



Support for implementing measures for the South East Europe Core
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WYG International part of the WYG group



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ROAD SAFETY AUDIT MANUAL

Specific Project Result 12A

(REVISED FINAL)



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1 Basics about the Road Safety Audit

1.1 What is Road Safety Audit?

The Road Safety Audit is a systematic and independent assessment of the safety performance of a road infrastructure project. Following the principle **“Prevention is better than cure”** the RSA makes it possible to design and construct road traffic facilities as safe as possible.

The Road Safety Audit is pro active and part of a comprehensive quality management system. It is a formal examination of a road or traffic project. The systematic application of road safety audits will address the safety needs of all road users: vehicle drivers, cyclists, agricultural-vehicles and pedestrians.

The idea for a Road Safety Audit came about because of dangerous road sections and intersection also along new constructed roads in many countries.

After almost two decades of experience with the Road Safety Audit all over the world – like in Great Britain, Australia, Germany and Denmark - this procedure is recognised as one of the most important engineering tool in our hands. With its DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL No. 2008/96 ON ROAD INFRASTRUCTURE SAFETY MANAGEMENT – published in October 2008 - the European Union made a clear decision the Road Safety Audit will be mandatory for the trans-European Road Network in the next years. In the mentioned directive the RSA 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:

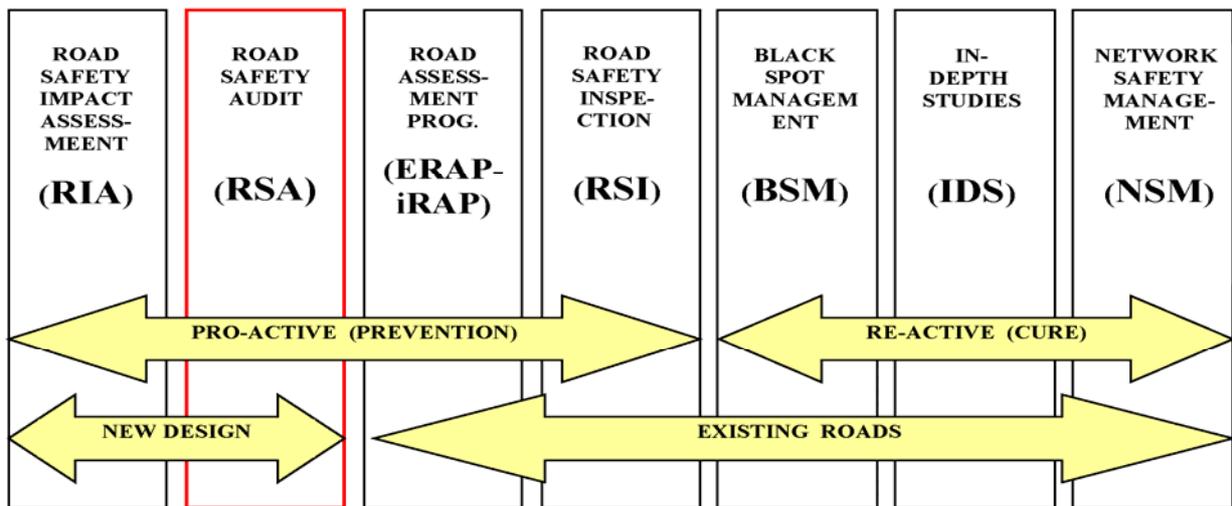
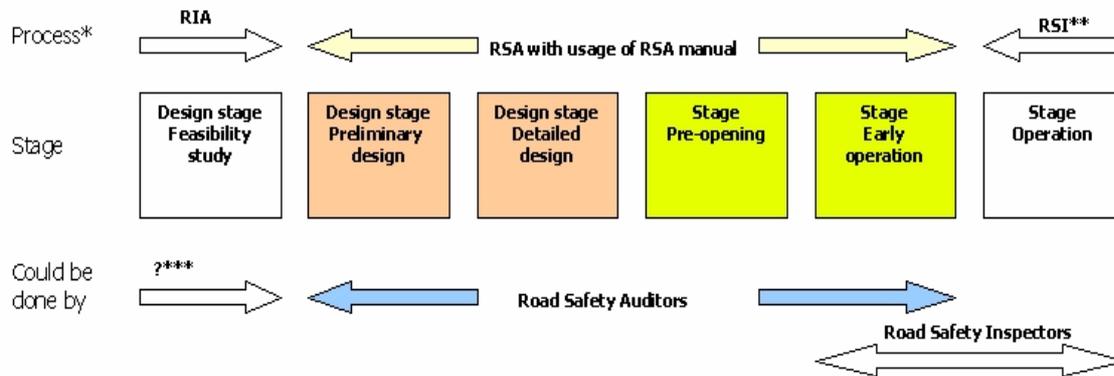


Figure 1.1,1: The Road Safety Audit as part of the Road Safety Management

As part of the road safety engineering the Road Safety Audit (RSA) has a strong relationship and a lot of similarities with the Road Safety Inspection. 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 Audit (RSA) provides a supplementary, pro-active approach to safety countermeasures in road engineering.

The RSA procedure is:

- A formal process;
- An independent process;
- Carried out by someone with appropriate experience and training;
- Restricted to road safety issues.

The outcome of a RSA is a formal Report, which identifies any road safety deficiency and if appropriate, makes recommendations aimed at removing or reducing the deficiencies. The time required to undertake a RSA is very short compared to the individual planning stages. Nonetheless, it should be considered early on in the scheme development process.

The addition of safety features and correction of safety deficiencies before building a road, not only helps prevent some road traffic crashes but also obviate the need for costly reconstruction (to remedy safety deficiencies). Thus, RSA is potentially very cost-efficient.

A variety of road-improvement schemes can be audited: major highway designs, road rehabilitation projects etc. After the RSA, road safety requirements must be weighed against other factors in a comprehensive review.

It is useful to distinguish among three parties or processes in a road safety audit – the auditor or audit team, the design team and the Client or decision-maker. The function of each party is different, and their roles must be consistent and well defined.

1.2 Why Road Safety Audit?

In the SEETO Region road safety requirements for planning, construction, and maintenance as well for operation and equipment are contained in the applicable and mostly not updated technical standards and specifications.

Nevertheless, road construction measures are constantly being planned and implemented that do not fully exploit the design possibilities for road safety offered by the latest technological developments. Also along newly constructed and rehabilitated road sections, the road accident statistics show an unacceptable number of accidents with serious consequences. There can also be issues with balancing the interests that are involved. Added to this, new scientific findings take some time to find their way into the technical standards and specifications, because they need to be verified and accepted.

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 at least some influence.

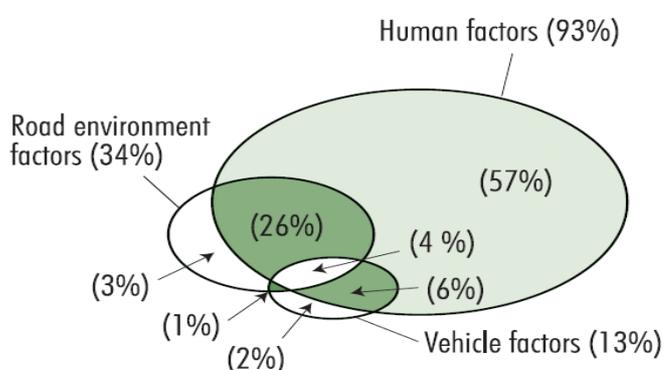


Figure 1.2.1: The contribution of accident factors

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

The RSA is an approved tool to improve the road environment factors. With the audit expert knowledge of the systematic Road Safety Audit it is possible to reduce the number and severity of traffic accidents by improving the road safety performance of an infrastructure project. The RSA as a part of a quality assurance system will ensure that every investment will be as effective as possible because a safe road is a sustainable investment.

1.3 Value and Costs of Road Safety Audit

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

The value of the RSA is the following:

- 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 design deficiencies,
- To minimize the need for remedial work,
- To minimize unsustainable losses to health and economy,
- To reduce the life cycle costs of the project,
- To improve the awareness of safe design practices of everyone involved in the design.

The earlier the project is audited within the design and development process the better. Early auditing can lead to the early elimination of problems and, consequently, minimisation of time and cost of redesign at later stages.

Although, it is not always easy to quantify precisely the economic benefits of RSA, there is strong evidence that audits are highly cost-effective. Some research results from different European countries giving us very positive results.

The Austrian Road Safety Board (KfV) estimates that the financial benefit of the RSA in Austria is 50 times higher than the costs [1]. A Danish study [2] came in 1995 to the result of a cost benefit ratio of 16,8. In Germany the Traffic Institute of the Insurance Company Association (VTIV) has made some case studies about the benefit of the RSA. The results were published in 2004 with a cost benefit ratio in a range from 4 to 99[3].

In addition it has to mention, that the implementation of the RSA leads to intensive discussion between the auditors, client and designer. This discussion is helpful to increase the knowledge of all involved parties and is also helpful to improve the daily work, design procedures and would also helpful in the process of the renewing of the standards.

2 What should be audited?

2.1 Area of Application

In SEETO Participants, roads are categorised in accordance with traffic planning standards for the functional classification of the road network according to:

- Its primary function in the network (part of TEN-T, Core network, regional road etc.)
- Traffic Mix (motor vehicles only or mixed traffic with non motorized or slow agricultural traffic)
- Locality (outside or inside built up areas).

Roads are planned, designed, built, maintained and operated in accordance with the corresponding technical standards and specifications.

A RSA should be undertaken on any design for new roads or on any proposal for changes in existing roads or road environment which are likely to alter interactions between different road users, or between road users and their environment.

A RSA is an integral part of the design process but independent from the actual design. The designer of a new road project (or other applicable project) remains responsible for the design. The designer should make regular checks of the implications for safety work on the design progresses. RSA does not alter the need for this “safety first” approach. The audit process provides, at regular intervals, an independent assessment.

The Client remains responsible for the ultimate design and should consider that assessment. In this guideline, Clients such as national and local road administrations, public enterprises for public roads and in special cases, the donors of financial means are in every case the final and regular decision makers in the design process.

This **Manual** for **ROAD SAFETY AUDIT** of road design is applicable for

- new roads, motorways and other road traffic facilities,
- RRR-projects (resurfacing, restoration, rehabilitation),
- inside and outside built-up areas.

It should be used with care and common sense and should be supplemented by experience. For example, an extreme reliance on the checklists is no substitute to experience.

After roads have been constructed, the conditions might have changed significantly, for example design standards, function of the road, traffic volume and distribution, vehicle weights, land use, and accesses can all alter. Following the intentions of the EU directive 2008/96 with the final RSA stage - “early operation” - should be checked if there occur safety problems in the first month after opening.

Furthermore it is important, from time to time, to inspect periodically the existing road network with the focus to the road safety. This task could also be co-ordinated with investigation of high risk road sections. This procedure is called Road Safety Inspection (RSI) and consequently the present guideline will be supplemented by a ***Manual for Road Safety Inspections on existing roads***. That Manual provides more details about the RSI process.

2.2 Types of projects

The types of projects to be mandatorily audited will be defined according to the legal regulations.

RSA can be carried out for all types of road projects, although it is quite clear, that the projects regarding the core network which serve a high traffic volume should be in the focus of the administration.

The RSA should be implemented in the following way:

- in every case for road traffic infrastructure projects with a mandatory character according to the legal regulations,
- should also used for other parts of the main network,

- is recommended also for measures in the secondary network.

The RSA can be used for interurban roads as well as for urban arterials.

No project is too small for RSA:

- Major projects, i.e. motorways, expressways, bypasses etc.
- Medium-sized projects, i.e. reconstruction and rehabilitation projects
- Minor improvements, i.e. minor remodelling, new bicyclist facilities, minor reconstruction
- Major maintenance works, i.e. could done be for special parts like marking or guardrail works

3 When should Audits be carried out?

3.1 Stages

According to the experience in Western Europe and the EU directive No. 2008/96 there are four different stages during which Road Safety Audits are conducted:

- Stage 1: draft (or preliminary) design,
- Stage 2: detailed-design,
- Stage 3: pre-opening of the road and
- Stage 4: early operation - when the road is some time in operation.

The evaluation of the very early design stage (feasibility study or planning) should be evaluated furthermore by using the road safety impact assessment method.

The RSA process starts with the decision to build a new road or invest in reconstruction, widening or major maintenance of an existing road.

In the case of new roads the audit process will usually start after the Road Safety Impact Assessment and the feasibility study stage if the proposed alignment is detailed enough to make a reasonable audit.

The RSA stage 1 and 2 will be conducted on the basis of the design documentation (drawings, explanatory reports etc.) of the project. To ensure an adequate accuracy of the RSA, the design documentation must have sufficient quality and content.

Before opening the new road to traffic with the stage 3, the audit should be made to check if the scheme has been constructed as designed with respect to road safety and whether any other items not previously discovered have come to light during construction. The final stage (stage 4) of the RSA process is monitoring of the early operation. It is important that an evaluation of the actual safety situation is made after some months.

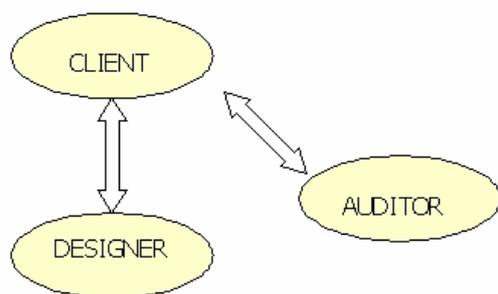
In the case of small projects like reconstruction projects, draft and detailed designs are only rarely prepared. In that case one single, combined audit for the first two RSA stages would be conducted.

4 The Audit Process – How to perform a RSA?

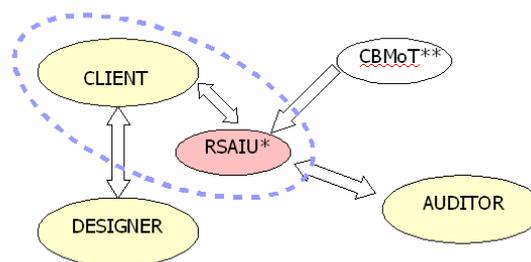
4.1 The partners in the audit process and their roles

The Client (usually the road authority, the Ministry relevant to Transport or private road operating company), the designer and the auditor participate in the audit process. The Client initiates the safety audits and commissions the auditor or audit team. All information and reports are distributed via the Client.

Model 1: Normal case in many countries



Model 2: Improved organisational chart – one proposal for SEETO Participants



* Road Safety audit and inspection unit

** Controlling Body in Ministry of Transport

Figure 4.1.1: The partners in the audit process – two possible models

After analysing the local situation, we propose to introduce the improved organisational chart for RSA as is shown in figure 4 (model 2). That will help to have a sufficient capacity building for the RSA and will ensure the quality of the RSA. The RSAIU as a part of the road authority is only one suggestion to ensure the needed quality of the RSA, the tasks could also be delegated to Road Safety Institutes or Agencies.

The **Client** is the institution (typically the road administration) which ordered the project from the designer. The Client is responsible for the basic condition on the project. This includes also the responsibility to arbitrate in cases when auditors and designers disagree. These disagreements will be presented to the Client. The Client has to prepare a formal written decision to the designer and the auditor. In case of the stage 4 the road maintenance unit or inspection unit should be involved in the process.

It is the Client's full responsibility to ensure that audit demands will be obeyed. The Client should make clear in his contracts with the designer and contractor the obligation of the designer or construction company regarding the necessary changes.

It is also the task of the Client to organise that the necessary costs for the implementation of the results of the RSA will be covered from the total investment budget.

In some Participants as part of the quality insurance system are Revision Commissions (??) still working. The main task of this Revision Commissions is to check if all design parameters are

according to the norms and standards. This is a very important step of the design process. It is improbable that comments and demands of the Revision Commission will lead to conflicts with the RSA results and vice versa. That is the exact opposite. The special knowledge of the auditors will support the targets of the Revision Commission to ensure the quality performance.

A special **Road Safety Audit and Inspection Unit – RSAIU or Road Safety Agency** and a **controlling body in the level of the Ministry of Transport – CBMoT** - can assist the Road Administration (Directories of Public Enterprises) in the RSA /RSI procedures.

The **designer** is responsible for the design. He has the full responsibilities to ensure a sufficient technical performance and road safety. The obligation of the designer is also that all design documents are containing the audit input information in a unambiguous way. The recommendations about minimum requirements of the design documentation content are described at page 14.

If the designer can not agree with demands of the audit report, he should present the reasons in a written way to the Client for a decision. Finally the designer has also to obey the results of the RSA report according to the final decision of the Client about acceptance. Depending on the design stage and the kind required changes, the necessary changes can be done in current or in the next design stage.

The **auditor** is the independent person, team or organisation who will conduct the RSA on the basis of the design material or the situation of the road under construction or in early operation. It is recommended, according to the best practise in other countries, to avoid in the audit undertaking step the direct contact with the designer to support the independent audit procedure. An early discussion with the designer could lead to a situation that the designer want to have influence to the audit results and could reduce the effectiveness of the RSA. Nevertheless a completion meeting can be part of the final RSA step (see chapter 4.2.3). The audit expert is responsible to check the documentation in a careful way, with road safety in focus. With a formal written report the auditor shall present the findings, the deficiencies and the references.

It is not the primary task of the auditor to check whether or not a project conforms to road standards. On the contrary, it is often necessary to go beyond the road standards. The auditor will use his knowledge regarding the best practise in the evaluation of a design. It is crucial that the auditors have profound experience in road design and construction as well as road safety engineering and accident analysis. To ensure the quality of the audit, auditors shall undergo an initial training in the award of a certificate of competence and should take part in additional periodic training courses. Where audits are undertaken by teams, at least one member of the team shall hold a certificate of competence.

The audit stages 3 and 4 should be preferably done by the auditor who has also solved the audit of the design stages. It is also possible to delegate the task of the stage 4 – early operation - to a team of Road Safety Inspectors.

4.2 The practical RSA workflow

Because of the need to tap the full potential of the RSA, it has to be organised with an effective structure and with clear responsibilities. The following describes the typical audit process based on figure 5 that follows.

The general RSA procedure will include three main phases:

- ordering,
- undertaking and
- completion.

Regardless of the scope and nature of a road infrastructure project and regardless the audit stage, it is possible to conduct the RSA on the basis of this diagram. It has to be mentioned that in the RSA stage 3 and 4 in the most cases no design work would be necessary, often the changes can be organised directly by the construction company (contractor) for the stage 3 or the maintenance unit of the Client for stage 4. It depends on the extend and type of changes in design, whether it would be necessary to have a partial repetition of the RSA to check the changed documentation. In a case of doubt the Client should send the auditor the relevant documents.

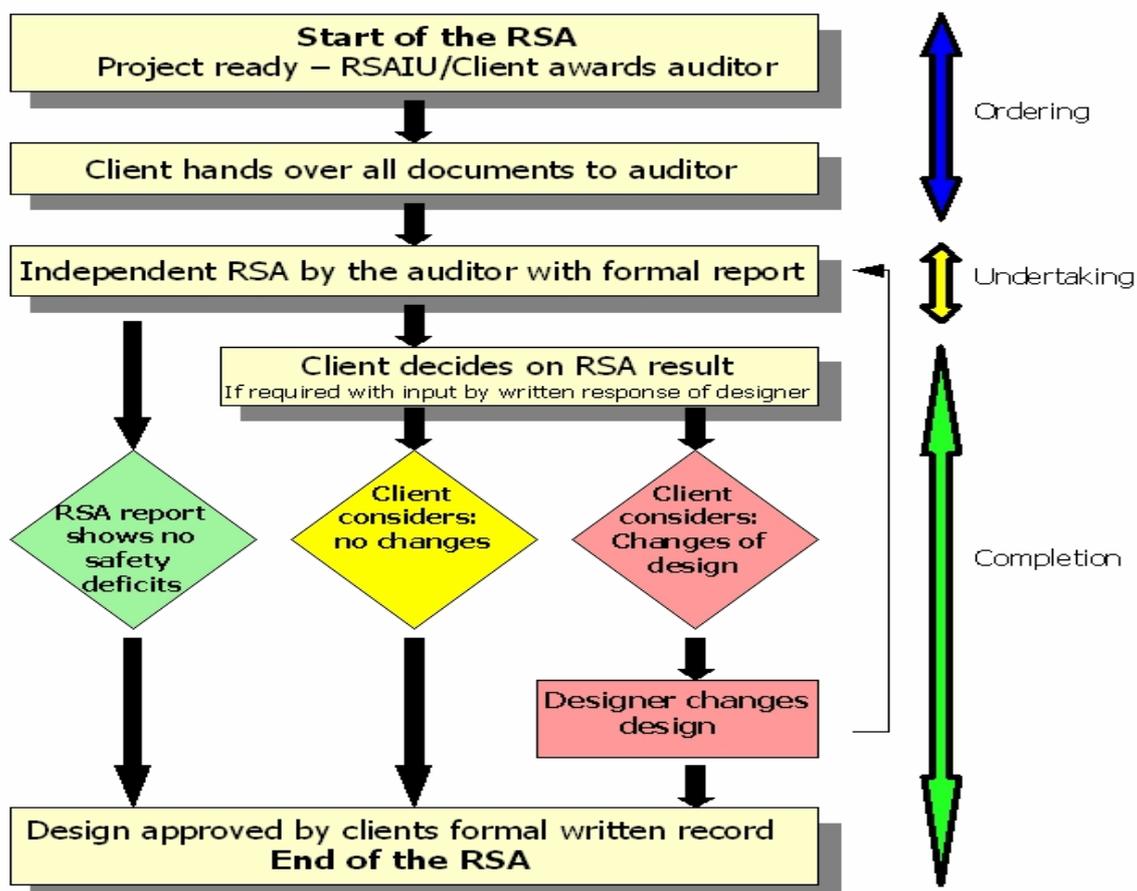


Figure 4.2.1: The RSA workflow (main steps)

To guarantee the sustainable quality of the RSA, the whole process should be controlled and documented by a controlling body in the level of the Ministry of Transport (CBMoT). The RSA report, Client's written final record etc. should be collected as an evidence.

4.2.1 Ordering a Road Safety Audit

Ordering the audit

Usually, the decision to audit 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 auditor, 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 auditors compiled by the Client can be helpful for the selection process.

An alternative procedure could be a regional or national Audit Centre. In that case, the Audit Centre will be responsible for the independence and quality of the audit.

The nature and synthesis of the team depends upon the complexity of the audit task and the size and type of the scheme being audited. It can also vary for each audit stage. The principal benefit of having a team is the exchange of diverse experience, knowledge and approaches of different experts. Audit at different stages may require different skills.

The first two design stages should be undertaken by very experienced auditors including road safety specialists, accident investigation specialists and highway design engineers.

At the detailed design stage the types of skills required call for a team of experts with expertise in road design, traffic signals, lighting and drainage, non-motorised users etc. A person with knowledge of human behavioural aspects of road safety could be also a very useful.

At the pre-opening and post-opening stages, it is important to consider having in the team experts 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.

Collection of background information and Audit Brief

The Audit Brief is the instructions to the audit team describing the scheme to be undertaken and must contain sufficient background information to enable the audit to be satisfactorily carried out.

All the necessary material (all drawings, information and reports) constituting the Brief and are gathered together by the design team and distributed to the audit team, via the Client.

It is important that the audit team is given all required documents at the beginning. Incomplete documents lead to questions and additional demands, resulting in more time and work being required for the audit.

At the minimum, the brief should include:

- a brief project description,
- an account of project conditions and design parameters (design speed, radii of curves, super elevation, sight criteria, traffic volume, accident data etc.),
- set of drawings (obligatory on paper, not only digital!),

- details and reasons for any deviation from road standards,
- any previous audit or Road Safety Inspection reports.

The number of documents required, increases as the design phases proceed. A complete recommendation about the minimum requirements of content of the documentation is shown in the table that follows.

For the early operation stage it could be helpful to have the same documents as for example concerning traffic volume at opening.

In every case is it necessary to have the RSA -report corresponding to the previous stage.

Preliminary Design	Detailed Design	Traffic Opening
Explanatory report with: Traffic analysis inclusive traffic volume prognosis Accident diagrams and maps with black spots and dangerous road selection Overview map with: Overview site plans with type of junction, Overview vertical alignment Cross section Horizontal alignment Vertical alignment Construction sketches Site plans of accompanying landscape measures Any existing signing and marking plans	Result of previous audit phase with Client's decision Explanatory report Overview map Cross section Horizontal alignment Vertical alignment Construction plans Site plans of landscape detailed planning Signing and marking plans Site plans with road equipment Junctions with all signs, markings and signal installation plans Inclusive traffic engineering Documents for signal planning	Result of previous audit phase with Client's decision Explanatory report Horizontal alignment Vertical alignment Site plans of landscape detailed planning Signing and marking plans Site plans with road equipment Signal installation plans Inclusive traffic engineering Documents for signal planning

Figure 4.2.1.1: Design documents for RSA

4.2.2 Undertaking the Road Safety Audit

Analysis of background information

The auditor studies the project material (the design drawings and other information provided) taking into consideration the potential impact on all different types of road users. All the information should be assessed. At this time, it is often possible to identify areas of the project which contain potential safety problems. Auditors should be given sufficient time to carry out a RSA in order to ensure it is thorough.

Field studies

Field studies are recommended for the audit stage 1 and 2. In order for a clear understanding of the project to be gained, it is important that the auditor carries out usually a site inspection. Field inspections allows the auditor to see how the proposal interacts with surrounding and nearby roads. They provide the audit team with a feeling for existing conditions. Site inspections should be undertaken under the range of traffic and environmental conditions likely to be encountered. 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 road market activities etc.).

When auditing in stages 1 and 2 the auditor must place himself in the position of the various road users (motorist, cyclist and pedestrian) using the planning documents so that he can judge the traffic safety of the construction from the viewpoint of all road users.

In the audit stage 3 and 4 the auditor can view the new road and conduct the audit on the field. In order to evaluate the traffic facility from the viewpoint of all road users, the auditor should inspect the road from the perspective of drivers, cyclists, pedestrians etc. as appropriate.

Reviewing documentation

The auditor carries out the Safety Audit on the basis of his personal experience and his knowledge of road safety. To ensure that safety aspects have not been overlooked during this experience-based procedure, *checklists* (see Annex 1 and 2) can be used to assist in this process.

The auditors must have the following basic questions in mind:

- Who can be hurt and in what way?
- Is the solution safe for all relevant road users to use the traffic facility?
- Is the design that has been selected the best for traffic safety, within the framework of the regulations?
- Do new findings concerning traffic safety and road design make a different design seem advisable?

Different checklists have been developed for different stages of a project's development and are attached as Annex to this Manual. The checklist present different questions regarding the safety of all users but they are not exhaustive. They identify issues and problems that can arise at the relevant stage of an audit. **The Checklists for the Interurban Highways are also including questions about the typical situation regarding the road section that transits small**

villages and linear settlements which have often not the character of through roads but create also conflicts with vulnerable road users.

The auditors should use their own judgement about the safety of any particular feature.

The checklists are set against the following background:

- Full exploitation of any room for discretion in the technical standards and specifications in order to optimise road safety,
- Findings from local accident investigations,
- Results of new research work,
- Experience gained from earlier audits,
- Regularly occurring design errors.

Audit findings and report

The auditor should note any problems on the drawings regarding road safety. It is useful to sort the findings by importance, relevance and type.

The audit results are described in a report, which is delivered to the Client. The report should clearly and concisely describe the project, the audit stage, the audit team members and the audit process but the main role of the audit report is to describe aspects of the project that involve road safety concerns and make recommendations about corrective actions.

The written audit report lists the safety deficits that have been identified. The auditors should suggest how to eliminate or mitigate the defects. There is for example the possibility to give clear advises in the RSA report with cross references to guidelines and norms. On the other hand some sketches with ideas about improvements in the audited design in an annex to main body of the report can be helpful. It is not within the auditors remit to create a new design but he may make proposals to avoid the safety deficits.

The audit report should contain the following information:

1. **General and detailed project details:** Name of project, audit stage, date of audit and dates and times of any inspection, weather conditions during inspection etc. A statement regarding which stage of the audit process the report relates to. Details of the teams involved. A overview about the content of the audited documentation
2. **Audit results:** Details of the specific deficiencies identified, with reasons why these are regarded as deficiencies. Recommendations for actions to remove or reduce the impact of these deficiencies.

In the traffic-opening and early operating phases, photographs should accompany the audit report.

To give the Client a better possibility to appraise the audit results the deficiencies should be structured into two levels **problems** and **remarks**:

- The **problems** are findings with a clear relationship to the road safety. That means that deficiency will increase the accident risk or severity. With the initiated changes of design, accidents and risks should be reduced. The auditor could illustrate his recommendations verbally or with sketches **but it is never the auditor's job** to design the change.
- The **remarks** should be made regarding findings which will probably not lead to more accidents but could improve the sustainability of the project or can ease the demands to the road user etc. Content of the remarks can also be related to the next project steps to lead special attention of the designer to safety relevant issues.

It is very important to write down findings on the drawings or other working documents and this must be kept as evidence. In this way, the checklists can be helpful as working documents. In the last row "comments" the auditor could make remarks if later the Client is asking for some explanations. Also in the case of findings which are finally not relevant and not part of the formal report, it would be helpful to mark them there.

It can happen during the audit procedure that the auditor finds deficiencies in the project documentation which are not safety related. It is recommended not to include these findings in the audit report. Furthermore it is recommended to mention this in a cover letter or in a separate (informal) annex.

The final report is sent to the RSAIU and via RSAIU also to the Client.

4.2.3 Completion of the Road Safety Audit

Upon receipt of the RSA report, the Client must consider the indicated problems and proposals and make a decision how the project should proceed. The Client refers the audit report to the designer.

Completion meeting

A clarifying meeting between the Client, the designer and the auditors and - if required – with attendance of a representative of the RSAIU, could be very helpful to discuss the audit results. It is important that the audit team leader, design leader and Client are present so that all parties can clearly understand the issues raised.

Response to the Audit report

The Client reviews the formal audit report and considers the indicated problems and proposals. The Client can request the designer to comment and give response to the report's recommendations but the **Client decides finally** whether recommendations are to be adopted or not. He has to determine if, and to what extent, the remarks and proposals in the audit report will lead to design modifications. All recommendations must be given due consideration. Those that are accepted should be implemented without delay.

Those 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**. The response should be given directly to the RSAIU and from them to the auditor. 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.

Following the Client's decision, the designer modifies the scheme in accordance with the accepted amendments and the work is implemented. The Client shall decide if it would be necessary to have a partial repetition of the RSA to check the changed documentation. This is depend on the kinds of changes in design, in some cases it would be possible to make the changes in the next project phase. In case of doubt, the Client should send to the auditor the relevant documents.

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

In cases of rejection of the audit requirements by the Client, with serious negative implications for the road safety, the auditor shall inform the RSAIU in a written way and can ask CBMoT for arbitration.

Follow up

A key element in the entire process is the post-opening RSA. It is vitally important that the safety performance of the project is monitored at specific intervals. It is usual for this to be some months after opening of the road to traffic. In this way, the validity of decisions taken can be checked and modified for future schemes if necessary.

The RSA reports of the auditor and decisions of the Client are important documents which will become a part of the design and construction documents of the project. All relevant documents should be kept safe as evidence.

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 road 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.

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. Important deficiencies that can have a critical effect on both number and severity of crashes are also included.

One of the most important propositions for the RSA is:

Humans make mistakes: minimise the opportunities for errors in road traffic!

If mistakes are still made → minimise the consequences!

The RSA should be conducted from the point of view of every kind of road user. For the first two RSA stages, the audit would be solved with a “virtual usage” of the traffic facilities.

As it is shown in the Chapter 1.2 road user and their behaviour are at least one contributing factor in a large number of accidents. We should keep in mind that our traffic facilities must be designed in a way that all drivers can get a clear picture about the situation of road design, signs, markings etc. and will be assisted to make the right decisions and actions in the right moment. That means that we should 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 to the driver, that means the road design must follow the expectations and experience of driver. That includes a harmonised way of signing the network and the usage of similar solutions for similar situations. To illustrate this idea, it has to be mentioned - for example - the advantage to use only few different and more or less similar and easy standard solutions for interchanges in a motorway network. That would make it much easier for the drivers to recognise the situation, to react in a sufficient way and avoid an overload of information.

This Chapter does not replace a comprehensive analysis of road safety within the framework of the safety audit, but it does provide some structure for using the checklists with all necessary questions for a proper RSA contained in the Annex 1 and 2. A collection of typical examples of the RSA pilots with relevant comments is presented in Annex 4.

5.2 Typical deficiencies

5.2.1 Interurban roads and motorways

Design elements

The design elements of the road network can be categorised as follows:

- Alignment of section (horizontal and vertical),
- design of intersections and interchanges,
- Cross section.

The design elements should be according to the function of the road in the network. It is necessary to choose a sufficient design speed with dedicated design parameters like curve radii and cross section parameters.

In addition it is necessary to keep in mind the problems with a lack of **access control**. That means, for interurban roads which are operated with high speed we can presume a direct influence of the type and frequency of access points with the road safety. Therefore the number of access to private properties should be minimized on existing roads or be total avoided on new roads and on motorways as well as on express roads. An alternative solution to improve existing private access is the creation of parallel service roads or a reorganized connection with a secondary network. The number of intersections or interchanges should be restricted and between two consecutive intersections or interchanges there should be a sufficient distance.

Alignment of road sections

Some typical safety deficiencies affecting the alignment of **interurban roads** (highways and motorways) are:

- Horizontal alignment: inconsistent radius sequence (speed differentials), usage of small radii in sections with high speed, sudden changes of alignment standards without any transition,
- Vertical alignment: small crest curves with sight restrictions, missing climbing lanes for trucks in the case of steep gradients on fast roads, optical illusions like "Hidden-dips",
- Insufficient sight conditions regarding stopping sight, orientation sight and overtaking sight (especially in roads with only single carriageway).

Design of intersections and interchanges

A reasonable number of accidents happens at intersections. Typical deficiencies in that area are:

- Lack of correlation between alignment and intersection type, that means for high speed roads like motorways split level interchanges etc.,
- Intersection are not proper recognisable for the drivers,
- Lack of sufficient sight conditions, obstructed visibility by road equipment, bushes, houses etc.,
- Unsafe geometry like Y – solutions,
- Lack of left-turning lanes on the major road,
- Lack of traffic signalisation in road sections with high traffic volume,
- Unsafe crossing facilities for pedestrians and bicyclists.

Furthermore the road safety can be improved by the reduction of the number of intersections in the high speed core network as a part of an intelligent network planning. The usage of roundabouts instead of intersections should be in the most case the favourable solution because that helps to reduce the number of conflict points.

Other typical problems of interchanges or split level junctions are the usage of insufficient or confusing solutions with regards to the volume of traffic streams and to small parameters in the alignment of the ramps with the result of dangerous limited sight conditions and a lack of guidance for the drivers.

Cross section

In the RSA the following deficiencies can often be identified:

- Choice of lane widths is not corresponding to the function of the road, lanes should not be wider than 3.5 m in the most cases,
- Usage of hard shoulders in single carriageway highways with a total width of the asphalted cross section by 11 – 12 m leads to a usage as 3 lane road with high accident risks,
- Insufficient cross fall in straight section (should be usually 2.5 %),
- Lack of either clear zones (a strip of land adjacent to the road with no dangerous obstacles in it) or “forgiving roadsides” (those where the obstacles are passively safe),
- Lack of sufficient superelevation on bends,
- Insufficient drainage, lack of drainage in section with the change of the direction of the crossfall in the transition from left hand to right hand curves, to small gutter gradient in curbed sections,
- Lack of strong and stable verges,
- Four lane roads without physically separation with medians etc.,
- Missing, insufficient or incorrect passive safety installations along the road and in the medians of roads with two carriageways and motorways.,
- Missing/insufficiently separated pedestrian and cyclist facilities.

5.2.2 Through road sections and Major Urban Roads

With the exception of motorways and bypass solutions on highways, all highways have sections which are crossing villages, towns and cities. The character of the through road section is

strongly influenced by the character of the urban area. There are big differences comparing the situation of highway sections in small villages with the major urban roads in large cities.

Because of the mixed traffic in through road sections, special demands of the traffic composition should be in the focus of the auditor. Children, elderly, and disabled people are particularly vulnerable in built-up areas. The operation speed should be not higher than 50 km/h if there is no complete separation (secondary service roads, safe crossing facilities like pedestrian bridges).

Safe sidewalks and pedestrian crossings, including centre refuge islands, both along the road and at intersections are very useful safety features. In addition strong regulations against parking on sidewalks should be considered. All too often the needs of pedestrians and other vulnerable road users are ignored and they are forced to share the carriageway with fast moving traffic.

Typical safety deficiencies affecting the design of **through road sections and Major Urban Roads** are:

- The choice of operation/legal speed is inappropriate (higher than 50 km/h without special separation).
- The design is not sufficient to demonstrate the driver the special situation of the through road section, the design solution especially on through road sections in villages is similar to the interurban section. There are no facilities to support the speed limits physically.
- Unsafe routing and insufficient protection of pedestrians and cyclists along the road and at intersections
- Intersections with traffic signals: signal controls that do not consider the needs of all road users, including lack of protection for left-turning movements or excessive delays for pedestrians and cyclists.
- Lack of protection for crossing pedestrians and cyclists on open sections of road
- Insufficient width of cross sections, i.e. too wide lanes in through road sections are leading to a dangerous speeding therefore there 3.25 m are sufficient,
- Inappropriate parking and loading facilities.

6 Training of the auditors and legal aspects

6.1 Experience and training of the auditors

It is important that the auditor has profound experience in road safety issues. The make up of the team will depend on the size and type of the schemes being audited.

Generally, as already stated, the team should comprise of a leader, team members, specialist advisers (where necessary) and observers (these will generally be junior staff gaining experience in RSA). The benefits of a team approach to an audit can be seen as more pairs of eyes, constructive debate, different skill sets, etc. The advantage of an audit team is to ensure all skill sets are adequately covered.

The audit team leader should have completed relevant university education and have significant experience in road safety engineering and/or road traffic accident investigation. About ten years would be a minimum length of experience. Team members would normally be expected to have relevant education also plus about five years experience. The auditors should get an intensive training and should pass an examination procedure. The content of training should include road safety related topics like accident investigation, road safety network management and road safety engineering and design. In several European countries like Germany, Denmark and Great Britain well approved training curriculae exist. It is a possible and sufficient solution in training courses for auditors also includes a part for the Road Safety Inspection. There are big similarities of the RSA stage 3 and 4 with 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). In the literature this solution is often called "internal auditor". The other possibility is to have contracts with RSI experts from private consultants "external auditor".

In addition, the creation of a national Audit Centre could be helpful in the future. Such an institution could organize the training, certification and refresher courses for the authorized auditors.

When setting up a team, consideration should be given to any particular features of the project that will require specialist input. For instance, non-motorised and other vulnerable users often have specific needs, railway crossings or complex traffic signal controlled intersections.

6.2 Legal aspect

Experience in many countries indicates that claims related to the use of RSA have not been a problem. RSA provide a means to check that all reasonable safety initiatives have been taken in the design, construction and operation of schemes. The auditors are simply identifying safety issues or concerns that have the potential to reduce the safety level of a future road or existing road.

The potential for liability can create an important factor for road authorities in deciding whether or not to undertake RSA.

However, the correct undertaking of RSA should not expose those authorities that adopt them to undertake a greater liability. With regard to legal liability, the following main principles can be expressed:

- If the road safety audit 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 audit report must provide reasons for not accepting any auditor's recommendation. The response should be detailed and defensible,
- Audit report and formal response report must be placed in the project file. It could be used for any investigation and
- a follow up procedure of the actions or inactions taken by the road authority and identifying what was said and done at the time of responding to the audit is helpful.

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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