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# ROAD SAFETY INSPECTION GUIDELINE

## Specific Project Result 12B

(REVISED FINAL)



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## 1 Basics about the Road Safety Inspection

### 1.1 What is Road Safety Inspection?

A Road Safety Inspection (RSI) is a systematic field study, conducted by road safety expert(s), of an existing road or section of road to identify any hazards, faults and deficiencies that may lead to serious accidents. Following the principle "**Prevention is better than cure**" the RSI makes it possible to evaluate existing road traffic facilities and to improve the road safety performance.

It is important to note that:

- A RSI is systematic – this means it will be carried out in a methodical way following a formal procedure.
- A RSI is pro-active, trying to prevent accidents through the identification of safety deficiencies for remedial action rather than react only after accidents were happen.
- A RSI relates to an existing road not roads being constructed (these constitute subject of Road Safety Audit).
- A RSI should be carried out by an independent person or team with experience in road safety work, accident analysis, traffic engineering, road user behaviour and/or road design. The persons should not involved in the regular maintenance of the road or road section.

Road safety inspections are a safety management tool that can be implemented by road authorities as part of an overall road safety management.

RSI goal is to find out potential problems and propose sufficient countermeasures to reduce the number of accidents or minimise the accident severity. This in turn will lead to reduced costs associated with accidents, to individuals, families and society.

After some years of experience with the Road Safety Inspection all over the world – like in South Korea, Romania, Germany and Vietnam - this procedure is approved as one of the most important and effective engineering tool in our hands in order to improve road safety.

With its Directive No. 2008/96 on Road Infrastructure Safety Management – published in October 2008 - the European Union made a clear decision the Road Safety Inspection will be mandatory for trans-European Road Network in the next years. In the mentioned Directive the RSI is part of a package of the following road safety measures like:

- Road safety impact assessment,
- Road safety audit for the design stages of roads,
- Safety ranking and management of the road network in operation (incl. management of high risks road sections)
- Road safety inspections for existing roads

- In-depth accident analysis.

The introduced measures are an integrated part of the road safety management:

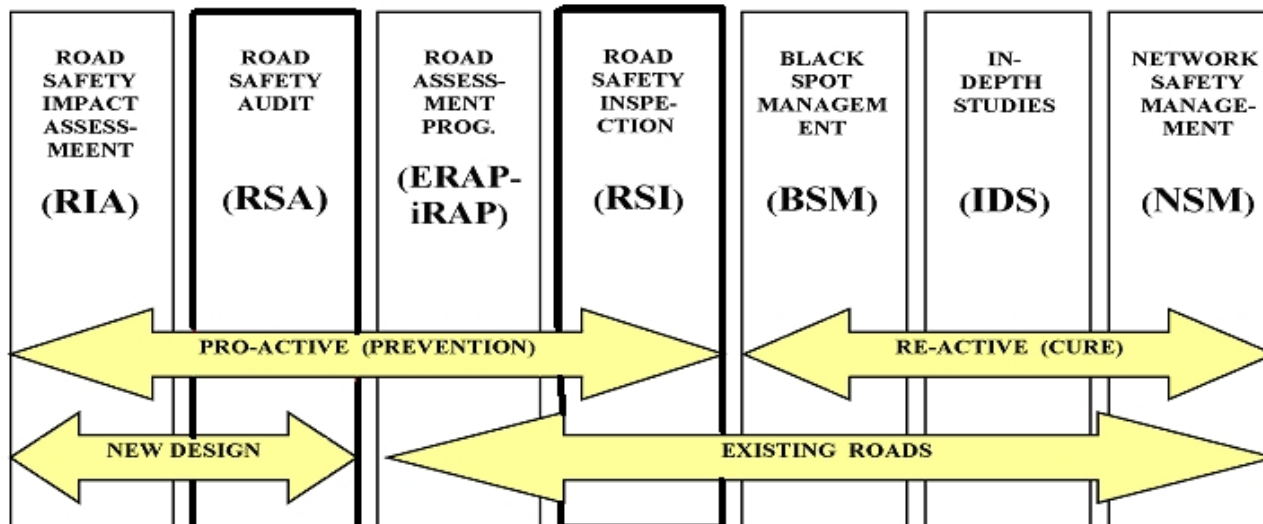
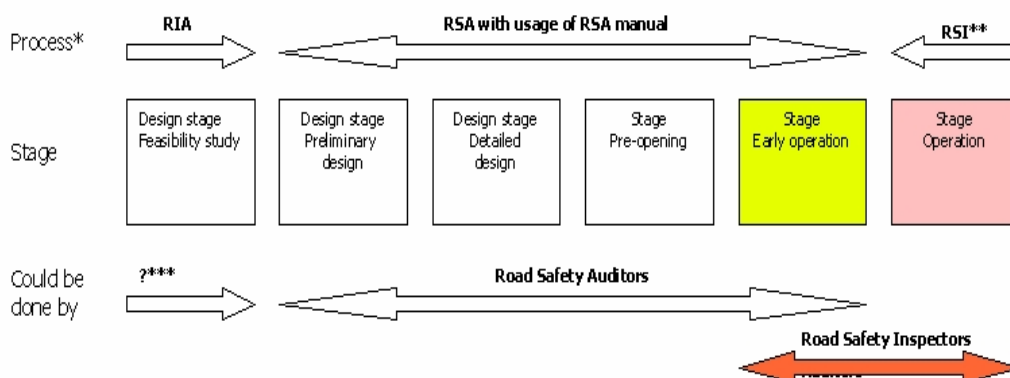


Figure 1.1.1: The Road Safety Inspection as part of the Road Safety Management

As part of the road safety engineering the Road Safety Inspection (RSI) has a strong relationship and a lot of similarities with the Road Safety Audit.

The similarities and differences of both procedures is explained in the following picture:



\* according to the definition EU directive No. 2008/96

\*\* Road Safety Inspection (RSI) with usage of RSI Manual

\*\*\* Part of the Feasibility Study – assistance of Auditors possible

Figure 1.1.2: The RIA, RSA and RSI – stages and responsibilities

The Road Safety Inspection (RSI) provides a supplementary, pro-active approach to safety countermeasures in road engineering.

The essential principles of the RSI are:

- Interdisciplinary detailed analysis of the road and the road environment;
- Identification of possible accidental risks;
- Analyses of the condition of drivers perception and quality of guidance;
- Formal check of the performance of road equipment like safety barriers etc.;
- Accordance of the local condition with guidelines and norms.

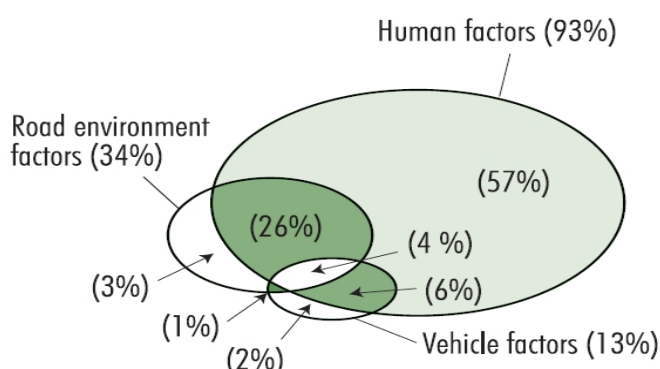
The outcome of a RSI is a formal Report, which identifies any road safety deficiency and if appropriate, makes recommendations aimed at removing or reducing the deficiencies.

A variety of different kind of traffic facilities can be inspected: motorways, interurban highways, urban roads as well as facilities for pedestrians and bicyclists etc.

## 1.2 Why Road Safety Inspection?

The number of severe accident in the SEETO Region is unacceptably high. One reason for this situation is that the existing network is partly not suitable regarding its road safety performance. Often the roads were designed and constructed some decades ago for less amount of traffic and a slower car fleet. In addition, in rehabilitated road sections the number of accidents is maintained high because improving road safety was in most cases not in the priorities of the project.

It is a popular misconception that the faults or bad behaviour of a driver are alone in almost all cases the cause of road traffic accidents. As result of a basic research project, it is evident that in every third accident the road environment has some considerable influence.



**Figure 1.2.1: The contribution of accident factors**

Source: J. Treat et al, *Tri-Level Study of the Causes of Traffic Accidents*, 1979, Washington DC

RSI is an approved tool to improve the road environment factors. With the inspection expert knowledge and with systematic RSI, it is possible to reduce the number and the severity of traffic accidents by improving the road safety performance of existing roads.

## 1.3 Benefits and Costs of Road Safety Inspection

The purpose of a RSI is to pro-actively manage safety by identifying and addressing risks associated with road safety deficiencies.

The benefits of RSI can be summarised as follows:

- To identify potential road or traffic safety concerns for all road users,
- To minimize the risk and severity of road accidents that may result from the existing situation of a road section,
- To minimize unsustainable losses to health and economy,

To be effective, treatments must be identified and implemented as a result of the RSI. Research by Rune Elvik shows significant expected accident reductions as a result of a road safety inspection and associated remedial works. Examples include:

- Correcting incorrect signs: 5 - 10% reduction,
- Adding guardrails along embankments: 40 – 50% reduction
- Providing clear recovery zones: 10 – 40% reduction
- Removing sight obstacles: 0 - 5% reduction

As we can see, the above constitute “low cost measures” which are typically included in a proposal of the RSI report for short and medium term implementation.

Although, it is not always easy to quantify precisely the economic benefits of RSI, there is strong evidence that such inspections are highly cost-effective. With the introduction of some typical measures like the ones mentioned above, it is possible to save lives. Obviously, even saving of only one human life per year in an inspected road section, the resulting benefit of the RSI would be much higher than the relevant cost.

#### **1.4 Road Safety Inspection and Accident data**

A RSI does not require accident data. Therefore, the RSI have big advantages in cases with no reliable accident data. It is a systematic review of a selected road or relatively long section of a road, regardless of the number of accidents. The traditional road engineering approach to safety has very often been some kind to “wait and see” approach, i.e. safety countermeasures are not considered until the accident situation becomes unacceptable. After the identification of high risky road section and the analysis of the accident situation countermeasures will be designed and implemented.

But the RSI process is systematic and not only focused on a particular high risky road sections which are identified by accident data or sometimes only by anecdotal accident or incident information from local police or local residents. An RSI is using experts experience during the field study and the support by detailed check lists. The RSI output is a detailed analysis of the problems and the proposal for sufficient countermeasures. RSI's aim to identify any risks that may lead to accidents in the future, so that our remedial measures may be implemented before accidents happen.

Road accident data can provide some additional guidance in terms of prioritising which roads should be inspected. The knowledge about the number and kind of accidents can help to organize the RSI in an effective way. For example when the road administration introduce RSI, it is recommended to start the RSI along the most risky road sections with bad accident records. On the other hand if data shows one type of accident occurs very often the RSI could focus on circumstance which leading to that type of accident. Some examples: a high number of accidents with pedestrians in built up areas could be a result of missing sidewalks and crossings facilities as well as speeding of the drivers. The RSI team should have a focus to the local conditions. In the case of run off accidents as typical accident type in curves the RSI should especially check out the situation regarding the superelevation, skid resistance and optical guidance. The information from Road Safety Network Management tools or a previous first investigation with computerised assessment programs like iRap can also provide valuable information in terms of selection of roads for inspections.

### 1.5 Inspections and maintenance

In every SEETO participant a road maintenance system is installed. In some cases a special Road Inspectorate is responsible for a periodical check of the roads in the network. But the RSI is not related to routine maintenance. The tasks of maintenance units and Road Inspectorate is to deal with key infrastructure issues such as overhanging branches, the road surface, potholes and poor quality signage are reviewed and remedied. The tasks of the regular maintenance can be carried out by people who do not necessarily have road safety experience but are simply following a planned process.

The RSI will help to increase the efficiency of the maintenance work. The RSI's can identify safety deficiencies that are sometimes a result of poor maintenance, for example poor signing and line marking or visibility issues caused by vegetation. The RSI is a formal and systematic field study with the focus to the road safety, the content of this procedure exceeds the content of the work of the Road Inspectorate and the maintenance units. On the other hand it could be possible to have manifold cooperation with the Road Inspectorate and maintenance units e.g. to invite them to RSI as guests or to have an exchange of basic information. In addition is everything very depend on the capacity building of the Road Inspectorates and therefore it could be necessary that they should focus the activities to their existing tasks.

### 1.6 Inspections and Human Factors

All inspections should take into account a range of human factors which relate to driver errors that are induced by the road. In the last decades traffic psychologists have done a lot of basic research which we are using in our design guidelines and accident investigations. For example typical issues that should be investigated include **strain/workload** issues (either a very low or very high level of "workload" leads to a poor quality of driving e.g. a changing landscape rather than a monotonous landscape could assist in keeping drivers awake, or multiple signals/signs and events at one location can overwhelm the driver and lead to confusion), **perception** (illusions can lead to incorrect estimation of speed, direction, curves) and **choice of speed** (this is mostly an automatic process that depends on different factors that include the road geometry and surrounds). Some question in our checklists are especially related to the Human Factors.

## 2 What should be inspected?

### 2.1 Area of Application

This **Manual** for **ROAD SAFETY INSPECTION** of existing roads is applicable for roads, motorways and other road traffic facilities inside and outside built-up areas.

Any road can be inspected, but a road authority may wish to prioritize for some reason, including funding restrictions. The prioritization could be based on the role of the road, location, traffic volume, network management tools or accident data.

### 2.2 The basic topics of RSI

The following key areas relating to the road should be investigated during a RSI:

- **Function**

Is the road suitable for its function in the network (does it have mixed functions, are speeds limits appropriate, are there any impacts from land development, problems with accesses to private properties)?

- **Cross section**

Is the road wide enough and is the number of lanes sufficient for the traffic using it, is the marking sufficient, what are the surface conditions, are the shoulders adequate but not too wide, is drainage from the road adequate, is the pavement in a suitable condition, separation of vulnerable road users?

- **Alignment**

Is the alignment consistency regarding the curve design, are sight distances adequate?

- **Intersections**

Are intersections appropriate for the traffic volumes, are there traffic signals and are they sufficient? Also need to look at local accesses to private properties and railway crossings.

- **Public and private services, service and rest areas, public transport**

Is there sufficient space and acceleration/deceleration lanes into the **Service and Rest Areas**, how is access controlled to other services such as schools, hospitals, supermarkets, restaurants etc. Should also look at parking and loading facilities and **Public Transport** facilities e.g. **bus stops**. Is there sufficient and safe space for waiting passenger?

- **Vulnerable road user needs**

This topic includes the needs of pedestrians, bicyclists and powered two wheeler. This issues are important because of the often serious consequences of accidents with this kind of road users. Furthermore it is realistic that the number of bicyclist and powered two wheelers will be increase in the next years.

- **Traffic signing, marking and lighting**

Is the signing and marking appropriate and clear, is lighting adequate or is it needed?

- **Roadside features and passive safety installations**

This complex of questions includes the safety related question about bridges and other civil engineering structures, about obstacle along the road and about the passive safety installations?



### 3 When should RSI be carried out?

#### 3.1 Key causes to start an RSI

An RSI can be started when:

- A road section or intersection is already identified as a high risk road section, e.g. according to the accident database, or iRap,
- There are other information about serious safety problems given by Police, Maintenance Unit, Court or local administration like city hall etc,
- A reconstruction or rehabilitation project is planned by the road administration in the near future, the RSI should identify the specific needs regarding the road safety,
- It can be started also as a periodical task according to the "RSI time schedule" for a road section

#### 3.2 Other considerations

At least the following issues need to be considered as part of the inspection process:

- **Time of inspection** - it is recommended that inspections take place both during the day and at night. This is important so the Inspector(s) can focus on issues that are specific to night such as checking if traffic signs and line markings are still visible at night time. An analysis of the lighting along a road or at an intersection should be undertaken to make sure it is suitable for all road users. The night inspection would be very important especially in the case of a high percentage of accidents during the night. When the RSI is done in a team the night time inspection can be done by only one qualified team member alone.
- **Seasonal variation** - it is also suggested that consideration be given to inspections in different seasons if the seasons are vastly different e.g. snow in winter and very dry and hot conditions in summer. It is possible to use knowledge about seasonal variation of accident to decide about the best moment for RSI.
- **Site specific matters** – should be taken into consideration. For example if the road passes a school for example, the inspection should take place partly when school children are arriving or leaving the school.

#### 3.3 Frequency

This Manual demands that the RSI become a routine process, carried out at regular intervals. This regulation follows the article 6 of the DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL No. 2008/96 ON ROAD INFRASTRUCTURE SAFETY MANAGEMENT a sufficient frequency of RSI is demanded. Design features such as cross sections and alignment may not change for many years but may have to be adapted to changing functions, traffic amount and composition. While no exact timing is recommended, a timing at **least every five years** is recommended with this Manual.

But we should bear in mind that other road elements can change more often. If road conditions are known to have changed e.g. new signing and/or markings, lighting and surface conditions, a focused or specific road safety inspection limited to these topics can be carried out by the road administration. If there was no Road Safety Audit for these measures done (maybe because there

were a part of maintenance activities), additional RSI are essentially checking the mentioned works undertaken to make sure no errors that can lead to accidents have been made. Examples could include wrongly installed traffic signs and markings. These specific road safety inspections would occur at additional irregular intervals depending on how conditions have changed.

Inspections could also be conducted if a one-off project such as relevant changes in the adjacent network like new motorways with new link roads or the building of a new shopping centre occurs. Such a project could affect road safety in terms of issues such as remarkable changes of traffic volumes, increased number of pedestrians and vehicles, parking issues and increased presence of trucks.

## **4 The Inspection Process – How to perform a RSI?**

### **4.1 Overview**

As it is mentioned above, the RSI can be instigated as part of the safety management of the road network. The first decision is to determine the extent of the inspection by defining the start and end points of the inspection. Generally this will be a road from start to finish (i.e. between well defined major intersections) but it could also be a section of a road, of a reasonable length). This will be outlined in an agreement between the parties involved in the inspection, usually the road authority (owner), a Road Safety Audit and Inspection Unit (RSAIU) and the Inspector or inspection team. The written agreement will describe what to inspect, who is paying for what, timelines and deadlines, what the local agency should contribute with and so on.

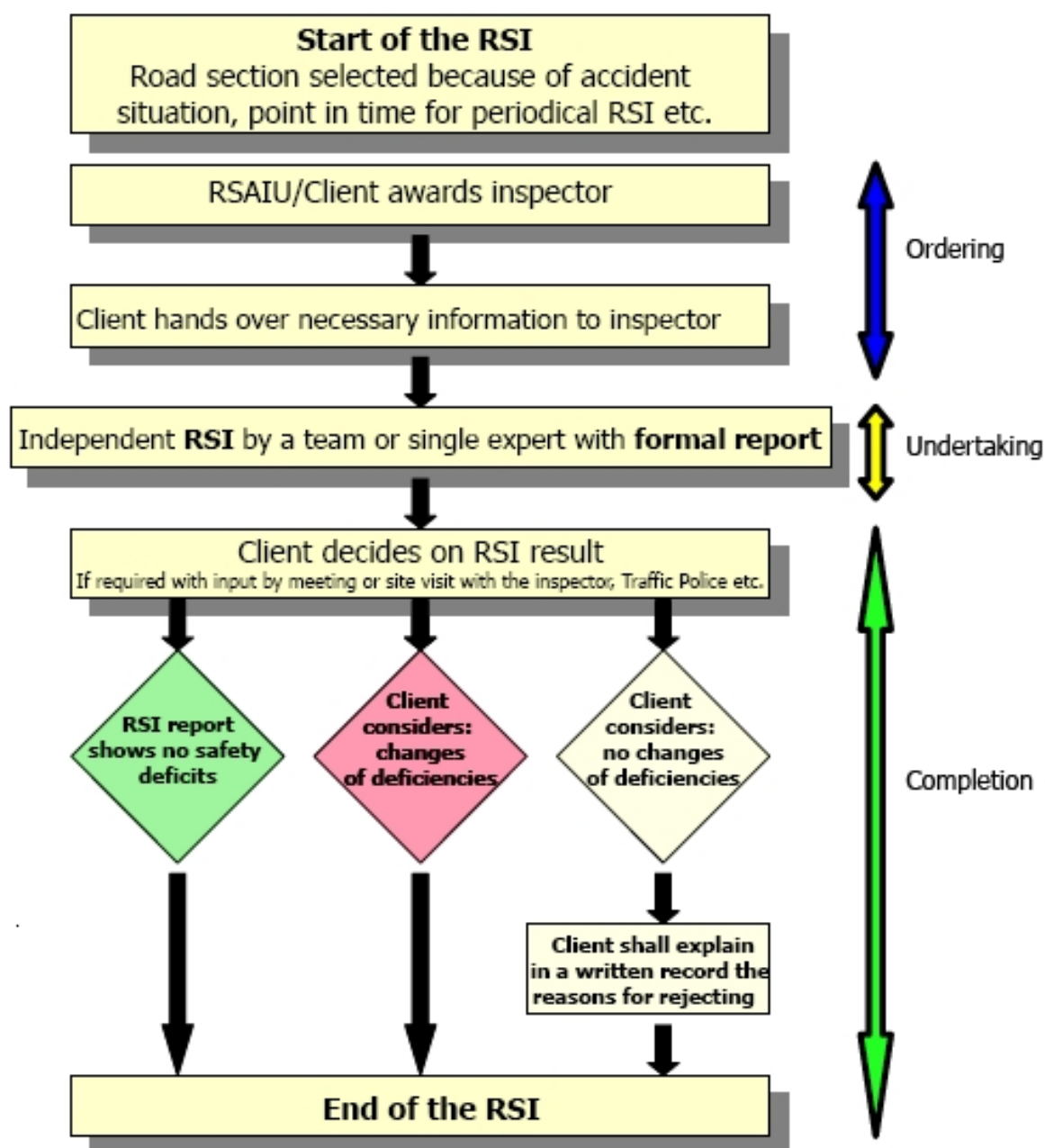


Figure 4.1.1: The RSI workflow (main steps)

For the practical procedure of the Inspectors work we introduce the following FOUR steps:

#### STEP 1 Preparatory work in the office

#### STEP 2 On site field study

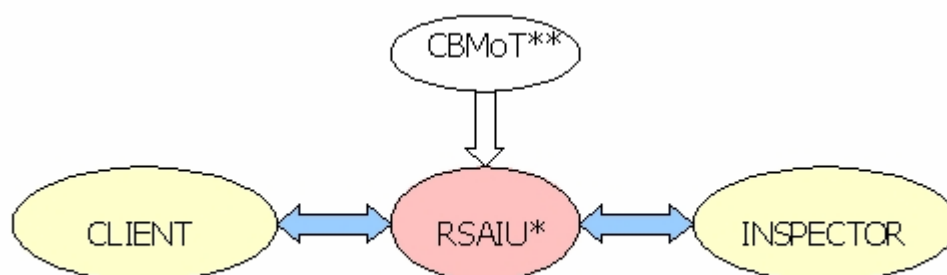
#### STEP 3 RSI report

#### STEP 4 Remedial measures and follow-up

It should be noted that Step 4 may be considered as two separate processes – the first is the implementation of remedial measures, while the follow up is likely to be some time later to evaluate the impact of the countermeasures.

## 4.2 The partners in the RSI process and their roles

The Client (usually the Road Authority or private road operating company) and the Inspector (or team of Inspectors) participate in the audit process. The process is supported and monitored by the RSAIU.



\* Road Safety audit and inspection unit (usually unit in the road administration)

\*\* Controlling Body in Ministry of Transport CBMoT

**Figure 4.2.1: The partners in the RSI process**

The **Client** is the institution (typical the Road Administration) which is responsible for the road safety in his network. It is the Client's full responsibility to ensure that inspection demands will be obeyed and will start as soon as possible the proposed improvements. It is also the task of the Client to organise the necessary investments for the implementation of the results of the RSI.

The second component in the system is a special **Road Safety Audit and Inspection Unit**. **This could be organized as part of the road administration – RSAIU and a controlling body in the level of the Ministry of Transport – CBMoT. Another solution is to delegate this task to a National Road Safety Agency or Institute. However, this component will assist in the RSA /RSI procedures.**

The **Inspector** is the independent road safety expert, a team or organisation who will conduct the RSI. The expert is responsible to conduct the RSI carefully with the focus to the viewpoint of the road safety. With a formal written report the Inspector shall present the findings, the deficiencies and references.

The Inspector will use his expert knowledge regarding the best practise in the evaluation of existing situation. It is crucial that the Inspector have profound experience in road design and construction as well as road safety engineering and accident analysis. To ensure the quality of the RSI Inspectors shall undergo an initial training in the award of a certificate of competence and should take part in periodic further training courses. Where RSI are undertaken by teams, at least one member of the team shall hold a certificate of competence. It could be also sometimes helpful to have experts from the local Traffic Police in the inspection team.

### **Order the RSI**

Usually, the decision to Inspector is taken by the Client (Road Administration or Road Authority). But it may be regulated by Ministry decision or by law as well as by the financing donor.

### **Selecting the team**

The Client commissions the Inspector, who can either be an individual or a team. Ideally, it should be a team with different skills appropriate to the project. One person in the team should be appointed as the team leader to manage the team and the process. A list of potential Inspectors compiled by the Client can be helpful for the selection process.

It is important to consider including members with experience regarding all aspects of facility maintenance including signage, lighting traffic controls, vegetation, snow removal etc. It may be useful to include a Police Officer who is experienced in road safety and accident investigation.

## **4.3 Preparatory work in the office**

Background information about the road, the function of the road, the road standards and the traffic volumes should be obtained as a first step. Information from local residents might prove useful and can be obtained through face to face discussions or a questionnaire. The list below provides information about the sort of questions that should be asked and the answers recorded during the preparatory work:

### **Road function**

- Describe the function of the road, is it a national or, regional road?
- Is the road a school bus route?
- Does the road pass through any towns or villages?
- What kind of vehicles traffic uses this road?
- Is it long distance or short distance traffic, or maybe there is a mix of different kinds?
- What about heavy vehicle traffic? Is the proportion more or less than other similar roads?
- Is the road a part of a special freight route (e.g. dangerous goods)?
- Do vulnerable road users, such as pedestrians, bicyclists ore powered two wheelers, use the road?
- If the road passes through agricultural areas, are there slow moving vehicles along the Road?

## **Traffic situation**

Important information for the RSI are:

- The traffic volume (AADT if possible for the last 5 years)
- Traffic composition (trucks, busses, vulnerable road users)
- Any traffic volume prediction for the road

## **Road standard**

- Describe the road standard in general and how it relates with the road function, traffic volume, types of junctions and intersections, speed limits, etc.
- Analyze the speed limits. Are they reasonable for built-up areas, presence of vulnerable road users, especially children, elderly and disabled persons, the alignment of the road, etc?

The relevant guidelines and regulations need to be available at least for the office work. If possible, reasonably detailed maps or drawings or the usage of satellite maps (e.g. Google earth) or any aerial views could be helpful. Printouts of this documents should be used as an instrument during the field-study but also as support for presentation of the results of the inspection. One of the most important parts of an RSI is to accurately indicate where particular problems are located along the road to give the right recommendation for remedial measures. The method of identifying concrete locations has to be determined at an early stage.

Different methods can be used:

1. The coordinates measured by GPS-equipment and registered in a GPS device or hand held computer.
2. The mileage from any km-posts.
3. The odometer of the car used during the field-study.
4. The distance or the coordinates measured on the map or the drawing.
5. Easily identified landmarks or reference to video footage.

The method 1 was tested during the RSI pilots and is recommended as the most convenient and accurate when the equipment is available. In addition some sketches and the digital pictures and movies are helpful in the reporting and discussion with the client.

For the RSI the following personal and technical equipment should be organised:

1. Maps, any drawing of previous projects
2. Water level to check the cross fall and super elevation especially in curves
3. Tape measure/measuring wheel
4. Digital camera (for pictures and on request short film sequences)
5. Aerosol can for marking specific spots
6. Some form of recording e.g portable computer, tape recorder
7. Paper and pencil
8. Stop watch if you wish to record vehicle speeds, headway gaps and traffic flows
9. Optical distance measuring tool
10. A handhold speed gun (radar pistol) may be helpful too
11. Checklist
12. Warning/safety vest or jacket – to be worn during the inspection so that Inspectors are visible to road users
13. Yellow blinking light for cars and blinking torches for inspection at night
14. Suitable clothing for the actual weather condition, stable boots
15. A letter of comfort is recommended, if officials or residents will be asking

Furthermore the following data should be organised:

1. Traffic data for all kind of road users
2. Accident data
3. Data from Traffic Police about typical traffic offences in the road section
4. Information about investments in the adjacent surrounding e.g. for through road section like planned shopping centre, new hospitals etc.

#### **4.4 Field Study**

Before conducting the field study, the Inspectors should clear with the Client and the Traffic Police which kind of safety equipment is necessary. This is of course depend on the kind of road, higher safety standards are necessary for an RSI on a motorway. At least the vehicle used to get the Inspector or inspection team to the site and for use during the inspection should preferably have flashing/warning lights. If team members are from the Road Directorate or Traffic Police it could also be helpful to use an official car. Inspectors need to take care, not only wearing a safety vest, but also ensuring they take all necessary precautions such as standing behind guardrail if it is provided or standing as far away from traffic as possible.



Additional safety equipment is typically necessary on motorways and similar high speed roads. There could be a need for a temporary closure of one lane according to the regulation for temporary working zone in the SEETO Participant. Some sort of warning signage could be placed on the road being inspected and on roads that intersect this road. For a reliable inspection report the inspection should be made both by car and on foot where needed and incorporate both sides of the road and roadsides. The road should be driven a number of times if possible and photographs taken of specific issues.



**Figure 4.2.1: Example – using warning vest and support by traffic police**



**Figure 4.2.2: Example – field study of the RSI team**

When an intersection is included in the road to be inspected it is necessary to inspect part of the intersecting road as well (at least the approaches), including both by vehicle and on foot.

Site inspections should be undertaken under the range of traffic and environmental conditions likely to be encountered. Like it is mentioned before both night time and day time inspection are essential to appreciate the situation. It may also be necessary to view the location at other times of the day (e.g. after school finishes, during peak hours, weekly road trade market).

When conducting the RSI the Inspector must place himself in the position of the various road users (motorist, cyclist and pedestrian) so that he can judge the traffic safety of the construction from the viewpoint of all road users.

The on-site field study should start with the description of the surrounding. It is necessary to describe the local situation (rural, urban or suburban and a description of what surrounds the road - forest, agricultural area, built-up area etc.).

The road safety Inspectors should observe the traffic flow and document traffic incidents which could easily lead to accidents in specific traffic compositions. If there is obviously a problem with speeding the team could measure the average speed (e.g. with speed guns).

In the core part of the RSI the deficiencies on the road should be detected that may cause accidents or could have an influence on the severity of accidents.

The checklists Annex 1 will help to detect deficiencies in a systematic way. Some typical deficiencies from the pilot phase of the preparation of this manual are collected and illustrated in the following Chapter 5.

#### 4.5 RSI findings and report

The RSI team or expert should note the detected problems in the report. It is useful to sort the findings by importance, relevance and kind. The report is delivered to the RSAUI and to Client via RSAUI. The report should clearly describe general information like the inspected road section and the inspection team members. The road safety deficiencies should be explained and the Inspector should make recommendations about stepwise measures to improve the situation.

It is very important to write down findings on any working documents and these notes must be kept as evidence. Also the checklists can be helpful as working document in that way. In the last row "comments" the Inspector could make remarks in case the Client will be asking for some explanations at some later stage. Also in the case of findings which are finally not relevant and not part of the formal report would be helpful to indicate them there.

The RSI report should be made up of an introduction, three parts and appendices with maps, pictures and illustrations as necessary.

The **introduction** part should include details of the road or section of road being inspected and the composition of the inspection team, date, times and conditions at the time of the inspection.

**Part A** should outline the background data obtained during the preparatory work in the office and a description of the activities undertaken.

**Part B** describes the shortcomings or deficiencies which were found and an assessment of these deficiencies. It should contain the completed investigation form and the documentation with pictures. The part B should be finished with a conclusion about the findings ("Assessment of deficits")

**Part C** should contain proposals for countermeasures, from short to long term.

A typical table of contents on a RSI report would be:

1. **Introduction** including details about road being inspected
2. **Part A.** Project data (road function, traffic situation, road standards, surroundings)
3. **Part B.** Investigation results with the deficiencies, the content should be sorted in formal way the rubrics in the checklist
4. **Part C.** Proposals and options for counter measures – short term (e.g. low cost measures which could be done from the maintenance), medium term (e.g. small investments like adding guardrails) and long term (larger investment).

**In an appendix** Maps and Illustrations (in order to clarify the results, different kinds of illustrations may be used including photos and sketches of countermeasures, locations need to be specified) as separate Annex or could also include in the Part B.

The Road Safety Inspection Report should propose and discuss a range of countermeasures. The safety effects of the alternative measures should be taken into consideration. The Inspector should conduct an internal check whether the proposed measures can cause any negative effects.

It is helpful to estimate the costs for the alternative countermeasures. In that way a ranking of remedial measures could be made for example on the basis of a Cost/Effectiveness ratio. Also the efforts in respect of the time that is needed to realise the measures should be taken into consideration to prepare challenging but realistic proposals. The Inspector should use his personal expert experience and knowledge about the best practice and the local circumstances.

The proposed measures will be helpful for the Road Administration to prepare an investment plan for the necessary stepwise investments to improve the situation.

#### **4.6 Completion of the RSI**

Upon receipt of the report, the Client must consider the indicated problems and proposals and make a decision on how and if he will implement the proposed measures.

##### **Completion meeting**

A clarifying meeting between the Client and the Inspectors could be helpful to discuss the inspection result. The responsible officer from the RSAUI should also be invited. It is important that the inspection team leader and representatives from the road administration (Client) are present so that both parties can clearly understand the issues raised. It can also be helpful to invite to the meeting officers from the Traffic Police.

##### **Response to the Inspection report**

The Client reviews the formal RSI report and considers the indicated problems and proposals. The Client decides finally whether recommendations are to be adopted or not.

All recommendations must be given due consideration. Those that are accepted should be implemented stepwise and the road administration should provide an investment plan for the measure.

Problems identified that are considered to be insignificant, outside the terms of reference or that solutions recommended are not considered suitable, must be addressed by means of a formal response. It is important that this formal response gives reasons why the recommendations are not accepted. This response acts as an evidence trail through the decision making process.

The written response to the audit report will become part of the project documentation.

In cases the rejection of the inspection results by the Client with serious disadvantages for the road safety, the auditor shall inform the RSAIU in a written way and can ask CBMoT for arbitration.

#### **4.7 Remedial Measures and Follow up**

Very important and sufficient will be the foreseen periodical RSI in the core network. That will guarantee an effective way for a serious follow up.

In addition it could be helpful to have some studies at a later time to evaluate the effects of the remedial measures. The Road Administration could organise such studies for example with the support of Universities. Behaviour studies should be made in the same way and in the same positions as during the investigation. Traffic volumes and speeds should be checked, as well as the traffic environment.

## 5 Typical Safety Deficiencies

### 5.1 General

Much valuable information can be gained from studying the crash patterns on different types of roads. In the last decades a lot of different scientific research was done all over the world, the results were published and are in use as basis for better design standards and guidelines of roads to improve safety. Furthermore, ongoing research can also be a source of information on potential safety deficiencies and improvements, even when this research has not yet been introduced into the relevant technical standards and specifications. We use the results of the road safety research to propose effective measure to rectify the identified safety problems.

This Chapter can not attempt to describe all the factors of a crash that are directly related to design issues but focuses on the primary characteristics of a crash that are particularly applicable to a specific road type and high risk sections ("black spots"). Important deficiencies that can have a critical effect on both number and severity of crashes are also included.

Like for the Road Safety Audit the most important proposition for the RSI is:

**Humans make mistakes: minimise the opportunities for errors in road traffic! If mistakes are still made, minimise the consequences!**

The RSI should be conducted taking into consideration the point of view of every kind of road user.

As it is shown in Chapter 1.2, road users and their behaviour are at least one contributing factor in a large proportion of accidents.

We should keep in mind that our traffic facilities must give to all drivers a clear picture about the situation of road design, signs, markings etc. and should be assisting them to make the right decisions and actions in the right moment. That means to think always about the so called "Human Factors" in the design and audit process and to ease the demands on the drivers and to avoid "overloading" when using the road.

Therefore we should always avoid:

- Excessive speed differentials,
- High absolute speed,
- Differences in direction,

- Unpredictable situations.

To improve the road safety we should try to warn the drivers in the case of unusual situations, to inform about changes regarding the road conditions, to give the driver guidance in the case of conflict points or sections. To minimize the consequences in the case of accidents we should follow the principle of the error forgiving roadside (obstacle free zone etc.).

We should try to avoid surprises and confusion that means the road must follow the expectations and experience of an average driver. That includes a harmonised way of signage in the network and the usage of similar solutions for similar situations. It is of course often difficult to improve a highway which was constructed long time ago and situations can mostly not be compared with modern highways. An overall improvement would lead to a solution with a complete new highway with high costs, time consumption for preparation etc. Because this way is not a realistic solution we should find arrangements to improve the existing traffic facilities.

## 5.2 Typical deficiencies

This Chapter does not replace a comprehensive analysis of road safety within the framework of the safety inspection, but it does provide some structure for using the checklists with all necessary questions for a RSI contained in the Annex 1.

In the following sections, some very typical examples of road safety problems in connection with the typical accident risks are collected.

Furthermore a collection of typical examples of the RSI pilot with relevant comments is content of the Annex 4.

### • Road function

A typical deficiency of existing roads is a lack of conformity of the function of the road in the network with high traffic volumes and the existing usage with mixed traffic. This situation can be found in through road sections of linear villages, towns and also in urban main roads. This leads to conflicts with vulnerable road users. The interest of the long term traffic is to pass a road section as fast as possible. On the other hand, we can find often large number of pedestrians with insufficient or unorganised crossing facilities and a lack of pedestrian walkways. These deficiencies will lead to accidents involving pedestrians.

Sometimes existing speed limits in urbanised areas are not sufficient, at least in sections with a high number of crossing pedestrians a legal speed of 50 km/h could lead to accidents. In addition often speeding is a serious problem because high speed kills.

The faster the speed of a vehicle, the greater the risk of an accident in built up areas. The forces experienced by the human body in a collision increase exponentially as the speed increases. The problem is that exceeding the speed limit by only 5 km/h in the wrong place can be dangerous for vulnerable road user, crossing pedestrians can be killed. If the speed of a car is higher than 45 km/h when hitting a pedestrian, there is almost no chance for this pedestrian to survive.

As the pictures illustrate, footpaths for pedestrians sometimes are either non-existent or completely occupied by shops, stalls, garages, restaurants, construction materials, or parked motorbikes. Pedestrians are forced to walk on the road itself which can be dangerous where there is traffic including cars and trucks. This situation is even more dangerous in areas where there are linear

settlements along the major roads and pedestrian fatalities particularly are a major cause for concern.

The pictures that follow are an illustration to the mentioned deficiencies.



**Figure 5.2.1. Intensive mixed function along a through road section of a long distance highway**



**Figure 5.2.2. Highway with high traffic volume is crossing a village**

#### • Cross Section

Head on collisions occur for a variety of reasons, but on some occasions a poor road cross-section can contribute. Head on collisions in interurban section have often terrible consequences because the speed of the vehicles is high. Illustrated below are two cross-sections that have the potential to lead to **head-on collisions**.



**Figure 5.2.3. Four lane express road without separation and a high number of access to adjacent areas**



**Figure 5.2.4. Two lane highway with unsafe width of road**

The picture 5.2.4 shows a two lane cross section with about 11 m width of carriageway with 2 m wide emergency lanes/hardshoulders on both sides. The pictures 5.2.3 is showing a four lane road cross section which is used for fast traffic without any separation of the direction. The 4-lane cross section has the potential for head on collisions and the 2-lane cross section with wide hardshoulders will be misused as a three or four lane cross section (head on collision risk in the case of irregular



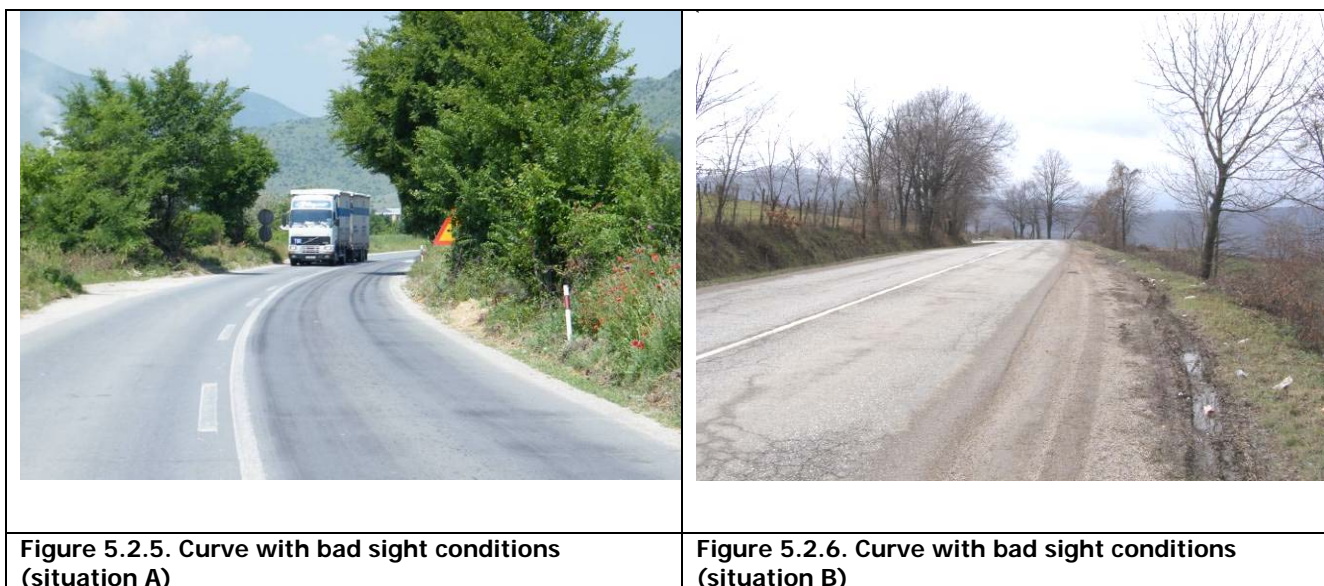
overtaking). Both design solutions were used decades ago in western European Countries but, due to the high number of head on collisions they are now constructed differently. For 4-lane interurban roads should we have a median with crash barriers. Other more safety problems can occur when cross sections are too narrow like and a high percentage of heavy traffic is present (e.g. side and head on collisions can happen).

### • Alignment

As a result of the RSI we can identify often problems with the alignment of existing roads. Typical are problems regarding the sight conditions. At least at every situation it is a must to ensure the "stopping sight". But to improve the road safety we should give the driver enough information about the alignment of the road, what is going-on ahead, this parameter is called "orientation sight". It is quite clear that the needs for sight condition depend on the legal and operating speed. As an example we should keep in mind that for a speed of 100 km/h the stopping sight should be 170 m (for long fall 0%) and the orientation sight about 240 m.

Reduced visibility can be a result of sharp bends, crests or planting. Some more typical problems regarding the horizontal alignment are: inconsistent radius sequences with high speed differentials, usage of small radii in sections with high speed and sudden changes of alignment standards without any transition and regarding the vertical alignment. We find often small crest curves with sight restrictions, missing climbing lanes for trucks in the case of step gradients on fast roads as well as optical illusions like "Hidden-dips".

The result of the mentioned deficiencies could be head-on collisions or single run-off accidents in curves.



### • Intersections

Intersections should be designed to minimise the risk of collisions, particularly right angle collisions (give way accidents). Some existing intersections are the same as in the times with low speed horse

drawn vehicles and pedestrians only in other cases the design is done some decades ago according to old guidelines. The situation is vastly different now and with the speed and volume of traffic better lay-outs at such locations is essential and the intersection must be capable of providing appropriate information to every road user in order to make a safe decision.

Some layouts for intersections can lead to significant problems. For example, Y-Type intersections, as illustrated below, can lead to risky decisions or misunderstandings regarding right of way and subsequent accidents. Others are poorly designed or obscured by vegetation (see photograph below) or obstacles and hard to detect. The suggested treatment could range from clearing vegetation to improved signage or infrastructure treatments such as converting the intersection to a roundabout or T junction from a Y junction (i.e make the smaller road intersect the major road at right angles) or a staggered T junction if the intersection was a cross road. The mentioned cases can lead to side collisions.

Another problem is a lack of left turning lanes and sufficient space for the usage with bigger trucks. The lack of left turning lanes leads often to rear end collision because cars have to stop for a left turn on the driving lane and other drivers behind them can't stop fast enough. In other case the intersection itself is not early enough recognisable for the drivers or there is a lack of sufficient sight conditions, obstructed visibility by road equipment, bushes etc. Therefore it must be checked if there is a need for a redesign or other changes.

In areas with pedestrian crossings, safe crossing facilities should be an integrated part of the technical solution.

In the existing network we can often find serious safety problem because the lack of access control. If we recognise this during the RSI, the report should contain proposals for improving the situation (at least the question are there "illegal" accesses – could be clarified with the road administration). Other typical deficiencies are lack of sufficient sight conditions, insufficient space for manoeuvres and problems with the sight condition regarding traffic lights.



**Figure 5.2.7. Truck need the space of left turning lane**



**Figure 5.2.8. Unsafe "Y" cross section**

- **Public and private service, rest areas and public transport**



To guarantee a sufficient amount of rest time for the drivers (esp. for the professionals) satisfactory number of rest places along long distance roads are necessary. Often the number and the size is not sufficient. If there are located on interurban road sections there should be separate exit and access lane to minimise conflicts with the ongoing traffic flow and user of the rest ore service area.

Otherwise rear-end crashes or side collisions can be happen.

Public transport stop should be well organised and a separation of pedestrians from the traffic flow is necessary. When there is a lack of safe facilities accidents with pedestrians can occur.



**Figure 5.2.9. Rest area along a link section, lack of separation, no regular exit and access**



**Figure 5.2.10. Unsafe Bus stops (situation A)**



**Figure 5.2.11. Unsafe parking place**



**Figure 5.2.12. Unsafe Bus stops (situation B)**

- **Traffic signing, marking and lighting**

Typical deficiencies are missing, incomplete or misleading signs or an “overload” on information (not more than 2 different signs should be placed at one spot).

The road signs should give the driver information of intersections, destinations, hazards, route numbers, mileage estimates, street names, and points of interest in a sufficient way. Another common problem is the missing or not readable directional signs. In high speed road sections like motorways the directional sign should have a repetition.



**Figure 5.2.13. Directional sign complete hidden by a tree**



**Figure 5.2.14. Marking in very bad condition, no guidance for the driver esp. at night**

The marking should be clear and visible also at the night time. Contradictions between marking and signing has to be avoided.

The lighting is a special topic in the built up area. For the road safety is very important to have a good lighting especially at pedestrian crossing and intersections.

- **Vulnerable road users (pedestrians and bicyclists)**

It is a important task for the RSI to identify road safety problems regarding the vulnerable road users. Such problems can be often identified in through road sections of villages, towns and along major urban roads. Sometimes there is along interurban road sections also pedestrian traffic because there are from time to time some farm houses beside the road.

Typical findings regarding the vulnerable road users are missing or unsafe footpaths and missing or unsafe pedestrian crossings. Often are there speed limits but not supported by the road design contrariwise drivers are invited by very wide cross sections to drive to fast.

The mentioned deficiencies can lead to accidents with pedestrians.



**Figure 5.2.15. Almost new constructed pedestrian crossing leads to nowhere**



**Figure 5.2.16. Missing footpath- people are forced to walk on the carriageway**

### • Collisions with roadside obstacles

Roadside hazards can make the consequence of an accident much more dramatic than if there was no hazard. Hazards such as poles, drains and trees are not “forgiving” when a driver makes a mistake by running or sliding off the carriageway. Such a mistake can occur for many reasons including sleepiness, when trying to avoid head on collisions caused by another driver or an accident with animals on the road. Obstacles very close to the carriageway can change incidents into accidents.

The nature of these obstacles can be very different, ranging from poles, to drains, to walls, to trees. Trees along interurban roads pose a particular problem as many do not want them removed, despite the clear hazard they create. It is interesting to note some trees/hazards have been the scenes of a fatal accident as illustrated by the flowers or memorials alongside, yet very few call for their removal. It is of course possible to install barriers in front of hazards as an alternative to removal but care needs to be taken as some barriers can be a hazard themselves.



**Figure 5.2.17. No guardrail on the bridge (gap in the system)**



**Figure 5.2.18. “Start”- element of a guardrail section made by concrete - hard obstacles**

## 6 Training of the Inspectors and legal aspects

### 6.1 Experience and training of the Inspectors

Depending on the complexity of the work, an inspection may be done by a single Inspector or by a group of Inspectors. A team should comprise of a leader, team members, specialist advisers (like from the Traffic Police to get information about accidents) and observers (these could be junior staff gaining experience in RSI).

This Manual suggests on major roads a multi-member team is engaged to ensure there are more than one pair of eyes doing the inspection, there is exchange of ideas from discussions between the members of the team and all necessary skills and backgrounds are covered by the team. However, on some smaller projects a single Inspector may be adequate and a more practical option.

The members but at least the responsible leader of the RSI team group should be “independent” i.e. not part of the team that is responsible for maintenance of the road or from the Road Inspectorate in the MoT. They should have very good specialised knowledge and in-depth knowledge of the region as well as an understanding of potential countermeasures and what is required for their implementation.

However, it is possible for a person with knowledge of road safety and road engineering, using the check lists provided to complete an inspection. But it is preferable for an Inspector to have specific initial training in audits and/or inspections and there are a lot of advantages in all Inspectors having the same training and certification on uniform safety analyses and solutions, providing a uniform approach to road safety in the SEETO Participant. Like it is mentioned before also certified auditors are in a position to conduct a RSI because the RSA of the pre opening stage and of the early operation stage are in fact similar to the RSI.

One way to train inspectors could be a combination with the RSA training. Because of the similarities of the methodology of the RSI and RSA (stage 3 and 4) the RSI could be done by auditors. An other possibility is to organize training courses similar to the RSA with a limited content focussed to the needs of the RSI.

Two principles of the practical RSI and RSA work are nowadays in use in Europe. One way is to dispose the needed qualified staff as employees of the public administration, public road safety institute or similar (e.g. from a University). This solution can be called as “internal inspector”. The other possibility is to have contracts with RSI experts from private consultants (“external inspectors”).

It is suggested that on-going inspection training be provided for Inspectors to provide any updating on issues critical to the inspection process.

The preferred requirements of a road safety Inspector should include:

- Professional education in road design, road maintenance and traffic accident investigation.
- Substantial experience in day to day road operation and/or road maintenance respectively or road traffic police work.
- An excellent knowledge of the regulations and guidelines regarding roads and road traffic, traffic signs etc.
- Strong communication skills to be able to write a clear and concise report and then convince various stakeholders of the proposed countermeasures.

## 6.2 Legal aspects

Experience in many countries indicates that claims related to the use of RSI have not been a problem. The RSI is simply identifying safety issues or concerns that have the potential to reduce the safety level of an existing road.

On the other hand the potential for liability for the Road administration can appear as an important factor for road authorities in deciding to undertake or not a RSI.

However, the proper execution of RSI should not expose those authorities that adopt them to a greater liability. With regard to legal liability, these main principles can be expressed in a more or less similar way like for the RSA:

- If the road safety inspection procedures are deemed to be an asset to the public, the fears of legal liability should not be used to prevent their use,
- Documentation is very important, indeed essential. The Client's response to an RSI report must provide reasons for not accepting any auditor's recommendation. The response should be detailed and defensible,
- RSI report and formal response report must be placed in the project file. It could be used for any investigation,
- a follow up procedure of the actions or inactions taken by the road authority and its special unit for RSA and RSI (RSAIU). With a well scheduled periodical RSI in the core network it is also possible to have a follow up and
- The control body CBMoT will monitor the RSI process.

Some details of the liability of the RSI team are depending on the practical solution how the RSI will be organized in the SEETO participant.

If the inspector is an employee of the public administration, the liability is regulated according to the legal regulation of liability for staff of the public sector.

If the RSI would be done from a consultant company, it would be necessary to use common procedures for the insurance of the consultants work.



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