for accidents and injuries.

In 2003, the results of an evaluation of results from several RSI carried out in Norwegian rural and urban road sections showed that those inspections focused on issues that are known to be risk factors for accidents or injuries. On the other hand, it is recognized that, on several occasions, Austrian RSI incorporate other detected deficiencies, in addition to those with a documented influence on safety. The Portuguese pilot showed that the list of analysed items includes both known risk factors for accidents or injuries and some elements that are related only indirectly to safety issues. However, in the latter cases, most of the relevant checklist elements indirectly reflect the influence of known risk factors.

Therefore, it is possible and viable to focus RSI on issues known to be risk factors for accidents or injuries.

4.2.3 All tested RSI are partially executed according to standardized procedures.

However, mention is made to the fact that in the Austrian and Portuguese RSI no formal checklists have been developed yet; inspectors use lists of relevant broad issues for different types of roads, but their detailed content is defined by each inspection team, since their use is not obligatory.

In Norway, checklists were defined, and the Norwegian handbook for road safety audits and inspections contains several check lists for video (Vidkon) and field inspections.

In all cases, it is unclear if inspectors actually follow existing checklists in their work; for the most experienced ones it is possible that checklists are used just to ensure no key issues are left unchecked.

The procedure for Portuguese RSI consists of a two stage inspection: in the first stage, performed by staff from the central office, safety issues are detected and broad recommendations provided; depending on these results, a more detailed inspection may be required from local staff, in which a checklist similar to the one used in the accident black spot analysis is used. This inspection also results in a report, with detailed proposals for correction of detected issues. The protocols to follow in these stages are standardized.

Therefore, it is possible and viable to define standardized procedures for RSI, even though it is not clear that all their content will be explicitly followed in practice.

4.2.4 Two tested RSI are fully executed according to standardized procedures.

In all tested RSI the list of relevant elements to be analysed include those that are recognised as most important: traffic signs, road markings, road surface, sight distances, dangerous objects in the obstacle free zone and speed.

It is not always the case that measurements of relevant variables are made (as for skidding resistance and speed distributions in the Portuguese RSI) or that design plans are used (as in the Austrian RSI). However, some of these issues are already part of other road asset management procedures, such as pavement management systems, for skidding resistance and other pavement surface characteristics (for instance roughness).

Nevertheless, taking into account the objective of checking regularly the whole road network, it is recognized that analytical accuracy will seldom be of overriding importance in RSI. The subjective appreciation of the inspecting team, based on rough measurements made during the on-site inspection and on the inspectors' general knowledge and experience, is expected to be the groundwork for detecting the majority of the hazards.

In conclusion, it is possible to include the most relevant safety issues in the list of items to inspect. In practice, it may be difficult to include measurements of some aspects (such as road surface quality) in RSI. While affecting the completeness of RSI, the consequences of this disadvantage may be mitigated.

4.2.5 Two of the tested RSI procedures include the standardized assessment of the detected hazards.

According to the Norwegian RSI, the assessment is made in a two step procedure. Firstly, hazards are classified in four categories: significant deviations, minor deviation, faults and remarks. This classification is indicative of the urgency of required treatment. In the second step, a two-way table is filled for each hazard, according to the probability that it will be an accident factor (low, medium and high) and the severity of consequences of the corresponding accident (minor, serious, very serious or fatal). As a result, proposed safety interventions are divided in three categories, according to their urgency and costs: immediate measures; minor investment interventions; major investment interventions, usually in whole itineraries.

Deficiencies detected in Portuguese RSI are assessed for their expected influence on the probability of accident occurrence (risk) and for their impact on accident severity. Four risk levels (very frequent, frequent, occasional and rare) and four classes of impact on accident severity were defined (very serious or fatal, serious, slight and minor).

These assessments are entered into a two-way table and a decision concerning the need for action is calculated.

Experience shows that it is possible to make standardized assessments of detected safety hazards that may be used to evaluate the need for safety interventions and to prioritize their construction.

4.2.6 All tested procedures include standardized reporting of the inspection results.

It is worth mentioning that the structure of Norwegian RSI reports is detailed in the appropriate Handbook (Statens vegvesen, 2006). It includes a description of the inspection process, a list of the analysed documents, the results of the accident analysis made, the anticipated accident reduction potential of the proposed interventions and a cost estimate. The Handbook also describes how every finding shall be assessed in a relative objective manner. Standardization of the report is enhanced by the use of a specially developed spreadsheet for describing each detected hazard.

The Portuguese road authority too is developing a template for reporting detected hazards.

In summary, it is possible in practice to report the RSI findings in a standardized way; a characteristic that helps road operator decision makers in the approval of selected corrective interventions measures, taking into consideration their costs and the allocated yearly budget for this type of activity.

4.2.7 Only one tested country showed reasonable compliance with guidelines, in what concerns inspectors' training and qualification.

Both Norway and Portugal have stated requirements for the composition of inspection teams (at least two persons). In Norway, the team leader must be a qualified road safety auditor or inspector, with at least five years of relevant experience, attendance of a course on road safety audit and inspection and participation in at least one inspection in the previous two years. In Portugal inspection teams at the central level include at least two senior engineers with experience in road design, operation and maintenance. Local office inspection teams are lead by a senior engineer. Formal training in road safety is not mandatory. Nevertheless, EP-EPE runs an internal training program that includes short courses on road safety issues, such as signing and marking, road consistency and roadside safety.

The advantages of multidisciplinary teams are recognized in the Austrian RSI, with the participation of police officers.

Therefore, it is practical to ensure that formal qualification of road inspectors, provided that technical education on road safety issues and training RSA and RSI procedures exist. Definition of formal requirements for the composition of inspection teams is also possible.

4.2.8 Follow-up of performed RSI, to check that recommendations have been applied and to evaluate their effect, are an important item of RSI guidelines, to ensure that the potential of this tool is fully explored and that RSI procedures are open for further improvements. Nevertheless, this is the least adhered to guideline item in the tested RSI.

In fact, none have formal procedures for complete follow-up of inspection results and recommendations.

However, in Norway each regional road operator must electronically store the reports in their server; additionally, regional operators must give priority to the execution of proposed measures, subject to yearly allocated budget. They are also responsible for reporting completed RSI to the Directorate of Public Roads.

In Portugal, reaction from local offices to the RSI report by the central office is mandatory. Local office RSI reports are sent to the central office, which ensures a follow-up of the first RSI stage. It was not possible to draw conclusions on the decision process regarding the application of the selected safety interventions, as described in the local RSI stage report.

As a result of the pilot RSI, it is not possible to confirm that in practice follow-up of RSI is viable; at the same time, there is no factual indication that it is not practical to carry-out these follow-up activities.

This is, however, an important issue, if the success of this procedure is desired and if long term interest in RSI is to be maintained. Long term success depends greatly on learning from errors and on acknowledging successful interventions; both are obtained by evaluating the results obtained with applied measures. Therefore, it is recommended that efforts are put into achieving this guideline recommendation, when RSI are implemented in any country.

4.2.9 In summary, the execution of the pilot RSI tests showed that six of the seven proposed items for best RSI practice are partially fulfilled.

Only one item is fully complied by all tested procedures: the requirement for a standardized formal report. However, the scale of standardization varies considerably and one case demonstrates that several tasks may be automatically executed.

Follow-up of RSI is the guideline item least fulfilled in the analysed procedures. This is unfortunate, since ensuring that recommendations have been applied and evaluating their effects are two important tools to ascertain the benefits of RSI. Furthermore, there are no factual indications that it would be impractical to carry-out follow-up activities with these two objectives.

5 Implementation Issues

Due to research performed in Work Package 5, it can be concluded that Road Safety Inspections (RSI) are effective as a means of infrastructure road safety management. Furthermore, RSI have been successfully implemented in several European countries.

Yet, currently used RSI protocols and designations vary considerably between countries. This gives the impression that this topic is one of the least agreed upon on safety management practices in Europe, especially in comparison with Road Safety Audits and Black Spot Management.

A widespread implementation of RSI implies that a number of technical, administrative, regulatory, legal and financial questions have to be solved beforehand. Some of these issues are analysed in the following sections.

5.1 Technical issues

5.1.1 The most relevant technical issues – such as road function, cross section, alignment, intersections, needs of vulnerable road users and roadside characteristics – are widely addressed by the best practice guidelines, as described in Chapter 3.

However, in order to implement RSI procedures, decisions concerning the content and details of the checklists have to be made. The content of the checklists should reflect the prevailing relevant types of hazard that may be encountered in a country and the type of road network they apply to. As an example, on motorways there is no need to inspect requirements for passing pedestrians; and on access roads, special care should be taken to inspect visibility in all driveways.

Two approaches are possible as regards the detailing of checklists: in one method, only broad items are described, such as “check adequacy of sidewalks”, an assumption being made that the inspector knows what to look for in detail; in the other type of structure, very detailed descriptions of the potential hazards are provided, such as “check width of sidewalk; check drainage of sidewalk; …”. Both approaches may be considered as suitable, provided that RSI are executed by qualified inspectors. In fact, experience shows that inspectors familiar with RSI procedures will use the checklists as reminders for the relevant main issues; as in the case of road safety audits, after some practice, only the headings of detailed checklists are expected to be explicitly used by both experienced auditors and inspectors.

5.1.2 In principle, RSI should be performed in selected periods of time, so that the most relevant traffic situations are evaluated: day and night, and dawn or dusk in East-West aligned roads; winter and summer, if considerably different; school/non school days; and shopping/non shopping hours, near malls. In practice, sometimes only the worst expected situation is analysed, especially for some minor roads where multiple inspections are not compatible with the requirement for analysing the whole network with a minimum frequency.

There is some merit in defining unique RSI procedures and timing for the execution of RSI in each type of road. In fact, the checklists are diverse; also, differences in average daily traffic and prevailing speeds result in distinct safety relevance for potential hazards.

5.1.3 According to the definition presented in Chapter 2, RSI are not intended to detect hazards resulting from lack of maintenance (Figure 3). However, this does not mean that detected problems of this type should not be reported to the relevant road operator, for appropriate remedial action to be undertaken. RSI procedures should enable swift communication of these issues, even before the report is issued.

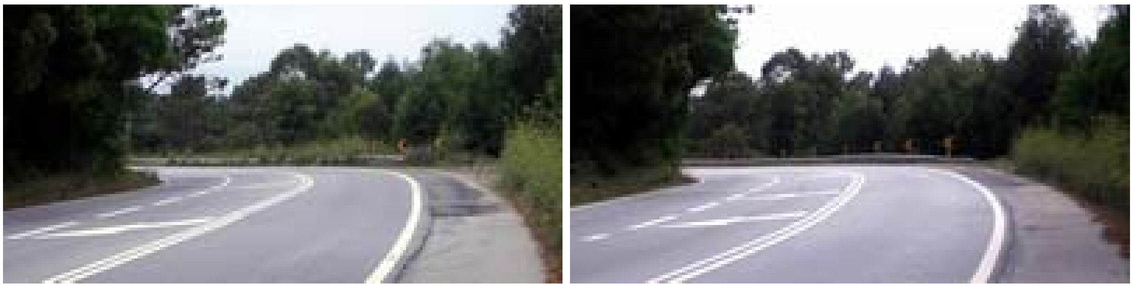


Figure 3 - Hazard issues due to lack of maintenance

5.1.4 As mentioned in the RSI definition (see Chapter 2), the whole road network should be inspected with some predefined frequency in order to detect road safety hazards. At some point in the implementation of RSI procedures, all kinds of roads (motorways, interurban and urban roads, etc.) should be potential targets for inspection, independently of their average annual daily traffic (AADT) or importance in the country's road networks hierarchy.

One obstacle to the complete fulfilment of this objective is the fact that road networks usually consist of several thousands of kilometres, of which only a small percentage belongs to the primary road network.

For example, from the about 120,000 km of the Austrian road network, just 2,000 km of motor and expressways and 35000 km of roads belonged to the jurisdiction of the federal states in 2006. Figures on length of in-town streets, i.e. the road network of municipalities are several years' old and very crude at the best. Latest estimates for the year 2003 refer to 80,000 kilometres.

Following this lead, the legitimate question arises: how can the resulting spatial problem – inspecting the whole network in periodic time intervals of 2-4 years – be solved?

Several ways of dealing with this situation can be found throughout Europe. They are described in the following paragraphs.

In Germany, a distinction is made between periodic and *ad hoc* tasks in road safety inspections [FGSV, 2006].

The inspections are divided into "periodic" RSI (performed at fixed time intervals), "dedicated" RSI (dealing with a specific topic) and *ad hoc* RSI (see Table 3). The major advantage of this classification is that, besides the regular safety inspection, specific and highly controversial (or important) safety topics such as pedestrian crossings, tunnels, crossroads, etc. are inspected separately and not all mixed together. This approach also makes sense considering the fact that different issues need diverse time intervals too, i.e. safety related signs and road characteristic have to be inspected more frequently than, for example, destination signs.

This approach also contributes to the goal of consistent solutions for similar problems, as uniform safety interventions towards a specific safety hazard are carried out within a short time interval.

Table 3: Tasks and scheduling of RSI in Germany

Type of RSI	Subject of inspection	Road categories	Interval
Periodic	Safety-related road signs (including road markings and traffic devices), hazards at the edge of the carriageway and in the road-side environment	Major roads (in built-up areas), federal-state roads, district council roads and motorways (outside built-up areas)	Every 2 years
		Municipal roads and minor roads (in built-up and non-built-up areas)	Every 4 years
Night-time	Road signs (including road markings and traffic devices), road layout, lighting of crossing points	Major roads (in built-up areas), federal trunk roads, federal-state roads, district council roads and motorways (outside built-up areas)	Every 4 years
Railway crossing inspection	Road signs and traffic devices in connection with level crossings	all roads	Every 4 years
Tunnel inspection	Safety-related road sign (including road markings and traffic devices), lighting	all roads	Every 4 years
Destination-sign inspection	Destination signs	all roads	Every 4 years
Inspection of other road signs and traffic devices	Road signs and traffic devices not covered by other RSI	all roads	Every 4 years
Ad hoc	Selected road signs and traffic devices	all roads	As required

Another approach to the problem stated above is to (pre)select roads based on their safety record.

In Norway, the safety record of a road is assessed in terms of its expected injury severity density, which is an indicator for the cost-weighted yearly number of injured road users per kilometre of road. One fatal injury for example counts as much as 33 slight injuries. This procedure is the same as the one used in Network Safety Management (NSM) for the selection of itineraries for safety diagnosis and intervention, as described in RIPCORD-iSEREST Work Package 6 (Sørensen, M. et al, 2007). In such cases, however, differences between RSI and NSM still exist, namely in the type of information supporting decisions concerning the safety interventions. Indeed, RSI interventions are defined according to road characteristics, based on knowledge of general safety factors; whereas the selection of NSM interventions is additionally based in information from reported accidents.

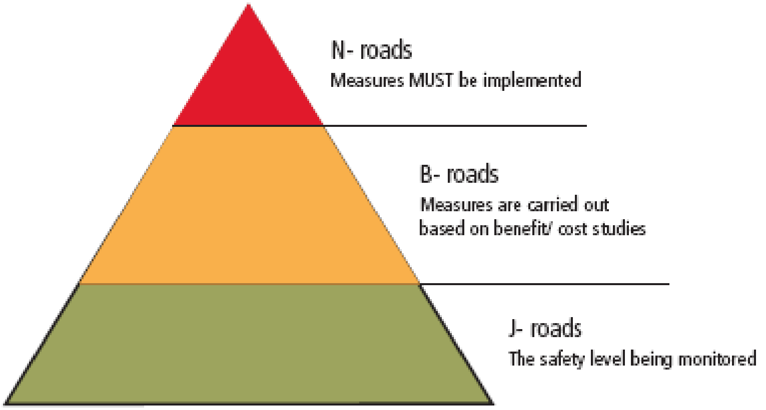
Expected injury severity density for a given road section is estimated by means of the Empirical Bayes (EB) method. According to this method, expected safety for a given roadway element can be estimated as the weighted average of the predicted safety for similar sites and the accident record for the given element. Safety for similar sites is predicted by means of a multivariate accident model, using negative binomial regression for goodness of fit.

Separate models have been developed for fatalities, critical injuries, serious injuries, slight injuries and injury accidents. Based on these models, normal values are predicted for fatalities, critical injuries, etc. These are then combined with the recorded values for each road section in order to estimate its predicted injury severity density. Road sections of 1 kilometre and data for 8 years were used in developing the models.

Accordingly, roads were classified into three groups, based on expected injury severity density:

- Red roads, comprising the 10 percent worst roads,
- Green roads, comprising the 50 percent safest roads
- Yellow roads, comprising the remaining 40 percent of roads (see Figure 4).

Safety inspections are first carried out on the worst of the red roads, and then proceed to other roads.



Source: Statens vegvesen, 2005

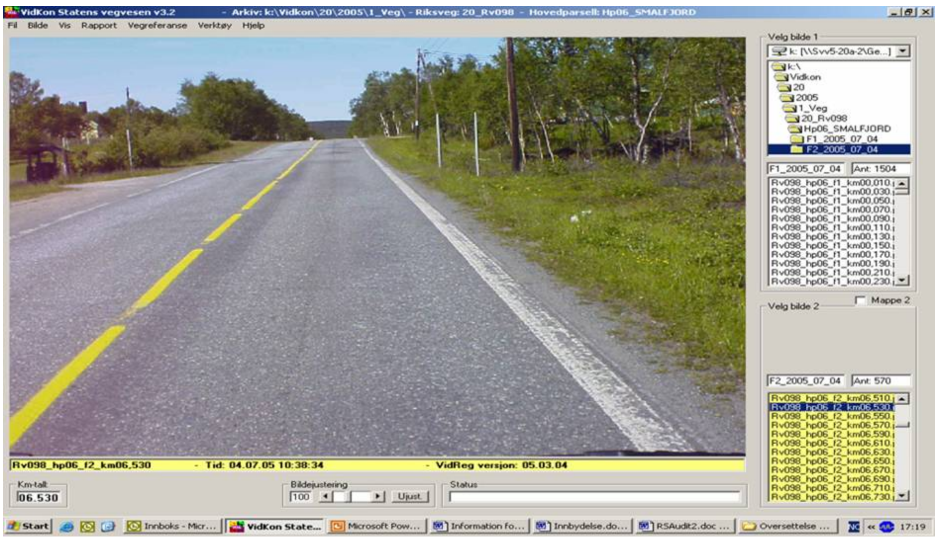
Figure 4: Classification of national roads in Norway due to the expected injury severity density

A third approach to the spatial problem consists on the definition of a two-step procedure for carrying out RSI. In the first step a preliminary on-site inspection (with the objective of detecting main safety issues) is carried out, followed by a second more detailed ("analytical") inspection. With such a two-step procedure, it is possible to entrust specialized departments within performing organizations (see 4.2.3, for the Portuguese two-step RSI procedure).

Experience in Norway [Statens Vegvesen, 2005] reveals that field inspections can be undertaken much more quickly when a so-called Vidkon overall inspection is carried out beforehand, using digital video equipment. The road section under investigation is driven through several times, with a digital camera being used to make two pictures (one on the actual roadway and the other on the roadside area) every 20 metres; alternatively, a video camera may be used to record a continuous stream of the whole section. On straight road sections, a large amount of items can be checked by driving slowly along the roadside.

For the road section under surveillance, a preliminary inspection is conducted at the road operator's office, in order to obtain an overview of the road section and to check for overall safety factors such as area type (does the road go through different area types), curvature and visibility, intersection types, signing and road markings, etc. Hence, this method gives the opportunity for inspecting the road at any time of the year, not being influenced by weather or traffic flow.

During winter months, when RSI are usually not feasible, those pictures and videos are then used for preparation of standardized spreadsheets (see below) for upcoming inspections during spring. Figure 5 gives an example of a RSI in Norway with Vidkon being used for data acquisition.



Source: Statens vegvesen, 2005

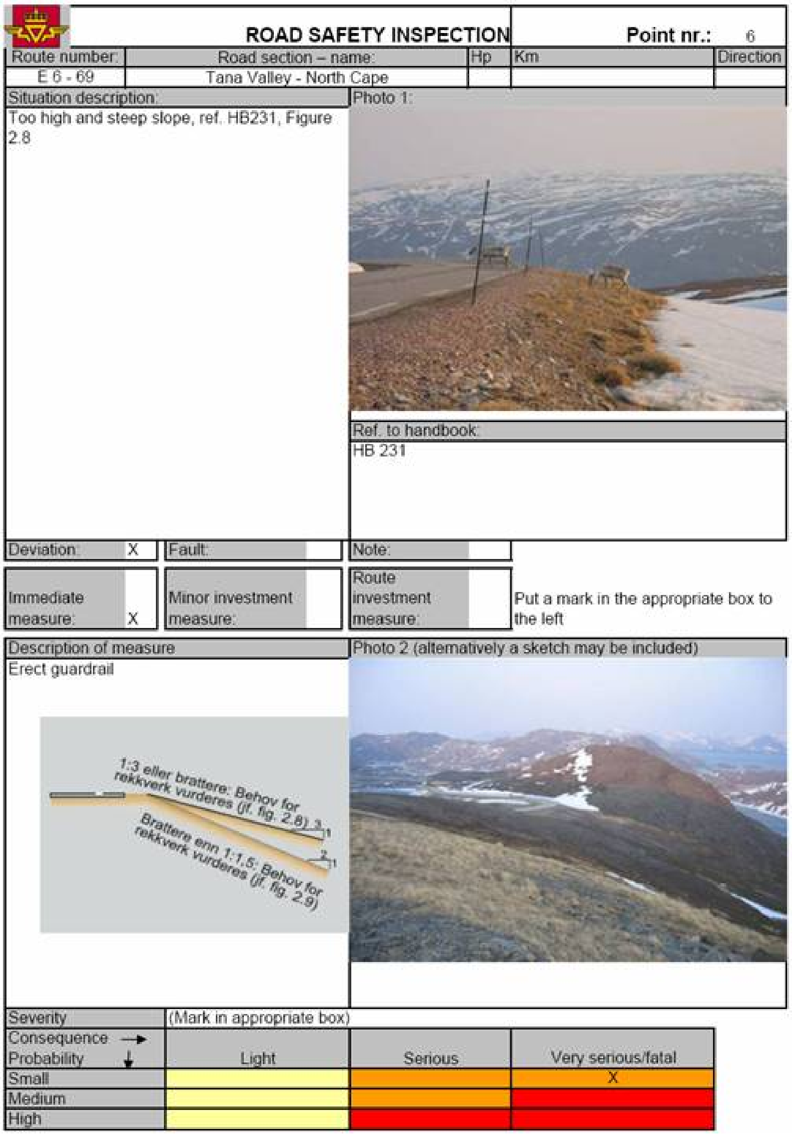
Figure 5 – Road Safety Inspection in Norway using Vidkon

This type of 'preliminary' road safety inspection offers several advantages:

- Less time spent in traffic, i.e. increased safety for the inspectors;
- Inspections are possible throughout the year - the winter season can also be used for preparations;
- Inspectors have the chance to rewind the tape and look as long as needed for critical sites, in order to detect common or veiled deficiencies;

- Discussions on safety hazards are carried out in a friendly environment, without danger to inspectors and pressure from running traffic.

The ensuing field inspection (the "actual" RSI) itself concentrates on checking conditions that are uncertain and on detailed analysis of specific situations picked up during the preliminary inspection. In Norway, standardized report forms are being used to guarantee that every RSI is free of subjective elements, irrespective of the performing inspecting team. To reach this goal, specific software for filling the report forms was developed, which includes standard texts describing a number of typical frequent situations (see Figure 6).



ROAD SAFETY INSPECTION — Point nr.: 6

Route number:	Road section – name:	Hp	Km	Direction
E 6 - 69	Tana Valley - North Cape			

Situation description: Too high and steep slope, ref. HB231, Figure 2.8

Photo 1:

Ref. to handbook: HB 231

Deviation: X — Fault: — Note:

Immediate measure: X — Minor investment measure: — Route investment measure: — Put a mark in the appropriate box to the left

Description of measure: Erect guardrail

Photo 2 (alternatively a sketch may be included)

Severity (Mark in appropriate box)

Consequence → / Probability ↓	Light	Serious	Very serious/fatal
Small			X
Medium			
High			

Source: Statens vegvesen, 2005

Figure 6 – Standard report form used for safety inspections in Norway

The information entered into each form contains the following items:

- Route number;

- Name of the section, such as from *Location A* to *Location B*;
- Main road section;
- Kilometre post and direction;
- Kilometre identification of hazard spot or km 'from-to' for a section with multiple hazards;
- Problem description for the hazard;
- Tick-off for deviations, faults or remarks;
- Tick-off for hazards requiring immediate safety interventions (resulting in minor investments or major investments);
- Photo of the hazard (from the Vidkon system);
- Description of proposed safety intervention.

This reporting method has several major advantages, as follows:

- Simpler and standardized report form, easier to read and use;
- Easy to compare different reports;
- Easy to insert pictures from Vidkon or any other video system;
- Standardized text for most common hazards (hazard and text data base);
- Includes risk matrix;
- Improved basis for prioritizing among hazardous conditions identified.

5.2 Administrative matters

Administrative matters include questions like:

- "Who is responsible for ordering a RSI?"
- "Who should respond to a RSI and be in charge of its follow-up?"
- "What is the required composition of the inspecting team?"
- "Who can be qualified as a road safety inspector?"

The first two questions correspond to the assignment of responsibilities regarding tasks such as RSI initiation, on-site execution, definition and construction of corrective measures and follow-up inspections. Assuming that not all of them will be appointed to the same institution, answers to these questions depend heavily on the administrative organization of each country and, most likely, on the type of road to which the RSI is being applied.

If there are national and municipal road networks, which are operated independently, most probably different systems will be set up for each type of road network.

If the national road administration structure contains a central office and several regional offices, one possibility is to assign to the central office the duty to define the list of RSI to perform yearly and to start the execution of the relevant RSI. It is also possible to execute the RSI in a two-stage procedure, with the preliminary detection of hazards being done in the first stage (by the central office, for instance) and the definition of safety interventions done by the regional offices.

For municipal road networks, an especially created supervising board or a supra-municipal administrative level may be required for defining the list of roads to inspect and the RSI initiation.

Issues concerning the composition of the inspecting team relate to the convenience of having several – at least two – inspectors in all but the simplest RSI, to ensure that there is a diversity of skills within the team and that discussion of different opinions on the safety issues is possible. In addition, at least one of the qualified inspectors in the team should be independent of the inspected road's operator to ensure a "fresh" look on current maintenance and infrastructure safety procedures.

Efficiency of RSI depends heavily on the qualification of the performing inspectors. Requirements for inspectors should include background and experience prerequisites, specific qualification on RSI procedures, regular updating of knowledge and communication skills.

Background experience requisites may include: a professional degree in road design and maintenance; knowledge in traffic engineering, in applied human factors and in road safety; familiarity with traffic regulations; and understanding of road design, signalling, signing and marking guidelines. It is also recommended that the inspector candidates have experience in day-to-day road operation and maintenance.

Road safety inspector candidates fulfilling the previous mentioned requisites should attend a short course on the procedures to be executed in a RSI. This is a requirement similar to the one for road safety auditor candidates [Vaneerdewegh 2007]. Typically this course lasts for no more than one week, assuming that candidates already have a strong background on road safety.

5.3 Regulatory aspects

Regulatory aspects are especially important if RSI are to be applied to the whole road network, to clearly specify legal competences of road operators and of the ordering entity.

It is expected that regulating RSI execution in main national road networks will not be especially difficult, as most of the tasks may be performed by the National Road Authorities, most probably using different departments for starting, executing and responding to planned RSI. In several countries, the increasing use of public private partnerships will dictate the need for a public supervising role for the RSI of this type of roads, which may be assigned to the National Road Administration or to an especially created institution.

It is expected that regulatory issues will vary considerably from country to country.

5.4 Legal issues

As in Road Safety Audits, liability issues are sometimes argued against the execution of RSI.

Legislation concerning liability arising from issues related to the influence of road factors in the occurrence of accidents differ from country to country, both in scope (whether there institutional and personal civil or criminal responsibilities) and object (which characteristics are pertinent to liability cases).

In some countries a distinction can be made between liabilities resulting from non observance of standardized design or construction criteria set in technical standards and those that may result from other types on negligence.

The last type of issues can be addressed by answering the following three questions:

- “What are the consequences of not having attempted to detect a hazard (no RSI is performed)?”
- “What are the consequences of not having detected a hazard (in a performed RSI)?”
- “Which consequences result from not having acted upon a detected hazard (RSI)?”

From a purely engineering perspective, it seems that road administrations that routinely carry out RSI demonstrate (at least an abstract) active concern for improving the safety, reducing the credibility of carelessness criticism. This argument supports the interest in having an active RSI programme.

The second question stresses the importance of having both an active programme for updating road inspector’s knowledge and regular technical forums for sharing experience amongst inspectors. This will enable a quick and widespread dissemination of recent road safety knowledge developments.

Referring to the third question, from common sense, intervention should follow hazard detection. However, it is well known that safety is not the only criteria to be met by road administrations while managing a road network. Namely, available funding is not unlimited, land use and geomorphology must be considered and social or environmental aspects may block some solutions. For this reason, in some countries road administrations are empowered the discretionary authority to decide how to act upon a detected hazard, according to predefined sets of rules. In these cases a register of the decisions taken and their rationale is usually kept.

The discussion above stresses the need for a thorough appraisal of the legal consequences of RSI prior to its implementation in each country and for the definition of a suitable legal framework, as these are issues that may hinder RSI usefulness and, in the worst cases, even obstruct its applicability.

5.5 Financial issues

On several occasions, hazards detected in RSI may be addressed by low cost engineering measures, not requiring right-of-the-way acquisition. On the other hand, reducing the potential safety impact of other hazards may involve major investment interventions (see Figure 1).

Therefore, it is desirable to have a systematic protocol to classify the priority for each type of intervention, based on the hazards' characteristics, urgency, cost and scope of the safety intervention and taking into consideration the available budget.

RSI procedures involve three types of costs: the costs of the inspection itself and for the elaboration of the ensuing report; the costs of the safety intervention constructed; and the costs of follow-up activities. Planning work and budget related to the first and the last activities is relatively straightforward for a mature organization. Yearly budget allocation for constructing elected safety interventions will depend on the overall policy of road operators, especially in what concerns the balance between new construction, reconstruction and maintenance activities. However, care should be taken to ensure that there is no inconsistency between the performed inspecting activities and the remedial measures that may be actually constructed.

There are only a few studies of the road safety effects of measures that are known to have been implemented as a result of RSI. Yet, these estimates of effect support the conclusion that such measures can improve road safety (Elvik *et al,* 2004).

In an analysis made in Australia to the results obtained with an activity similar to RSI as defined in Chapter 2, it was concluded that the majority (78%) of the proposed interventions had benefit cost ratios greater than 1.0 and that 35% had a benefit cost ratios greater than 10. Over 250 interventions were analysed (Macaulay et al, 2002).

6 CONCLUSION

In this RIPCORD-iSEREST Work package 5, Road Safety Inspection was defined as:

a. a preventive tool,

b. consisting of a regular, systematic, on-site inspection of existing roads, covering the whole road network,

c. carried out by trained safety expert teams,

d. resulting in a formal report on detected road hazards and safety issues,

e. requiring a formal response by the relevant road authority.

Following the analysis of the answers to a questionnaire circulated by 14 European countries and of the experience in other countries it was concluded that RSI were successfully implemented in several countries and that they are an effective tool for infrastructure road safety management. Differences towards Road Safety Audits and Network Safety Analysis, as defined in other RIPCORD-iSEREST Work packages (RIPCORD-iSEREST, 2007), were detected as well.

RSI protocols and designations in use vary considerably between different countries. By comparison with Road Safety Audits and Black Spot Management, RSI are one of the least agreed upon safety management practices in Europe. This may result from the fact that management activities depend on the administrative and regulatory context they are implemented; therefore they are influenced by country specific practices.

Widespread implementation of RSI in Europe seems to be possible and desirable.

To this end, best practice guidelines were defined and tested in three countries, leading to the conclusion that there are no major practical impediments to their extensive application in European countries.

Implementation of Road Safety Inspections, however, implies that a number of technical, administrative, regulatory, legal and financial questions have to be solved beforehand, in order to adapt the concept to each country.

Road Safety Inspections procedures are subject to constant development and improvement, following the conclusions of result evaluation activities.

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8 ANNEX - PILOT ROAD SAFETY INSPECTION REPORTS

8.1 Road safety inspection in Norway. The municipality of Notodden, Road Section Tuven – Viperudmoen, 2006-09-28

Road Safety Inspection

The municipality of Notodden

Road Section Tuven – Viperudmoen

28. September 2006

A - Introduction

The district of Øvre Telemark (district of the Norwegian Public Roads Administration, Southern Region) want a traffic safety inspection to be made for a 5 km long road section of the E134 (Europe Road) in the municipality of Notodden (km 3,000 – 8,000).

The road section is located in medium densely populated areas and rural areas with scattered buildings. The road section has an AADT of 7500. On the first 2.4 km the speed limit is 60 km/h and on the last 2.6 km the speed limit is 70 km/h.

For the most part there is a combined cycle lane and sidewalk alongside the road section. For the remaining part the pedestrian and bike-riding people can use the local roads. The Church of Heddal, the Public school of Rydi and the Kindergarten of Rydi are placed along the road section.

There are many intersections, driveways and crossings on the road section. The side area is complex and irregular and the shoulders are relative level.

B - Inspectors and inspection process

The road safety inspection was carried out by:

- Svein Stigre, civil engineer, The district of Øvre Buskerud (Inspection leader)
- Jan Brevik, senior engineer, The district of Øvre Buskerud
- Elin Børrud, senior engineer, Road and traffic department, Veg- og trafikkavdelingen, Southern Region

In addition Lars-Gunvald Hauan from The district of Øvre Telemark participated in the field inspection. Elin Ødegård from the Directorate of public roads participated in the Vidkon inspection (Digital still photographs for each 20. m of the road section).

The start-up meeting and the field inspection was carried out Wednesday the 21st. of June 2006.

C - Basic inspection documents

- Handbook 222, Road Safety Audits and Inspections – guidelines
- Handbook 231, Barrier standards (In Norwegian)
- Handbook 017, Road and street design (In Norwegian)

D - Accident study and important data

Table 1: Important data for the road section

Important data	**Km 3.000 – 5.400**	**Km 5.400 – 8.000**
Speed limit	60 km/h	70 km/h
Buildings along the road section	Medium densely built up area	Rural areas with scattered buildings
AADT	7500	7500
Safety Zone	5 m	7 m
Stop sight distance	94 m	119 m
Free sight intersection (side road X main road)	10 m X 141 m	10 m X 179 m
Free sight access drive (access drive X main road)	4 m X 113 m	4 m X 143 m
Road standard	H2/S1	H1/S6
Cycle lane and sidewalk standard	GS2	GS1

Accident data

The accident data is from the STRAKS traffic accident register (register with all traffic accidents with personal injuries recorded by the police). In the period 2000-2005 the police have recorded 15 traffic accidents with personal injuries (PSU) on the road section with a total of 24 personal injuries. One of these was serious injured, while the rest (23 people) had minor injuries.

Table 2: Traffic accidents distributed after accident type

Accident type	**Number of PSU**	**Number of injuries**
Rear end accident	2	3
Head on accident	1	2
Accidents in intersections and drive ways	8	14
Accidents with pedestrian	1	1
Accidents while overtaking	3	4
Total	**15**	**24**

Table 2 shows that the dominant accident type is accidents in intersections and drive ways. These accidents account for eight of the 15 accidents.

Four out of five rear end accidents have happened on a 100 m long road section by the access way to the garden centre of Frøymyr – see picture (km 6,660-6,760). All five accidents happened in the years 2001-2002.

Table 3: Traffic accidents distributed after time

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	**Total**
00.00 – 06.00							1	**1**
06.00 – 12.00		1			1	2		**4**
12.00 – 18.00	2	1	1	1	2			**7**
18.00 – 24.00	1				1		1	**3**
Total	**3**	**2**	**1**	**1**	**4**	**2**	**2**	**15**

Table 3 shows that eight of the 15 accidents have happened from Friday to Sunday and seven of the 15 accidents have happened in the afternoon.

The accidents are evenly distributed over the year, and most of the accidents have happened in daylight. 14 of the 15 accidents have happened wet or dry road. One accident has happened on icy road.

E - Inspection summary

The field inspection resulted in 75 findings on the road section (64 deviations, 9 faults and 2 notes/remarks). Immediate measures have been proposed for all findings, except one.

The most typical findings is trees and other fixed obstacles in the safety zone, vegetation and other obstacles which block the free sight in intersections and drive ways and road sections where guardrails are needed.

Problems relating to inferior shoulders together with steep and deep ditches have also been pointed out along several road sections.

The width of the road was not measured on a regular basis under the field inspection, but a general problem on the road section is a narrow road width.

F- Anticipated accident reduction effect of proposed changes

The anticipated accident reduction effect of proposed changes is not assessed.

Attachment

Filled out inspections reports consist of the following four documents:

- Part 1: E134 Hp3, km 3.000-5.500, right side
- Part 2: E134 Hp3, km 5.500-8.000, right side
- Part 3: E134 Hp3, km 8.000-5.500, left side
- Part 4: E134 Hp3, km 5.500-3.000, left side

Road safety Inspection		**Item nr.:**	23
Road number:	Road Section	Km	Direction
E134	Tuven km 5.500 - 8.000	6.594,6.647	With nr.

Description of situation	Photo 1
2 pylons in the safety zone	
	Reference to handbook:
	Handbook 231: Barrier standards

Deviation	x		Fault		Remark		
Immediate measures	x		Minor in-vestment measures		Route invest-ment measures		

Description of measure	Photo 2 - A sketch of the measure
Move the 2 tree pylons out side the safety zone - preferably on the other side of the cycle lane	

Severity			
Consequence → Probability ↓	Minor	Seriously	Very seriously / killed
Low		x	
Medium			
High			

Figure 1: An example of a filled out report from Part 2.

8.2 Road safety inspection in Austria. A13 Brenner Autobahn (km 3.050 – km 10.080), 2007-07-27

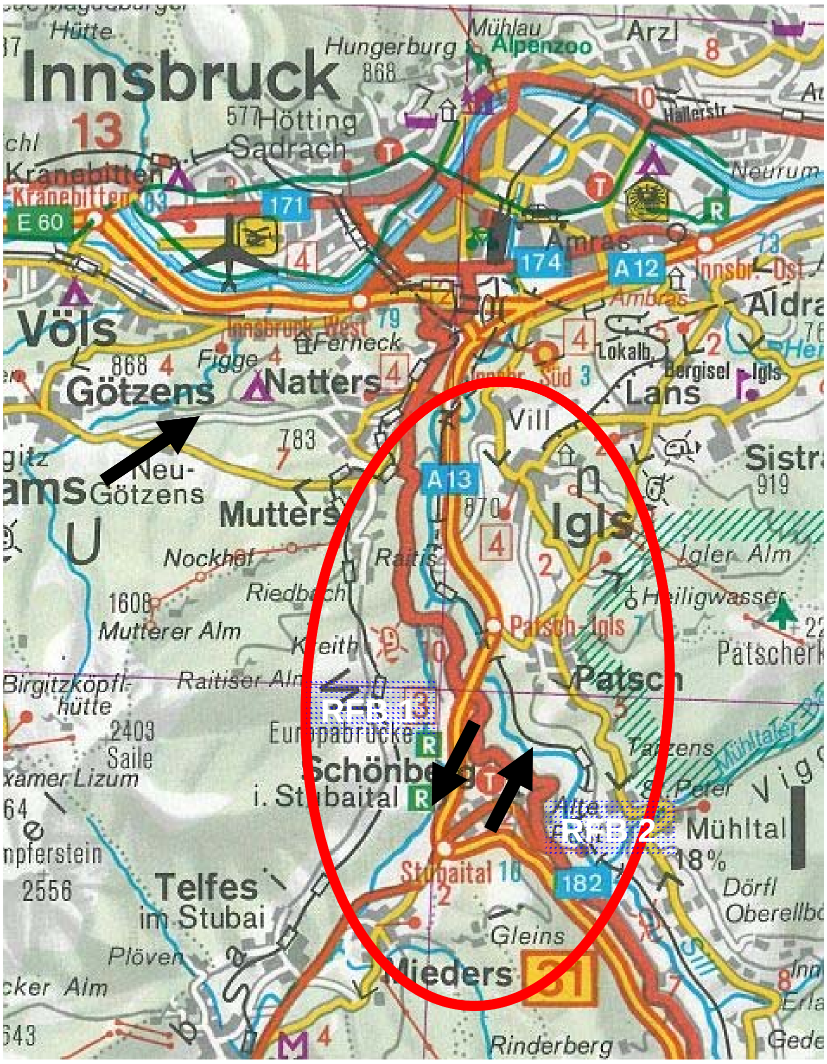
Basics

Road Safety Inspection	A13 Brenner Autobahn (km 3.050 – km 10.080)

General Information

Client:	Highways agency (ASFINAG)
Street Category:	Motorway
Section:	2x2 Lanes (2x3 at Innsbruck South)
Road Volume:	35,700 – 39,500 vehicles/24h, Heavy traffic: approx. 18-19%
Maximum speed limit:	between 40 and 100 km/h, VBA-Area
Inspection Time Frame (Accidents):	2002 - 2005
Length of Roadway:	7.030 km
Junctions:	Junction Innsbruck South (km 3.050) Junction Zenzenhof (km 4.500) Junction Patsch-Igls (km 7.180) Junction Stubaital (km 10.080)
Secondary Roads:	Heading towards Brenner: Parking Area at km 6.3
Rest Area:	‚Europabrücke' (bridge) km 8.2
Rest Area:	'Schönberg' km 9.4
Travel Direction/Roadway:	Roadway 1 = Travel Direction 'Brennerpass' Roadway 2 = Travel Direction 'Innsbruck'

Overview Map



Report Components

Findings
- o Checklists
- o Assessments

Opinion
- o Recommended Measures
- o Assessments

Findings were achieved through a combination of test-drives on the roadway under surveillance, inspection of suspicious road sites and discussions with officials form the highways agency and local police force. Furthermore, an examination of the existing survey was conducted.

Checklists

The following tables represent an overview of the inspected roadway of the inspection criteria within the context of the Road Safety Inspection.

	IST-Analysis	Safety Relevance		
	Defect	**high**	**aver-age**	**low**
A Structural Conditions				
A1 Roadway Area				
Longitudinal Section	Longer ranges with stronger gradient ratio, in contrast with emergency braking ranges.		x	
Surveyor's Plan	„Schönberg Loop“ represents inhomogeneity in route		x	
Section	Narrow section particularly within the three lane section (3x3,25m); structural separation by means of guard rails Narrower section consequently leads to increased and faster groove formation		x	
Route Planning Layout	Unproblematic during the course of the roadway (however, refer also to the Surveyor's Plan – Schönberg Loop)			x
Visibility Conditions	Visibility in the roadway course unproblematic (except Schönberg Loop). Reflectors installed on guard rails.		x	
Drainage	No problem, longitudinal gradient, diagonal gradient ok, could be a problem with other groove formations (refer to section)		x	
A2 Secondary Roads (parking places, etc.)	Many side roads, some within short distances, connection to main roadway partially without deceleration and/or acceleration lanes, with stop sign; parking lot at the end of Galerie poor visibility, lorries require more than one lane in order to enter the main roadway; dividers are somewhat poorly constructed (e.g. km 4.0 Dir. to the border, before Galerie)	x		
	High conflict potential through frequent merging and inadequate acceleration potential			
A3 Junction	Dir. Innsbruck ASt. Patsch: very narrow, barely visible, merge required on entrance ramp, no acceleration lane. Note: Sharp angle to connect to exit ramp Innsbruck South (DIR Innsbruck) at B 182, poor visibility conditions (use of mirrors advisable)	x		
	High conflict potential with unfamiliarity and inadequate acceleration potential			
B Roadway Conditions	Roadway was partially repaved in 2006; however there are already grooves visible again. Different lane roadbed between lanes (3rd lane has weaker		x	

	dimensions – could pose a problem during and/or after roadwork)			
C Road Analysis				
C1 Speed Limits	Unadjusted speed limits in the „Schönberg Loop“ lead to accidents (particularly single vehicle accidents)		x	
C2 Road Volume (passenger cars/lorries)	AADT 2005 exit Innsbruck-South till exit Patsch-Igls: 39.500 vehicles/24h exit Patsch-Igls till exit Stubaital: 35.700 vehicles/24h Share of heavy traffic: approx. 18%		x	
D Lighting Conditions	Galerie lighting (km 8.760 – km 9.645) is partially (heading ‘Innsbruck’) adapted, should be enlarged to include the entire Galerie area in 2007. Within loop range, 10 km of the route with lighting. Bright sun glare possible, however no accidents resulted there from in the ABM / ABP.		x	
E Road Technical Configuration				
E1 Road Signs / Sign-Posting	Junction signage for the most part does not conform to guidelines for three lane motorways. Signposting somewhat inconspicuous (e.g. some portions unlit in Galerie area) Road signs (distance markers, cantilever markers) somewhat poorly secured Generally many road signs, information signs, advertisements		x	
	Inadequate navigational possibilities for the vehicle operator. High probability of accidents, information overload			
E2 Road Markings	Heading ‘Brenner’: markings between 2nd and 3rd lanes poorly visible; between first and second lane have already been re-marked. Lane ending (heading ‘Innsbruck’ before the exit Innsbruck-South) is not designated by any marking, lane just ends		x	
E3 Shrubbery	No problem.			x
E4 Control Equipment (Day/ Night)	Partial short guard rail sections and/or short gaps in the guard rails; No shock absorbers located at Galerie portals	x		
	Changing boundary conditions, less support ability of the guard rails, increased number of guard rail onset pieces; Higher accident potential caused by non-security of the Galerie, high probability of structural damage accidents			
E5 Wild Life Protection	Wildlife is not a problem as per Road Authority/Executive Branch no large problem, for legal reasons each agency posts adequate deer crossing warning signs.			x
E6 Electronic Data/Signal Transmission	In operation since April 2005, with positive results		x	
F Motorway Environment				
F1 Road Direction Signage	At the time of the test drive (21.11.06) we noted sufficient signs posted for ‘Europabrücke’ in direction Brenner; advertising signs after the approach to Innsbruck South (heading ‘Brenner’, Information signs (see also road signs)		x	
	High density of road direction signage results in			

	high distraction of the motor vehicle operator			
F2 Accidents Events	Generally higher accident rate than the Austrian average, above all between Patsch-Igls and Stubaital. In almost all circumstances (dry/wet, single vehicle accidents, traffic accidents) above the Austrian average on motorways.			

Accident Statistics (Abstract)

As evident from the diagrams, the accident rate in the observed route generally falls above the average accident rate of the Asfinag routes, the highest accident rates is registered in the section between Patsch Igls and exit Stubaital.

Somewhat different is the accident recorded concerning travel direction: based on available accident data there were proportionately more accidents in the travel direction Brenner with property damage than in the opposite direction (ratio 53%: 47%), while there were more registered accidents involving personal injury in driving direction Innsbruck more accidents were registered (ratio 43%: 57%). Possibly here the difference in the driving speeds between the driving directions plays a role due to the longitudinal gradient

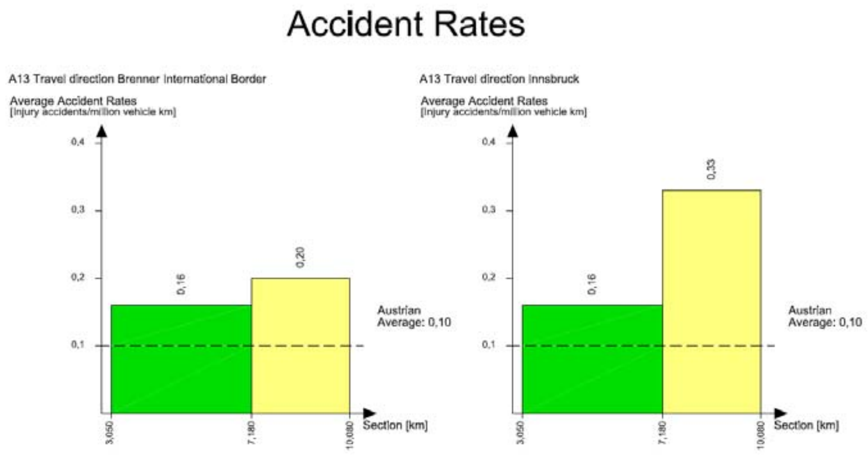


Figure 1: Accident rates on the A13, Brenner Autobahn, km 3.050 – km 10.080, 01/2002-12/2005

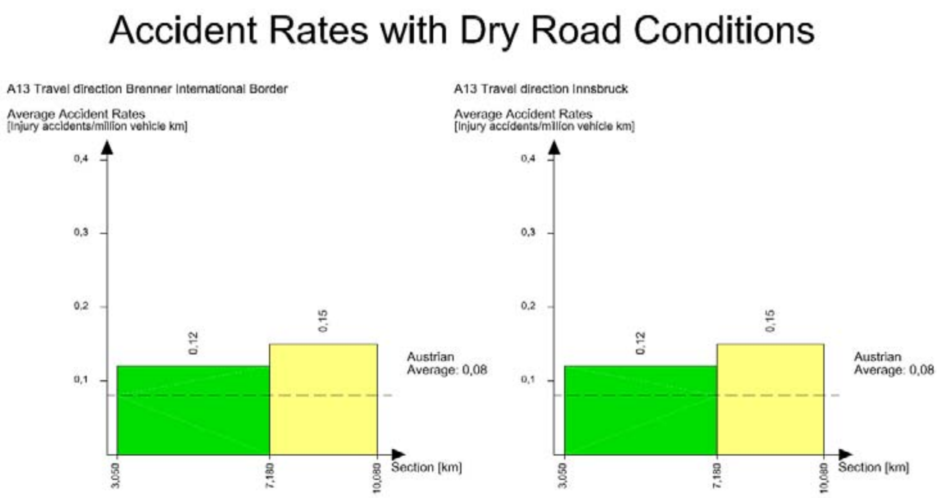


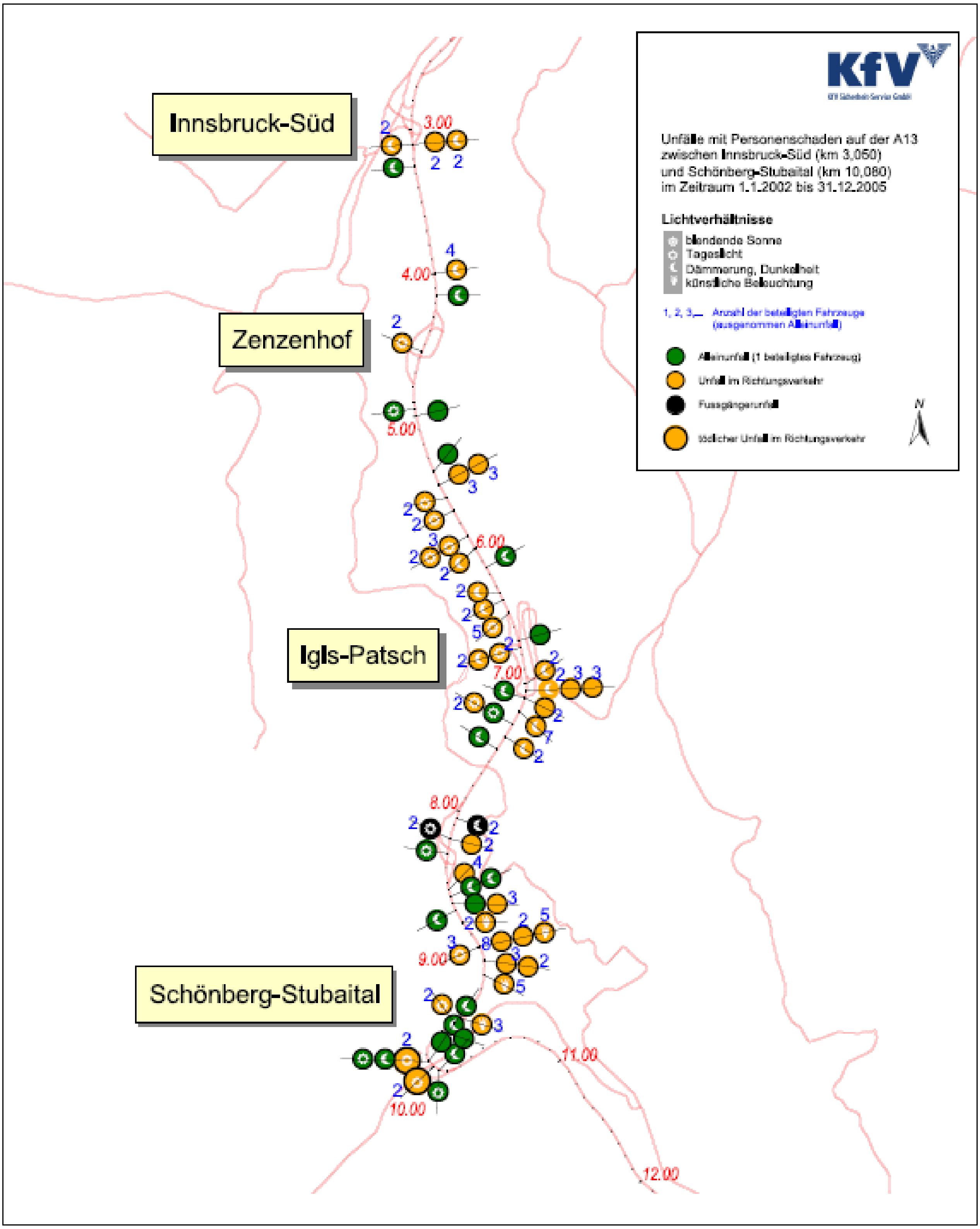
Figure 2: Accident rates on dry roadways, A13, Brenner Autobahn, km 3.050 – km 10.080, 01/2002 – 12/2005

Recommended Measures (Abstract)

A 13 Brenner Autobahn, km 3.050 – km 10.080 Recommended Measures Road Safety Inspection	**Legend**		
		(red)	High Priority
		(yellow)	Medium Priority
		(green)	Low Priority

Nr.	Local Assignment	Problem / Defect	Proposed Measures	Anticipated Improvement	Implementation		
					Short term	Standard	Long term
	Total Area	Formation of grooves visible relatively soon after reburbishment	In future refurbishments strengthen upper dimensions, examine work	If groove formation decreases, improved discharge possibility of the water on the roadway surface			x
	Schönberg Loop	Unadjusted Speed Limits	Coordinate stationary radar	Better adapted driving speed of the motor vehicle operator in unstable area	x		
	Galerie	Lighting in the Galerie	Uniform lighting for the entire Galerie, design possible adaption lighting, recommend tunnel recommend tunnel standard	Better visibility conditions, better eye adjustment to conditions before/after Galerie		x	
	Approach Innsbruck South, km 3.2, heading 'Brennerpass'	Several Poster advertisement one after the other (radio stations) in the area, in which there are also numerous signs	Eliminate	Better notice of relevant safety road signs	x		
	Europabrücke km 7.9, heading 'Brennerpass'	Advertising posters to the right side of the Autobahn, directly behind bridge	Eliminate	Fewer distractions for the motor vehicle operator	x		
	Galerie area, both headings	No shock absorbers installed at beginning of Galerie	Coordinate	Lower accident rates	x		
	Exit Innsbruck South, heading ‚Innsbruck' km 4.0	Missing road markings in driving lanes	„Fish Belly" (check surface in left lane) Coordinate to place arrows instead of "bottle neck" to signal the end of a lane.	Better information for the motor vehicle operator and better integration of vehicles	x		

ATTACHMENT: ROADWAY ACCIDENT MAP



8.3 Road safety inspection in Portugal. EN 234, Mira (km 0.0) – Cantanhede (km 14.937), 2007-05-09

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1 - GENERAL DESCRIPTION OF THE ROAD

Road Element	Initial km	Final km	Type	Observation
Node 1	0.0		Roundabout	
Link 1	0.0	1.2	Single carriageway	With horizontal curves
Node 2	1.2		Intersection	Rounded islands Minor road
Link 2	1.2	1.9		Straight
Node 3	1.9		Intersection	Circular islands Access road
Link 3	1.9	2.7		Gas station at km 2.100, left side Straight
Node 4	2.7		Intersection	No islands Access road
Link 4	2.7	3.0		Straight
Node 4a	3.0		Intersection	Circular islands Access road
Link 4a	3.0	3.4		Straight
Node 5	3.4		Intersection	No islands Access road
Link 5	3.4	3.6		Straight
Node 6	3.6		Roundabout	EM 629 (inside urban area)
Link 6	3.6	4.7		Straight
Node 7	4.1		Intersection	Rounded islands; no left turn Access road
Link 7	4.1	4.7		Straight
Node 8	4.7		Roundabout	End of urban area
Link 8	4.7	5.4		Straight
Node 9	5.4		Intersection	Rounded islands Access road
Link 9	5.4	6.5		Straight
Node 9a	6.5		Intersection	Circular islands Access road
Link 9a	6.5	7.2		Straight
Node 10	7.2		Roundabout	Access road
Link 10	7.2	7.7		Straight

Node 11	7.7		Roundabout	CM1017
Link 11	7.7	8.3		Straight
Node 12	8.3		Intersection	Circular islands Access road
Link 12	8.3	9.2		Straight
Node 13	9.2		Intersection	Circular islands Access road
Link 13	9.2	10.0		Straight Gas station , right side at km 9.7
Node 14	10.0		Roundabout	Access road
Link 14	10.0	10.3		Straight
Node 15	10.3		Intersection	Triangular islands, no left turns Access road
Link 15	10.3	10.6		Straight
Node 16	10.6		Roundabout	Access road
Link 16	10.6	11.2		Straight
Node 17	11.2		Intersection	Rounded islands Access road
Link 17	11.2	12.2		Straight
Node 18	12.2		Intersection	Circular islands Access road
Link 18	12.2	13.3		Straight
Node 19	13.3		Roundabout	Access road
Link 19	13.3	13.6		Horizontal curve
Node 20	13.6		Intersection	Triangular islands, no left turns (median) CM 1033
Link 20	13.6	14.9		Straight
Node 21	14.9		Roundabout	EN335

Shaded cells correspond to urban areas.

2 – Safety related issues

Road Element	Safety related maintenance issues		Safety Issues		
	Description	Severity; Probability	Description	Severity; Probability	Action
Node 1					
Link 1	Ditch obstructed		Possible inconsistent horizontal curve (XXV, XXVII) Safety barrier too short (XXVI) Dangerous obstacles near carriageway (XXVIII)	1 / II 2 / III 2 / II	Check consistency class & signing Lengthen New water inlet
Node 2			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 2	Holes in pavement surface (8)				
Node 3					
Link 3			Dangerous obstacles near carriageway (XXIV)	2 / II	Soften water inlet
Node 4					
Link 4					
Node 4a			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 4a					
Node 5					
Link 5			Dangerous obstacles near carriageway (XXIII)	2 / II	Remove pole
Node 6			Visibility (vehicles and pedestrians) in the approach to the roundabout (XXII) Visual noise originated by high density of traffic signs, obscuring each other (XXX) Dangerous obstacle caused by unnecessary safety barriers on roundabout	2 / III 3 / II 3 / II	Danger sign Relocate signs Remove barriers
Link 6			Inconsistent road environment: the sidewalk does not start at the beginning of the urban area (XIX). Sidewalk width reduced by trees and posts (XX). Visibility of access road obscured by building (XXI)	2 / III 2 / III 2 / III	Relocate start of sidewalk Relocate posts Check speed limit
Node 7					
Link 7					
Node 8			Dangerous obstacle caused by unnecessary safety barriers on roundabout	3 / II	Remove barriers
Link 8			Dangerous obstacles near carriageway (XIX)	3 / II	Remove small concrete sign
Node 9					
Link 9					
Node 9a			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 9a					
Node 10			Dangerous obstacle caused by unnecessary safety barriers on roundabout	3 / II	Remove barriers
Link 10	Visibility of traffic				

	signs - vegetation (6)				
Node 11	Missing STOP sign (4) Damaged safety barrier (5) Road works signing and pedestrian paths (7) Damaged sidewalk		Complex lay-out (XVII) Deficient transition between different types of safety barriers (XVI) Dangerous obstacle caused by unnecessary safety barriers on roundabouts (XVI, XVII) Visibility (vehicles and pedestrians) in the approach to the roundabout (XXXI)	3 / III 2 / II 2 / II 3 / II	- Remove barrier Remove barrier Danger sign
Link 11			Guidelines (typical for rural area) adjacent to side walk not needed in urban area – inconsistent road environment (XIV, XV) Intersecting access road difficult to perceive (XV).	3 / II 2 / III	Remove Check mirrors
Node 12			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 12			Visual noise originated by high density of traffic signs, obscuring each other (XII) Lengthened pedestrian paths (XIII) Visibility of pedestrian crossing (XIII) Sidewalk width reduced by obstacle (XIV) Inconsistency between sidewalk layout and traffic island layout (XII)	3 / II 2 / II 2 / II 2 / II 2 / III	Relocate - Danger sign Remove obstacle -
Node 13			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 13			Passing permitted near access to gas station (XXXIII)	2 / III	Mark no-passing zones
Node 14			Dangerous obstacle caused by unnecessary safety barriers on roundabout	3 / II	Remove barriers
Link 14					
Node 15					
Link 15					
Node 16			Dangerous obstacle caused by unnecessary safety barriers on roundabout (XI)	3 / II	Remove barriers
Link 16			Incomplete information in direction sign (X) Inconsistent 90 km/h speed limit (section too short)	3 / II 3 / III	Complete Limit = 70 km/h
Node 17			Deficient lay-out of intersection, due to insufficient channelling of allowed traffic movements and misleading form of traffic island (VII, VIII and IX) Bus stop inside intersection (VIII)	2 / IV 2 / III	- Relocate bus stop
Link 17	Missing panels in direction traffic signs (3)				
Node 18			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 18					
Node 19			Dangerous obstacle caused by unnecessary safety barriers on roundabout	3 / II	Remove barriers
Link 19			Safety barrier too short (XXXII)	2 / III	Lengthen
Node 20			Insufficient channelling of allowed traffic movements (VI)	2 / IV	-
Link 20	Uneven transition between paved non-		Steep embankment slope (III) Lack of visual separation between	3 / III	-

	paved shoulder (2) Ditch obstructed		traffic on two parallel roads - at night. (III) Dangerous obstacle near carriageway (IV) Safety barrier too near obstacle (XXXIV)	3 / III 2 / II 3 / II	Anti-glare screen Remove obstacle Check compliance with working width of safety barrier
Node 21			Dangerous obstacle caused by unnecessary safety barriers on roundabouts (I) Deficient transition between different types of safety barriers (II)	3 / II 3 / II	Remove barriers Remove barriers

Ratings:
Possible harm: **3 – Slight; 2 – Serious; 1 – Very serious.**
Probability of harmful event: **IV – Rare; III – Occasional; II - Frequent; I – Very frequent.**

3 – Photos (Abstract)

3.1 - Safety related maintenance issues

Photo 1

Photo 2

Photo 3

Photo 4

3.2 - Safety Issues

Photo - I

Photo - II

Photo - III

Photo - IV