Road Safety Audit, tools, procedures, and experiences: a literature review and recommendations

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Research in the framework of the European research project SAFESTAR, Workpackage 8

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VTT	*Technical Research Centre of Finland; Espoo, FIN*
LNEC	*Laboratório Nacional de Engenharia Civil; Lisbon, P*
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CETE	*Centre d'Etudes Techniques de l'Equipement Normandie Centre; Grand-Quévilly, F*
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Executive summary

Introduction

This report describes tools and procedures established in different countries which apply Road Safety Audits (RSA). These RSAs are utilized to identify potential safety problems and they concentrate on safety measures to overcome these problems. This technique is used to detect possible safety hazards, in the various stages of a scheme, before a new road is open to traffic. The slogan 'Prevention is better than cure' is already well known to us, and Road Safety Auditing can establish an association with road safety. The application of this preventive technique can prevent accidents or reduce the severity of accidents. Except for minimizing trauma, and increasing the designer's awareness of road safety, RSAs can also reduce the overall lifetime cost of a scheme, for it is less likely that remedial rebuilding of road sections will take place. Therefore this report deals with schemes subject to design and redesign of new roads, rather than existing roads. Strict application of design regulations does not always lead to a safe road for general rules don't always apply to specific situations. When applying an RSA, it improves awareness of road safety, and highlights safety among other aspects of road design.

Objectives of safety audit

The main objective of safety audits is to ensure that highway schemes operate as safely as possible, i.e. to minimise the number and severity of occurring accidents. This can be achieved by avoiding accident-producing elements and by providing suitable accident-reducing elements. The purpose of safety audits is to ensure that 'mistakes' are not built into new schemes. The items summarised below, concerning the Great Britain situation, give quite a general picture about specific aims of the Road Safety Audit.

- to minimise accident risk on the network adjacent to new schemes;
- to lay emphasis on safe design practice and increase the awareness of everyone involved in planning, design, construction, and maintenance of roads;
- to highlight the importance of taking into consideration the needs of all types of users;
- to reduce the whole-life cost of the schemes, by minimising the need of future corrections.

The UK definition is as follows:

> A formal procedure for assessing accident potential and safety performance in the provision of new road schemes, and schemes for the improvement and maintenance of existing roads.
>
> (Guidelines for The Safety Audit Of Highways, IHT, 1996)

In order for a safety audit to be successful, some certain factors should be taken into consideration. The key factors that contribute to the efficiency of the safety audit may refer to the organisation and the selection of the audit team. With respect to safety audit organisation, support and commitment of senior management is necessary. Safety audits should be an integral part of an agency's overall program. Local authorities often use a Road Safety Plan

as a framework in which the RSA is placed. By doing so, the RSA is part of the overall safety management strategy.

Checklists fulfill a structural position

The purpose of the checklists is to insure that nothing is overlooked. Practitioners should not rely solely on them and are encouraged to expand them. Over the past few years checklists were re-considered and the new checklists in the revised guidelines are meant to indicate 'principal issues' rather than provide detailed lists of the items to be examined. Different checklists are provided for each safety audit stage. Checklists appear to be not very important. The usage of checklists decreases as the knowledge of Road Safety Audits increases.

Utilization of Road Safety Audits

When conducting an RSA, the audit team should not try to redesign the scheme, instead they should pay attention to road safety for all kind of different road users, and theirs suspected road user behaviour. The way this should not be done, is to compare the design with relevant standards and see if it matches, but the audit team should check if the design appropriately interacts with the design standards, for strict application of standards does not always lead towards a safe road. Some other findings about RSA are mentioned below. It is important that a site visit is carried out. Both in daylight and at night. Thus the visibility for different road users can be checked in the context of the road and its surroundings. When an RSA is carried out in an early stage of the design process it is less likely that 'errors' become embedded in the design and become harder to correct later on. A RSA should not seriously delay a design process, thus attention should be paid to the embedding of the RSA during the planning of the design process. Attention should be paid to monitoring and feed back to the audit team after opening of the road when accidents occur. The RSA process should be formally organised and its outcomes documented. Concerning the formalization and purity of an audit, it is to recommend that the audit results are documented before there is discussion (if any) with the client, and concessions could arise. Some say that a formalised RSA leads towards a more systematical approach and enlarges the chance on a consistent outcome. The ultimate level of formalisation is to make an RSA mandatory. Relevant plans and documents should be available to the audit team and should be mentioned in the report. It should be clear what should be audited, which tasks there are and who is responsible for those tasks. It can be beneficial to use the same names and numbers of stages for less misunderstandings and for comparison with other RSA documents.

Introducing Road Safety Audits

Probably the best way of introducing RSA is 'top down' (management and governmental) approval and 'bottom up' training. In this introduction stage the use of checklists could be useful. When introducing RSA, knowledge of accident investigation techniques or safety engineering audit team is necessary. Another crucial point in introducing RSA is to how to tell when a designer is wrong. The best answer dealing with this problem is probably an increase of accidents. On a European level, the procedure could perhaps be

used in a highly aggregate level, using local knowledge of road safety when performing an RSA.

Proposal for the development of a framework

A framework for the development of RSAs can be found in five points containing tasks for the different bodies responsible for different aspects of road safety.

- National governments; they should develop RSA procedures and methods.
- National road authorities; they should perform pilot audits for all roads, including TERN.
- National organisations which are responsible for design guidelines & manuals; they should integrate RSA in tools for improving road safety
- National road research institutes; they should evaluate RSA.
- European Commission; it should initiate pilot audits on TERN roads. These pilots should point out how the audits for TERN roads will be performed, with regard to procedures, the audit team, and responsibilities.

General conclusions

Some European countries have developed a national RSA system. Many people involved in this development think of RSA as a promising way to improve road safety.
RSA Pilot projects point out that design inaccuracies can be discovered in new road designs and RSA evaluations already carried out in some counties have been very positive; RSA seems to work.
The introduction of an RSA system can either be done bottom up or top down. A bottom up approach can lead to a vast, enthusiastic participation whereas a top down approach can lead to a more explicit introduction.
Although road safety comprising design solutions can be tracked using an RSA, the precise effects are yet still unknown.
Quality is added to a national road system by using an RSA system.

Contents

1. Introduction

This report is the result of SAFESTAR Workpackage 8.1, concerning Road Safety Auditing. SAFESTAR stands for *SAFE*ty *STA*ndards for *R*oad design and redesign. It is one of many projects within the Transport Programme of the fourth R&D Framework Programme of the European Commission.
SAFESTAR has been structured by means of nine Workpackages. This survey about RSA is part of Workpackage 8. Many European institutes are cooperating in this Workpackage 8. SAFESTAR primary deals with roads which are part of the Trans European Road Network between main European centres of population. In this literature review procedures concerning other types of roads are also dealt with.
This report describes tools and procedures established in different countries which apply Road Safety Audits. These RSAs are utilized to identify potential safety problems and concentrate on safety measures to overcome these problems. This technique is used to detect possible safety hazards, in the various stages of a scheme, before a new road is open to traffic.
The slogan *'Prevention is better than cure'* is well known to us, and Road Safety Auditing can establish an association with road safety. The application of this *preventive* technique can prevent accidents or reduce the severity of accidents. Except for minimizing trauma, and increasing the designer's awareness of road safety, RSAs can also reduce the overall lifetime cost of a scheme, for it is less likely that *remedial* rebuilding of road sections will have to take place. Therefore this report deals with schemes subject to design and redesign of new roads, rather than existing roads.
Strict application of design regulations does not always lead to a safe road; When applying an RSA, it improves awareness of road safety, and highlights safety among other aspects of road design.
In the first chapters this report describes the state of the art of RSA in the UK, Norway, Denmark, Australia, New Zealand, the USA, and France. In contradiction to previous proposals, Greece and The Netherlands are not accounted for in this review, for those countries do not have experiences with RSAs yet. There are other organisations and countries that have experiences with Road Safety Reviews, like the World Bank and some countries in the Far East, but they are also not reviewed in this survey.
The later chapters concentrate on comparison and conclusions.

Annex A of this report describes the checklists belonging to the different procedures in the different countries. *Annex B* contains Workpackage 8.2, the visit to the United Kingdom. *Annex C* contains the constraints and possibilities for Road Safety Audits in various countries related to this SAFESTAR Workpackage 8. *Annex D* contains the report of the two days workshop which was held in Copenhagen In 1997. This workshop dealt with different aspects of RSA and included some experimental audits conducted by the workshop members. This workshop was held in addition to this SAFESTAR Workpackage, replacing intentionally planned experimental pilot studies.

2. United Kingdom

2.1. Introduction

In the UK there has been an increasing awareness of road safety issues since the early 80's. The reduction of annual accident tolls has become an objective of high priority. The Department of Transportation as well as local authorities have put considerable effort in analysing the problem and in seeking ways for overcoming it. Steps towards improving road safety in the UK, include the following [1]:

- In 1983 the Inter-Departmental Review of Road Safety was set for examination of the current situation in the UK, regarding road accidents, and the results of the study were published in 1987 in 'Road Safety: the Next Steps'. The main recommendations of the report were setting a target for the reduction of casualties by 1/3 of the 1981-1985 average by the year 2000 and establishing a national strategy based on which the problem would be tackled efficiently and the objective met.
- Since 1990 safety schemes are financially supported through Transport Supplementary Grant (TSG), for which all local safety schemes are eligible and in 1992 an increase in the grants was announced.
  During the last decade a number of initiatives have been made and a number of measures have been suggested towards safer roads for all the users. Such measures cover behavioural and vehicle aspects as well as highway improvements and included provision of highway safety elements (e.g. zig-zag lines on pelican crossings), changes in legislation, enforcement (speed limits, seat belts in rear of cars). Among the means and methods introduced in the UK for reaching safety objectives through highway improvement, is the practice of safety audits.

2.2. General description of Road Safety Audits

2.2.1. *Safety Audits*

Traditionally, safety engineering in the UK was concerned with accident reduction by remedial treatment of sites with high accident frequency. Modifying high risk sites is accepted as an essential policy towards safer roads. However, it was acknowledged that 'prevention is better than cure' and as a result, a different approach to accident reduction has recently been adopted. Placing emphasis on accident prevention. It was realised that accident reduction policies would be more efficient if measures were taken at an early stage and the existence of 'hazardous' schemes were avoided, especially within new designs. The philosophy of accident prevention was that of using the experience gained from past accident investigation to minimise future accident problems. For this purpose the introduction of Safety Audits was suggested.
A road safety audit is defined as 'a formal procedure for assessing accident potential and safety performance in the provision of new road schemes and schemes for the improvement and maintenance of existing roads' and

concentrating on road and traffic engineering measures (rather than education or enforcement) [2].
Safety audits can be applied in schemes of various types. Such schemes generally fall into the following categories:

- major highway schemes;
- minor improvements;
- traffic management schemes;
- development schemes;
- maintenance works.

2.2.2. *Background of introduction of safety audit*

The need of taking measures for accident prevention became apparent in the early 70's and the concept of checking schemes prior to opening was discussed.
As a means of applying safety principles in new design schemes, safety audits in the UK first appeared in the early 80's. Today safety auditing is a formally established practice, widespread throughout the UK.
Important steps in the history of safety audits in the UK are the following:

- The Road Traffic Act of 1974 stated that, when constructing new roads, local authorities should take appropriate measures in order to reduce possibilities of accident occurrence when the road is in use.
- In 1980 IHT publishes the first Guidelines with the title 'Guidelines for Accident Reduction and Prevention'. One of the objectives set by the guidelines was 'the application of safety principles in the provision, improvement and maintenance of roads as a means of accident prevention'.
- In 1988, according to changes in legislation included in the new Road Traffic Act, local authorities are statutorily appointed bodies responsible for the safety of the roads within their area. The Act stated that a local authority must, in constructing new roads, 'take measures as appear to the authority to be appropriate to reduce the possibility of accidents when the roads come into use'. Highway authorities are commissioned to :
  - carry out road accident studies
  - take measures for the prevention of such accidents.
- In 1989, the Local Authority Association publishes 'Road Safety Code of Good Practice' in which ways of achieving accident reduction are discussed. The application of safety audits was recommended. In the same year the Scottish Office issued Circular 23/1989, referring to Road Safety Audit procedure in Scotland.
- In 1990, Guidelines titled 'Guidelines for the Safety Audit of Highways' were issued by IHT with the purpose of giving description the process of safety auditing and advice on how to carry out safety audits, based on the experience gained throughout the years. The report included detailed checklists [3].
- In April 1991, and in accordance with HA 42/90, HD 19/90 'Road Safety Audits', safety audits were made compulsory for trunk roads and motorways in England and Wales.
- 1991 onwards: Individual local authorities, like Northamptonshire and Kent county council, continued to produce their own Safety Audit guidelines.
- In 1994, HA 42/90 and HD19/90 were revised and HA 42/94, HD 19/94 were issued.

- The new IHT Guidelines published in 1995 reflect the experience gained in procedures and the practice of safety audits. Revised checklists are included in this edition [2].
- In the revised version of 'Road Safety Code of Good Practice' of 1996, produced by the Local Authority Association, the conformation with IHT guidelines is suggested.

2.2.3. *Objectives of safety audit*

The main objective of safety audits is to ensure that highway schemes operate as safely as possible, i.e. to minimise the number and severity of occurring accidents. This can be achieved by avoiding accident-producing elements and by providing with suitable accident-reducing elements. The purpose of safety audits is to ensure that 'mistakes' are not built into new schemes.
Other specific aims of the Road Safety Audit are :

- to minimise accident risk on the network adjacent to new schemes;
- to lay emphasis on safe design practice and increase the awareness of everyone involved in planning, design, construction, and maintenance of roads;
- to highlight the importance of taking into consideration the needs of all types of users;
- to reduce the whole-life cost of the schemes, by minimising the need of future corrections [2];

In order for a safety audit to be successful, some certain factors should be taken into consideration. The key factors that contribute to the efficiency of the safety audit may refer to the organisation and the selection of the audit team (AT):
With respect to safety audit organisation, support and commitment of senior management is necessary. Safety audits should be an integral part of an agency's overall program. Local authorities often use a Road Safety Plan as a framework in which the RSA is placed. By doing so, the RSA is part of the overall safety management strategy.
With respect to the auditing team:

- The team should include specialised safety engineers with experience in accident investigation and analysis.
- In order to ensure that the procedure is as objective as possible, the auditors should be independent of the design team. This is insisted on by the Department of Transport.
- Attention should be paid to all road users; pedestrians, (especially children), bus drivers and passengers, cyclists as well as motorists, especially for urban schemes, and their needs should be considered. In order to achieve this, the auditors should take the role of all users and try to predict/visualise, as precisely as possible, the way different users will perceive the scheme ('drive, ride, walk' concept).
- Consultation with experts outside the auditing team (such as traffic signals engineers, the Police) may be necessary.

2.3. Auditing procedure

2.3.1. *When should safety audits be carried out*

Safety aspects can be considered during planning, design, construction process. The following stages of a project are indicated as possible stages for a safety audit to be carried out:

- stage F- Feasibility study
- stage 1- Completion of preliminary design
- stage 2- Completion of detailed design
- stage 3- Prior to opening

The choice of safety audit stages will largely depend on the type, size and importance of the project as well as the procedures within the authority in charge and will be indicated by client's needs.

Generally, current UK practice requires formal audit reports at stages 1, 2 and 3. More specifically (according to 1995 guidelines) [2]:

- Stage F is specified by some Local Authorities for schemes on non-Trunk roads, but is usually unnecessary for traffic management, major maintenance works, or accident remedial schemes. If a formal Feasibility Stage is carried out, one might have the opportunity to question route choice, or indeed to question whether to build the road at all.
- The Department of Transport Design Manual for Roads and Bridges covering Trunk roads requires only stages 1 to 3, with combinations of stages 1 and 2 in certain circumstances.
- For smaller improvements stages 1 and 2 may be combined.

2.3.2. *Process*

Independently of how the safety audit is organised, it is recommended that certain procedures should be incorporated. The full and formal implementation of safety audits, includes the following steps [2]:

- *Commissioning the audit*: the highway authority (client) should identify the schemes to be audited, the safety audit stages, state the scope and organisation of the audit, and determine the roles of everyone involved in the procedure, specifying each of these elements in clear terms of reference. Special requirements of the audit should be included.
- *Initiating the audit*: as an initial act in the auditing procedure, it is the responsibility of the Project Manager to provide the selected auditing team with a brief that includes information about the scheme and relevant documentation (general description and purpose of scheme, plans, predicted traffic composition, terms of reference).
- *Undertaking the audit*: is a responsibility of the auditors who should work within the terms of reference, in order to ensure that the client's requirements are satisfied.
- *Responding to audit*: it is the responsibility of the Project Manager to review and assess the result of the safety audit. The project manager should consider feasible ways of achieving the recommenced by the auditors changes in the design. The amended design should then be re-audited. Any objections on the actions suggested to mitigate the problem should be reported and an exception report should be prepared, giving full reasoning.

- *Finalising action*: the final decision on impending changes, is a responsibility of the client. As part of the finalisation act, completion of the documentation on any action taken, is necessary, for subsequent inspection or potential use in case of litigation / public inquiry.

2.3 3. *Undertaking the safety audit*

Typically, auditing involves certain tasks. The procedure is as follows :

1. Collection of information. Such information may include: detailed plans, design standards, traffic volumes, pedestrian counts, and accident records are relevant. At this stage, prior to any appraisal of the layout a discussion with the design team about the objectives of the design, is advisable.
2. The systematic and detailed check of the design follows. At stage 2 this often involves overlaying the details from one plan on to another, as there will be different drawings for road layout, street-lighting, safety fences, signs and markings. It is often the interaction of features that causes problems - for example, no one intends that lamp columns should be erected on the wrong side of safety fences. For stages 1 and 2, following up a preliminary assessment of the design, it is essential that a site visit is carried out, so that the tie-in with existing roads can be considered, and the local conditions assessed. For stage 3, examination of the physical elements in site is the main task at this stage of the process. This may involve negotiating the scheme from different directions, in the dark, under adverse weather conditions.
   In examining and evaluating the design, checking each element individually is one aspect. Once the audit team has predicted the type of accident problem that is likely to be associated with an aspect of the design, a known remedy to mitigate that problem should be suggested. It is important that the scheme is viewed as whole and the impact of the combination of its elements and features to the users, is taken into account.
   In undertaking this task, the use of checklists is strongly recommended.
3. The findings of the audit are presented in a formal report. Precise description of the possible problems identified is required, giving reasons for the anticipated conditions. For the purpose of strengthening the arguments and ensuring the objectiveness of the results, it is required that the auditors make use of control data and the guidelines. The final report should also include recommendations on how to solve the problem. Location plans on which identified problems are referenced and drawings for presenting the proposed amendments can be used.
   When recommending it should be kept in mind that the objective of the audit is the improvement of the suggested scheme and that contradicting the designer and questioning/challenging the pertinence of the design, is not desirable. Within the local situation it is likely that the safety audit team will discuss their findings with the design team, possibly with an informal report. This will not be the case on a Road Safety Audit for the Department of Transport where a formal report is required to be produced, and sent to the Department direct.

Monitoring

On the basis of assessing the procedures and practice of safety auditing, it is necessary that the safety aspects of the scheme are monitored, in order to ensure the safe operation of the scheme throughout the service life of the scheme. After the opening, safety audits should be carried out [2]:

- shortly after the opening;
- after any incident or accident;
- shortly before the end of the contract maintenance period.

The Department of Transport is responsible for the monitoring on strategic road schemes.

IHT Guidelines suggest that a safety audit process record is kept, with the purpose of [2]:

- making a record of possible problems in the design and their implications and thus providing the designers and auditors with necessary feedback and a means of training.
- assessing the effectiveness of safety audits by identifying the actual condition, regarding road accidents, with the use of accident data. This will contribute to a better understanding of road safety causation factors.
- recording scheme costs. This involves resource costs of audits at each stage and the cost of any improvement works. Such records can be used in accident saving potential analysis, to evaluate the costs and benefits of safety audits.

Checklists

The purpose of the checklists is to insure that nothing is overlooked. Practitioners should not rely solely on them and are encouraged to expand them.

Over the past few years checklists were re-considered and the new checklists in the revised guidelines are meant to indicate 'principal issues' rather than provide detailed lists of the items to be examined. Different checklists are provided for each safety audit stage.

Safety Principles

IHT Guidelines discuss the safety principles and give detailed advice on the checking of each element of the design. This will help the audit team make predictions about the type of accident that can be expected in association with various aspects of the design. Safety principles may refer to features within the following broad areas of consideration :

- geometric design;
- road surfaces ;
- road marking and road signs;
- street furniture;
- traffic management;
- road works and maintenance.

Auditing existing roads

Safety audits refer mainly to new designs. They can however be implemented on existing roads as a complementary tool together with the analysis based on accident data. One of the main purposes when auditing existing roads is to identify if elements and features are in accordance with the standards indicated by the hierarchy within the network.

2.4. Resources required

The required resources can be examined in terms of personnel, time, and cost. The figures in *Table 1* refer to 1993 records and are indicative.

Resources	Required amount
Personnel [number of persons in team]	1-7 (depending on type and stage of scheme) major highway schemes (average) : 3
Hours to complete an audit [person hours]	average: 25 min: 10 (in 21% of cases) max: 40 (in 7% of cases) for major highway schemes *: 41
Audit cost [pounds]	£ 100 - £ 6000
Redesign cost [% of construction cost]	major schemes: average0.5 % max: 10 % lesser schemes **: average3 % max: 33 %
Redesign time [days]	½ - 35 days
* major highway schemes : ** lesser highway schemes :	schemes with costs of £ 500,000 or more schemes with costs of less than £ 500,000

Table 1. *Road safety audit resources 1993 [2, p.16]*

2.5. Benefits from the use of safety audits in the UK

In assessing the benefits from the use of safety audits, the most direct factor is the reduction of the number of accidents. The potential change in accident frequency however is difficult to determine, firstly because of the uncertainty in estimating the number of accidents that would have occurred if the audit had not been carried out, and secondly due to the lack of control data to compare with figures from similar unaudited schemes.
An indication of the potential benefits in terms of economic returns can be derived given the estimated cost per injury accident of £ 55,650. Based on this estimate it is clear that 'on most schemes, the prevention of only one injury accident will produce a positive economic benefit'.

2.6. Review of current audit practice

In order to review the national UK practice of RSA, in 1994 research was done by means of a questionnaire sent out to 63 local authorities and 30 consultancy firms. There were 62 respondents. This summary of 'current practice' has been used as an aid to the revision of the Institution of Highways & Transportation Safety Audit guidelines. Previous analysis of the current practice of road safety audit (County Surveyors' Society 1993) indicated that most authorities use their own systems rather than those published by IHT or the Department of Transport. As a result of this investigation, different issues were analysed and commented upon. These findings about e.g. management, resources, and monitoring are mentioned below.

2.6.1. *Management*

The position of the initiator of the RSA varies per organisation. The way in which results of an RSA are dealt with also differs. Sometimes the project manager decides what to do, and in other cases the audit team plays a more

decisive role. The RSA procedure should pay attention to the following three considerations:

1. Any advice that is provided; the findings, recommendations and exceptions to the recommendations of an audit at all stages; should be formally documented.
2. The designer should be provided with explanations of any advice that is rejected.
3. Procedures should be established for arbitration.

2.6.2. *Types of schemes audited and stages of Audit*

Six stages of audit were identified; they are:

1. feasibility / initial design stage,
2. preliminary design stage,
3. detailed design,
4. stage prior to opening,
5. post opening,
6. maintenance period / monitoring.

Most of the respondents' RSAs stages concerned preliminary design (32 %), detailed design (35%), and prior to opening (17%). Schemes concerning Major highway and or schemes > £ 0.5 million and Minor highway - non junction together, accounted for some 42 % of the total of schemes which were used in this investigation by A. Crafer. Crafer found that earlier formal involvement from safety experts would mean that safety would be considered in the same context as other major design constraints, such as cost and capacity.

2.6.3. *Resources*

The time spent on conducting an RSA varies considerably. The responding consultants needed 8 to 109.3 hours with an average of 58 hours to complete an RSA. The RSA undertaken by the local authorities themselves took from 2 to 80 hours, with a average of 21 hours. The overall weighted average for completing an audit was found to be 25 hours. Time could be reduced in the later stages if a feasibility stage RSA had been carried out and there were informal consultations throughout the design of the scheme.

2.6.4. *Redesign costs*

Table 2 indicates the average percentage of construction costs as a result of redesign due to the audit compared to the original construction cost for varying sizes of schemes. The combined average percentage for audits carried out by both local authorities and consultants, was found to be 0.72 %. Smaller schemes tend to require a greater percentage. In some cases the audit team recommendations even led to a cost reduction.

Size of scheme (original construction costs)	Local Authorities		Consultants	
	Percentage	Range	Percentage	Range
Lower than £ 500,000	3.36 %	-3.1 % to 33.3 %	1.6 %	0 to 10 %
Higher than £ 500,000	0.24 %	0 % to 10 %	1.16 %	0 to 5 %
All schemes	0.35 %	-3.1 % to 33.3 %	1.16 %	0 to 10 %

Table 2. *Road Safety Audit costs. The costs of redesign due to the audit, as a percentage of the original construction costs.*

2.6.5. *The audit team*

The size of the audit team (AT) and the background of the auditors vary according to size and type of the scheme and stage of the audit. The overall weighted average number of personnel comprising an audit team was found to be 2.2. This varies between 1 and 7 for the different stages of audit and types of schemes. There does not appear to be any correlation between the size of a scheme and the number of people comprising the audit team, although the number does increase with the later stages of the audit. This could be a result of the specialist personnel being included in the audit team. It appears that in this particular investigation, consultant auditors hold more qualifications, with 55% having degrees, compared to 35% of Local Authority auditors.
The current IHT Guidelines and HA standard do not prescribe the specifications or amount of experience the AT should possess, but specialist safety expertise must be used. Some counties, however, do have policies about the background of the auditors. Northamptonshire County for example, expects that auditors on major schemes have attended the RoSPA AIP course.

2.6.6. *Monitoring, evaluation, and training*

The use of monitoring and evaluation is a method by which safety auditors can learn about certain issues affecting the scheme, which can be applied to similar projects and areas. Feedback to the designers could lead to more awareness of the implications of their design to safety. Nevertheless the Dep. of Transport HA 42/92 says: It is central to the auditing procedures that the audit team have no connection with the scheme design and should maintain their views are not influenced by familiarity or from natural 'pride of authorship'. Providing safety advice by the AT to the design team conflicts with the importance of independence, however many respondents to the questionaries think this kind of education is more important than perfect independence. Training for all participants in road safety audit, including staff members, could increase the awareness and importance of safety issues. Another way of training the design team is providing them with checklists. By doing so, the audit team knows which items the audit team will take notice of. Some 'evident' mistakes could be prevented from being incorporated in the design. This does not make the Road Safety Audit obsolete, this rather gives the AT more time to use their experience and intuition. For obvious errors are probably not embedded in the design.

2.7. Summary and general discussion

Safety audit is a means of applying safety principles in the context of road accident prevention. In use since the early 80's, it is established as a requirement in construction and maintenance of highway schemes in the UK. The importance of safety audits is that, in examining the safety aspects of roads, all road users are considered, and the particular safety conditions of the given alignment are taken into account.

There is evidence that benefits from applying the safety audit counterbalances the cost of undertaking the safety audit. Given the estimated cost of a single casualty in the UK, and in terms of financial returns, safety audits are beneficial on most cases. Furthermore, benefits can be derived if safety audits are viewed as a training/education medium and as an aspect of Quality Assurance.

Over the years the evolution of auditing process has been dynamic. The idea behind safety audits and the scope remain the same, since safety audits were first introduced, however experience gained from practice has been used to improve the procedures. Since the release of the last Guidelines:

- Legal requirements have been strengthened.
- The objectives were better defined. The importance of taking into account all the road users, with special consideration of vulnerable ones, is highlighted.
- The consequences of application have been identified and stressed. The legal implications of possible litigation are among the main considerations of the auditors.
- More emphasis was placed on management issues and necessary procedures.
- The form of recommended checklists has been changed. Less emphasis is given on detailed guidelines on how to deal with each element of the alignment. The checklists were modified to give guidelines on issues to consider.

In the revised Guidelines of 1996, the safety audit process is described in detail, and the roles and responsibilities of everyone involved at each stage of the safety audit process are more clearly defined.

Auditing is complex an *iterative* process, especially in the local authority situation compared with the mandatory trunk road and motorway situation. It requires the examination and assessment of the audit results and recommendations from the other parties involved, and often the reconsideration from the auditors, of decisions taken. When applying safety audits, it should be kept in mind that, in order to ensure that design, construction, and maintenance procedures are not obstructed, the very good coordination and collaboration between all parties is required. The organisation of the audit should also provide a path in this direction.

3. Denmark

3.1. Introduction

Road Safety Audit was introduced in Denmark on a pilot basis in 1993. The pilot project was initiated in 1992 (strongly inspired by the concept of Safety Audit from the UK) by the Road Safety and Environment Department of the Danish Road Directorate. The Danish Road Directorate adapted the British concept to the specific Danish conditions and published a Manual concerning what should be audited, when, how, and by whom it should be done /1/. After an evaluation of the pilot project a new Manual is on the way.

3.2. The pilot project

Via the pilot project, the adapted procedures were applied in a number of selected National and Regional road schemes designed by the Design Department of the Road Directorate's own Highway Construction Unit, as well as by one of the 14 Regional authorities at the County level. At the same time Safety Audit was included in the Quality Management procedures of the Construction Unit, and used in a number of new bypass schemes.
Furthermore, the Road Safety and Environment Department audited a number of municipal road construction schemes, as a consultant.

3.3. Prevention is better than cure

The purpose of Safety Audit is to ensure that all road schemes should function as safely as possible. This means that the road users will be exposed to a minimum risk of an accident, both on new roads and on existing roads. When this is not the case today, it is rarely due to a lack of good will, but rather, that road safety considerations are lost amongst all the technical and economic demands which are also made when the scheme is designed.
If the things are done properly from the start, a lot of lives can be saved and serious injuries can be avoided, while at the same time limiting the cost of the scheme over time. Although the initial cost of the design will be a little higher, the expense of rebuilding subsequent 'black spots' can be avoided.
Often, but not always, the wishes for a high capacity at a low cost can be inconsistent with the right safety solutions. These conflicts cannot be solved by the audit. However, the conflicts are made apparent so that a decision can be made at the right time and at the right level of organization.

3.4. The Danish definition of safety audit

Safety Audit is a review (scrutinization) of road schemes from a traffic safety point of view, before the schemes are carried out in the field. The purpose is to avoid the building of road designs which, as experience shows, result in many accidents. The experiences about what is safe, and what should be avoided, stems from research, but also to a considerable extent from practical experience working with *accident reduction* measures.
Safety Audit is carried out by an auditor who looks through the scheme with 'safety glasses on' and writes up a report with comments and suggested

changes. The auditor's role is to act as an independent expert; if necessary from another organization than the scheme designer and the client.

3.5. How is a Road Safety Audit carried out?

3.5.1. *The audit stages*

In most cases RSAs are recommended at several stages during the planning, design, and construction of a scheme, unless the scheme in question is a very small one. Five stages in the planning and design process have been identified where RSA would be appropriate:
Stage 1, Initial Design, is the feasibility stage where the audit deals with the road safety aspects of the initial design (route options, standard, and number and type of junctions).
Stage 2, Preliminary Design, where the general outlines of the geometric design are available but can be adjusted. Focus points of the audit are horizontal and vertical alignment, cross section, visibility, and intersection layout. This stage is prior to government decision and land acquisition.
Stage 3, Detailed Design, is at the stage of completion of the detailed design, but prior to completion of the tender. At this stage the audit will focus on detailed junction layout, drainage and camber, signals, signs and markings, lighting, planting, and landscaping.
Stage 4, Opening, is a concluding road safety examination of the completed design before its opening and/or shortly after opening.
Stage 5, Monitoring (existing roads), to evaluate whether the road users make use of the layout as intended. New roads are inspected a few months after they are opened. The monitoring may be included in a regular programme in order to detect safety deficiencies of the road network.
The full range of safety audits will normally apply to large-scale new schemes only. For smaller reconstruction schemes the audits at the first stages may be omitted, or combined.
There are check lists for the purpose of each auditing stage. The lists describe problems and situations which can affect the road safety in a scheme. The check lists can also be used by the designer as an aid.

3.5.2. *The safety audit organization*

For any RSA three separate parties are to be identified:
- the scheme owner (the client),
- the design organisation (the designer);
- the auditor or audit team.

RSA is based upon the principle of independent review. In addition, any disagreement between the designer and the auditor should be decided by the client and not by the designer.
The *designer* is responsible for the audit to be undertaken and for taking any necessary measures arising from the auditor's recommendations and/or the client's decisions. Prior to the audit, the designer will provide the auditor with all the drawings and other information about the scheme and its background.
The *client* is responsible for deciding upon any disagreement between the designer and the auditor. In case of such a disagreement, the designer will present the issue to the client, who will make his decision and inform both the designer and the auditor in writing.

The *auditor* (or audit team) is responsible for carefully reviewing all the scheme information presented to him or her, based on the auditor's best knowledge of road safety matters, and from the viewpoint of all road users, including vulnerable road users. The auditor will identify and report any issue that may give rise to road safety concerns, and describe and give the reasons why the issue is highlighted.
The auditor is *not* expected to check whether the scheme complies with current road standards. Road standards form an important tool and a basic reference to the auditor. However, in some cases an auditor will have to go further than the road standards indicate. The designer is presumed to decide on the standards and guidelines, and to report to the auditor about any departures from the standards and the reasons for them.
It is vitally important that an auditor or audit team has a profound specialist knowledge and experience of accident investigation and accident reduction in road traffic. Furthermore, a road safety auditor must be familiar with road design and road construction, and commit himself to keep his knowledge up to date.
In the near future a road safety auditor should be certified. As a first step towards a certification system, an RSA education has been established. In addition to the above-mentioned demands an auditor should have attended this education and have passed the final examination.

3.5.3. *The safety audit procedure*

The procedure outlined below applies to any RSA, regardless of the size or character of the scheme, and of the audit stage:

1. *Commissioning the audit.* The designer contacts an auditor and a written agreement is signed. The designer will provide all necessary drawings and background information about the scheme.
2. *Review.* The auditor reviews all the documents and identifies all the issues of concern. A site visit is strongly recommended. A first draft of the audit report is set up. At this stage an informal contact between the auditor and the designer may prevent any misunderstandings concerning the scheme and its background.
   The audit findings should distinguish between *problems* and *remarks*. *Problems* are issues which imply a documented increase of the accident risk. Problems must lead to design modifications in order to eliminate or mitigate the risk. *Remarks* cover issues to be considered in the later design stages but which - at the actual design stage - cannot be documented as leading to increased accident risk.
   The auditor should state recommended solutions to the problems. However, the auditor should not redesign the scheme but merely illustrate one or more possible improvements to the design.
   The final audit report is signed by the auditor (or by the head of the audit team).
3. *Discussion.* The designer formulates his written response to the audit report, a meeting between designer and auditor may be held, and any remaining disagreements are presented to the client for a decision. The designer describes the design modifications and informs the auditor. Finally the auditor declares the audit to be completed.

3.5.4. *Where is Road Safety Audit recommended?*

The Danish Safety Audit Manual recommends that RSAs are conducted for all types - both urban and rural - of new schemes and reconstructions of a certain size. As RSA is seen as an integrated part of the road authority's Quality Management system, it is recommended that traffic management schemes, major maintenance projects, existing road schemes, road safety work, and development proposals are included as well; to the extent that these activities are influencing the safety of the road users.

3.6. Evaluation of the pilot project

The pilot project was completed by the end of 1994 and was concluded with an evaluation carried out by an *independent expert panel* in the spring of 1995.
The chairman of the panel was Professor N.O. Jørgensen from the Technical University of Denmark.
Based on a cost-benefit analysis and subsequent sensitivity analyses, the main conclusion of the panel about Safety Audit was that:

> "[...] the procedure is profitable (with a first year return of 146%). The quality of the completed schemes was improved. The procedure is evaluated to be generally positive for the parties involved." /6/.

Furthermore, the panel recommended that:

> "The procedure of Safety Audit should be continued and expanded to encompass all larger schemes by the State, counties, and municipalities." /6/.

The cost-benefit analysis was based on 13 selected schemes. All measurable costs as a result of the audit (i.e. time, changes in layout expenses etc.) were compared to the expected accident reduction that was expected as a result of the auditors' suggested improvements.
The expert panel furthermore concluded that the professional qualifications of the auditors play a large role in the process, and that a distinct education for Safety Auditors in preparation for certification should be organized. Certification will help secure the *independence* of the auditors in the organization.

3.7. Status

3.7.1. *The new system in 1997*

The project group involved with the pilot project is in the process of following up on the evaluations and recommendations made by the expert panel. The goal is to make Safety Audit practical to use by other road authorities and make it possible to introduce the measures as soon as possible on all Trunk Roads schemes.
The plan is to introduce Safety Audit as a common practice, similar to the Danish Road Standards which are designed to represent the interests of all road authorities, as well as road users. The Danish Road Standards contain very few binding regulations; however, they are accepted nevertheless and are complied with to a very large extent.

The work is therefore initiated by a project group with representatives from selected departments in the Danish Road Directorate, a county representative, a municipal representative, as well as organisation and education consultants. The group has evaluated that the introduction of the procedure requires among other things:

1. a generally reproducible Safety Audit system;
2. an easily accessible, but precise, description of Safety Audit (a manual);
3. a qualifying auditor's education;
4. certification of auditors along with;
5. updating of the knowledge about road safety via an information data base.

No 1)
The general Safety Audit system contains a description of the procedures an auditor will follow, the organization and the role of each party, the individual activities and cooperation between parties, as well as a standard description of the basic stages in the course of the scheme planning and design process from which the auditing can be carried out (the auditing stages).

No 2)
The Safety Audit Manual consists of a substantiated description of the general Safety Audit system, and practical examples, as well as step-by-step instructions about structure that can be useful when road authorities should decide to introduce the system. In addition, the manual includes checklists, forms, etc., and describes which types of schemes can be audited advantageously and which auditing stages to use.

No 3)
The education of Safety Auditors occupy a relatively short period of time - approximately five days. The applicants are expected to have a certain knowledge of scheme design and road safety. The education consists of learning the procedures for Safety Audit, 'to think road safety', study concrete exercises, and how to obtain and apply information about the most up-to-date knowledge about road safety. The education will be carried out at an already existing educational institution.

No 4)
The certification ensures that Safety Auditors will live up to carefully specified demands about knowledge, experience, application, and maintenance. The system will be established under a recognized agency.

No 5)
The quality of the audit will always depend on whether the knowledge of the auditor is up to date. For this reason, a part of the Safety Audit system consists of a cd-rom/Internet data base with interactive and updated documentation on road safety knowledge. The system will be initiated with existing knowledge in the form of comprehensive manuals, road standards, and Danish and foreign experience, etc. Thereafter, a method of gathering new information and updating the database will be established. The idea is for the base to be used especially by the auditors, but can also be of use to the scheme designers and others.
In addition to the above mentioned five points, a local road safety system is being worked out for the Trunk Roads. Other road authorities are urged to do

the same on their roads. A local Safety Audit system will be based on the general Safety Audit system (No. 1) but will also specify which types of schemes will be audited, and on which auditing stage the selected types of schemes will be audited. The local system furthermore defines who the parties are, i.e. who acts as client, scheme designer, and auditor.

3.7.2. *New manual*

In Denmark, the structure of a Safety Audit system has come a long way. By the beginning of 1997, the manual and the general system would be ready, and by autumn of 1997, the first auditors would be fully trained.
The Danish road sector has no doubt that Safety Audit is a good idea which should be compulsory for all road planning in the future. As a consequence, Safety Audit is included in the national plans for road safety to a considerable extent in the future work on road safety in Denmark.

4. Norway

4.1. Introduction

In 1993, the Norwegian Road Directorate set up a work group to design a line of action to improve the follow-up on road safety at the designing stage. On account of restructuring the Norwegian Public Roads Administration in 1994, the work in progress was stopped. However, now in 1996, the work has been resumed, and an interim handbook dealing with inspection and audit is now drawn up /1/.
The work group has based some of its work on investigations conducted in Great Britain and Denmark, and from discussions with colleagues who were directly involved with the Safety Audit project. Furthermore, the work group has visited the Safety Audit Project Group in the Danish Road Directorate.

4.2. The Norwegian Public Roads Administration's quality control

The Norwegian road safety auditing system is not solely based on foreign experience. The audit system itself is based on general guidelines for quality control systems set by the Norwegian Public Roads Administration. As a result, the road safety audit has become an integrated part of the general quality control system of the Public Roads Administration.
The quality control system is based on recommendations made by the international standards of the ISO 9000-series. The system is developed and designed to fit the operations of the Public Roads Administrations and has the goal of ensuring that the quality control measures are carried out, and to ensure that in general, the goals set out are achieved.
The quality control manual of the Public Roads Administration describes their quality control policies and the quality control system which apply to all concerns affiliated with the Public Roads Administration work force. In order for there to be a quality system which can be depended upon in the future, and to prevent the quality of the system from deviating, it is the Roads Administrations main concern to ensure that only a single system is used by all concerned, and consequently also the area of road safety /2/.
The Public Roads Administration's quality system is designed at three levels:

Level A: Quality policies - quality manual of the Norwegian Public Roads Administration.

Level B: Main tasks and activities: quality manuals, procedures, and other guidelines for common use within the Norwegian Public Roads Administration, including the County Roads Offices.

Level C: Products and services in the Norwegian Public Roads Administration (the operational level). Quality manuals, quality plans, procedures, and records for the County Roads Offices and for departments within the Public Roads Administration.

The last mentioned *Level C* is also called *The operative level.* All work involving internal quality systems and ensuring quality, including the road safety audit, within the Public Roads Administration will be under *Level B*. Quality manuals, procedures, and other guidelines given for the Public Roads Administration at large will thus be under *Level B*. *Level C* includes all local

quality systems, plans, manuals etc. for the departments within the Public Roads Administration and for any one of the County Roads Offices.[1]

The quality control manual defines the quality audit as "a systematic and independent examination to determine whether quality activities and related results conform with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives." /2/, /4/. Road safety audit is discussed in the quality control manual as a *special auditing*, i.e. a form of auditing where the focus is on a special topic that is evaluated, in this case road safety. Road safety audit *might* in this form consist of examining:

- The quality of the audit system - *system audit*. System audit is used to determine whether the systems organizational and managerial aspects work sufficiently to ensure that the activities are defined, organized, planned, carried out, inspected, and documented.
- The quality of the work process - *process audit*. The designers' own work process in planning for a road is itself considered a process which can be audited by independent auditors (process audit). A process audit has one essential purpose. That is to examine whether those quality control measures which the designer should use to attain a good result, a faultless plan, are used and work according to the purpose. Check lists are such a measure.
- The quality of the product itself - *product audit*. The product can, e.g. be a plan, a road element, etc. With a product audit, the degree by which the standard requirements are in accordance with the results can be determined. In other words, the focus is on the results.

For the time being, it is the *product audit* which is in focus in the interim Norwegian handbook of inspection and audit, /1/.

4.3. Safety inspection and safety audit

The Norwegian handbook of inspection and audit makes a distinction between two concepts: *road safety inspection* and *road safety auditing*.
Road safety inspection is carried out by the person who is responsible for the planning and design and/or someone who is technically skilled within the same department: *own quality inspection*. The inspection can also be carried out by a member of another department: *internal quality inspection*. The road safety inspection employs check lists which are also devised for the road safety audit.
Road safety auditing is defined as "a *systematic* and *independent* evaluation which ensures that the products (roads, traffic systems, traffic control) have the quality desired with respect to road safety. The audit should not primarily control whether the planning is in agreement with relevant design manuals, standards and guidelines, but should also be concerned with the auditor's knowledge and assessment techniques and implementing of the check list"/1/. The point is that the auditor must never give the impression that he or she is superior with respect to the person whose work is being audited. In other words, the responsibility for the quality must not be transferred from the planner/designer to the auditor.

[1] Norwegian Public Roads Administration is built around a central Road Directorate and 19 so called County Road Offices. There is a road office in every one of the 19 Norwegian counties. Every road office has a Chief County Roads Officer who is subordinate to the Director General of Public Roads.

The Norwegian goal of the audit is to first and foremost investigate whether quality activities are used and work appropriately. A 'good solution' is, in connection to quality work, a comparison with in advance defined and documented demands on road safety. And it is the designer's responsibility to ensure that. The auditor should first and foremost ensure that it has been done. /Nyland, K./.

4.4. How is a road safety inspection/road safety audit carried out?

Which activities should be inspected and which should be both inspected and audited? Who should conduct the actual audit? Which qualifications should the auditor possess? How should the audit be communicated and how should any disagreements be handled?
These issues should be clarified and resolved before the work of inspection and auditing. In connection with road safety, the following guidelines and intentions are set forth for the time being:

4.4.1. *Road safety inspection and road safety auditing*

Inspection of all work is delegated to the Public Roads Administration. This happens either in the form of own quality inspection and/or internal quality inspection. To begin with, it should be decided whether an inspection of the project will be conducted or whether *both* an inspection and audit will be conducted. The decision is made by the road chief from each county and is dependent on the complexity of the project and the expected effects on road safety. The more complex the task is, and the larger the expected safety effect is, the better the argument is for a road safety audit to be implemented.
For the time being the road director must write up a contract with the road chief each year detailing which goals should be set for each county. A goal could, for example, be to conduct at least three audits for that year, of these, two road safety audits. It is at this point that either the road chief or the department leader of the county decides and prioritises which project will be audited.
It is the Norwegian Road Directorate's intention that an audit should be conducted for all road planning within the Norwegian Public Roads Administration, at least for the larger projects. The Road Directorate furthermore deems it reasonable that the road offices of each county at their discretion should choose to conduct an audit of small projects, while on the other hand, strongly suggests that the road offices conduct audits for all larger road projects.

4.4.2. *Who should conduct the audit, and which qualifications should the auditor possess?*

The auditor should be an independent technical person or a team. The auditor can be from the Road Directorate, from neighbouring counties, or from a consulting firm. If the requirement of independence is fulfilled, the auditor can come from the same organisation as the planner/designer.
The main point of the auditor is not error finding, but to give constructive criticism to improve the schemes. It is therefore essential that the auditor have an in-depth knowledge of the actual project and moreover, act as a qualified technical support for the designer and plan leader. The auditor should possess a thorough knowledge of road safety issues.

4.4.3. *Contract/agreement about the audit*

An agreement for an audit is entered between the Chief County Roads Officer or the head of the department being responsible for the project, and the auditor. In the case of an inspection, a formal, written agreement is not necessary unless the inspector is an external consultant, i.e. service which is bought. An external consultant demands a contract. The Road Directorate presume that the road offices and the directorate them self has got the requisite competence, e.g. persons who have auditing as a field of responsibility or part of it. /Nyland, K./.
All auditing activities should be planned and coordinated in connection to the annual action plan. In a way this plan is an agreement between a head of department and his or hers subordinates.

4.4.4. *Reporting*

The auditor can make use of the check lists to conduct the audit. After the road safety audit is completed, all comments and remarks about the plan should be documented and signed by the auditor. As proof or as confirmation that the person who commissioned the audit (a road chief or department engineer) has read and understood the auditor's comments and recommendations, the commissioner should countersign. If he or she chooses not to consider the auditors recommendations, his/hers reasons should be stated in the report as well. It is the road chief or the department leader who should approve of points that deviate from the auditor's recommendations.
In contrast to the audit procedure in Denmark, the auditor does not have to make any new suggestions to the plan, but since the auditor is supposed to be an experienced expert, it is recommendable. The auditor is thus allowed to come up with problem solving solutions and recommendations. These should be regard as suggestions and not requirements which the client is obliged to implement. The client should however report to the auditor whether or not the recommendations are implemented, and to give a reason when not doing so, in a separate report.

4.5. **Checklists**

Checklists have been compiled for the following five project areas:

- Planning (initial design, preliminary design, detailed design);
- Details (traffic control projects: intersections, traffic lights, roundabouts, pedestrian and bicycle paths, etc.);
- Construction work (road tunnels, bridges);
- Construction phase/prior to opening;
- Prior to road making/Prior to maintenance work

With respect to his/her own quality inspection the checklists can be used as a kind of memory list for the designer. This will ensure that road safety is attended to properly. In connection with the audit, the lists can be seen as a helpful tool. The questions in the checklists are designed to be used for guidance.

4.6. Status

4.6.1. *A pilot project*

Norway's handbook *(Guideline)* of inspection and audit is presently only available in a temporary edition. A practical application of the road safety audit has not yet been attempted, but a test of the method and checklists is impending; a pilot project was started in early 1997 and would run until the autumn of 1997.
A number of County Road Offices have recently submitted a number of projects to the Road Directorate, wishing to be accepted as pilot projects. The Road Directorate will choose which projects will participate according to some criteria which, among other things, will attempt to test all checklists.
The Norwegian Road Directorate has decided that the first audits will be made before the end of 1997. The County Road Offices can moreover conduct audits as need be. Road Safety Audits will probably be made compulsory from the end of 1998.

4.6.2. *Choosing of auditors for the pilot project*

It has been decided to form a team of auditors, which will probably consist of people from a number of different road offices. The projects to be audited will come from the team members' own county. Combined, the auditing team will cover all topics dealing with road and traffic issues, and common to all of the persons in the team is a good basic knowledge of road safety.
At the present time the road offices have selected people who are qualified to form a team, and now it is the Road Directorate's job to form the work teams.
Prior to starting the pilot projects, each auditor chosen for a team will have to participate in a road safety auditing course which should take approximately two days.

4.6.3. *The handbook*

The present draft of the Norwegian guidelines for inspection and road safety audit, including the checklists, will be re-evaluated according to the experience obtained from the pilot projects.
A complete version of the handbook *(Guidelines)* is expected to be finished by the end of 1998.

5. Australia

5.1. Introduction.

Road Safety Auditing started in the UK in the 1980s, following the development of Accident Investigation and Prevention techniques, and reached out to some parts of The British Commonwealth, including Australia. Various states in Australia applied Road Safety Audits and published their guidelines. The New South Wales Roads and Traffic Authority, for example, started to develop their Road Safety Audit manual in 1990. This was after a series of truck crashes and two severe bus accidents. Their manual was published in 1991. In New South Wales there is a minimum number of Road safety Audits to be carried out on all new work proposals and Safety Audits are also carried out on existing roads. In Victoria, Road Safety Audits are known as 'safety reviews'. This safety review is seen as an integral part of a Quality Management process and is a part of all new major projects. The national association of road transport and traffic authorities in Australia is called Austroads, part of their mission is to promote national standards. They published their guidelines in 1994, thus providing a set of guidelines and procedures which could be used by all its member traffic authorities.

5.2. Definition and goals.

The Queensland Department of Transport defines a Road Safety Audit as a formal examination of road and traffic works, both existing and future, in relation to their accident potential and safety performance by an independent, qualified examiner. The key words are formal, independent, and qualified. In a pre-construction stage, poor safety elements thus can be excluded, trying to prevent the occurrence of accidents, or at least to reduce their severity. The scope of an RSA is mainly to identify problems, as a practical supplement, and it should in no way mean a redesign or rebuilding of a road section, and no decisions should be taken by a safety audit team. In spite of guidelines and standards for building roads, an RSA can be very useful, whereas these building standards are often developed with many objectives in mind, not only safety, so their strict application does not always result in the safest environment. Different goals can be achieved when conducting RSAs. Apart from less and less severe accidents there are also financial benefits. Less accidents will cause less trauma and thus financial damage to the community, and it is easier, quicker and cheaper to change a drawing, than to actually rebuild the road. Another benefit from conducting an RSA is an improved awareness of road safety by Australian road designers and traffic engineers.

5.3. Organisation

In Australia, different states use slightly different RSA methods, but they all have a management commitment, an agreed organizational process, and independence of the audit team. These three features are fundamental organizational requirements to the RSA.
The number of stages of an RSA differs according to which Road Directory, i.e. state, you are in. Queensland uses a five stage RSA, Victoria four, New

south Wales four. The Victoria and Queensland approach is more or less like the method used in the UK. Austroads produced a set of national RSA procedures and checklists. This publication uses five phases:

- the feasibility stage;
- the draft design stage;
- the detailed design stage;
- the pre opening stage;
- an audit of an existing road.

A fifth stage RSA could be carried out during a maintenance programme, for checking the safety of the workmen and assuring the temporary traffic management to be carried out properly.

Generally an RSA process can itself be divided into the three following steps. However, different types of projects have different organisational needs, so there can be a change of emphasis depending on the type of project. These are in brief the three steps:

1. The designer or client:
   - selects an auditor;
   - provides all documents;
   - holds a commencement meeting with the auditor, sometimes called an entrance meeting, to introduce oneselves to each other, and discuss the scope, timetables, and procedures.
2. The auditor:
   - reviews the documents and drawings;
   - inspects the site (as many times as necessary and at night);
   - writes report;
   - holds completion meeting with designer or client.
3. The designer or client:
   - decides on actions;
   - documents these actions. This must be a formal response to the RSA report.

In some cases a few points are added to these three steps. Sometimes an exit meeting is held. In this meeting the audit team could present and explain the results of the RSA report. A safety Assessment Report can also be part of the procedure. This is an overview of the whole RSA procedure.

5.4. The auditor

There are different possible ways of organising an RSA, concerning the audit team. Three of them are mentioned below.

- audit by a specialist auditor or audit team
  (i) : work cannot proceed to the next stage until formal approval has been issued by the audit team;
  (ii) := (i), except that the report is submitted to the client;
  (iii) := (ii), and the report is submitted to designer, who decides which action to take.
- using other road designers;
  (i) : assessment of the RSA report by the client;
  (ii) : RSA submitted to the project manager;
- person in original design team;
  Essential is that a formal report is prepared and documented. (this option has major limitations).

Improvement in performance can be achieved when a team of auditors is used instead of one single auditor, for it is not often that all these skills can be found in one person. It also makes cross-fertilisation possible when discussing ideas. The auditor should have a sound knowledge of safety principles and design standards and should have experience in road safety engineering. Other skills valuable for an audit team are accident investigation, understanding of traffic engineering, traffic management, road design and construction techniques, and knowledge of human perception. Independence of the audit team is also seen as very important for it is less likely that the audit team can be 'prejudiced' about the designers, client or project, the design can audited with 'fresh eyes' and 'an open mind'.

5.5. Quality Assurance

Another way of monitoring safety aspects of design is Quality Assurance (QA). The difference between Quality Assurance and an RSA is that a QA is a continuous proses of detailed checking, usually using detailed checklists; and an RSA is a 'step by step' process. It is possible that a Safety Audit is a part of a QA to ensure that the checking is conducted appropriately.

5.6. MAP

MAP means *M*ass *A*ction *P*rogramme, a proactive road accident reduction programme. This Australian method applies a proven remedy to rectify problems - en masse - to similar locations that exhibit similar average accident characteristics, and where area wide treatments could be expected to produce significant cost - benefits ratios; for instance problems with narrow bridges and their approaches. Whether or not to apply a MAP depends on an investigation of accident records to assess likely costs and possible / probable benefits. The MAP Procedure can contain an identification, a recording of existing conditions, a deficiencies determination, and a work preparation phase.

5.7. Reporting.

Prior to the actual Safety Audit, the client provides all necessary information to the audit team. This includes plans, drawings, a statement of the project objectives and site information, e.g. traffic volumes, design standards which have been used, and, if possible, accident history to pinpoint existing problems.

The RSA report produced by the safety audit team contains four types of information:

1. project information; this e.g. contains the project name.
2. background information; e.g. names of audit team, site visiting date, a list of material provided by the client.
3. findings and recommendations, this is the major part of the report. The comments and recommendations could be marked in some way indicating their importance.
4. a signed and dated statement by the auditors indicating that they have completed the audit.

In reaction to the RSA report the client or designer writes a report whether or not to follow recommendations made in the RSA report. In the case of rejection the motivation for not supporting the RSA must also be stated in this report. It is recommended that this report should be signed.

5.8. The checklists

Each stage has a set of checklists of its own and they can be useful identifying problems. The use of checklists though, can never be a substitute for thinking, knowledge, and experience. Also the checklists are not exhaustive; they are an aid to the audit team to ensure that nothing has been forgotten. The designer also can take advantage of the checklists, for he will know that his design will be audited again and by knowing this, increase his awareness of the safety issue.

5.9. Common problems

Due to the relatively new RSA process, not much is known about the costs and benefits. It has been stated that RSA will add to a maximum of about 10% of the design costs, which in turn can be in the order of 5% of total implementation costs for larger projects. On the other hand, it is hard to tell how many crashes one prevents by conducting an RSA.

5.10. Juridical comments

In Australia, the issue of public authority liability for acts of negligence is an evolving area in which the courts are still searching for definitive answers. The authorities are unlikely to be held liable for failing to adopt an RSA. Nevertheless, for defects in roads causing injury they may. In Australia, any person injured as a result of the alleged negligence of a highway authority must prove, upon the balance of probabilities, that the authority had a duty to care, failed to act reasonably, and caused the damage suffered.
However in some cases Highway authorities are immune to liability. This is when they fail to repair or maintain a road. This failure to act is termed 'nonfeasance' and is distinguished from 'misfeasance', taking positive action but acting carelessly.
There is yet another issue involving liability. If the authorities performed neglectfully, and this performance is a result of 'policy' decisions, the case should be left to the authorities, but 'operational' decisions should be subject to review by the courts. It is clear that in those cases where a decision, whether or not to adopt to problems located in an RSA, has been taken and documented, and the decision is based upon cost or political considerations, it is much easier for a court to decide that the decision was a policy decision rather than a decision in the operational sphere. This pleads for a sound and documented reaction to comments made in an RSA. Not adopting the conclusions of an RSA certainly would be an issue in court. Therefore reasons for rejecting audit recommendations should be in writing.
Nevertheless, authorities that fail to adopt an RSA, run the risk that avoidable defects on the road will not be discovered, and that the defects will cause accidents.

5.11. Education

Training in Safety Audit is seen as a vital ingredient. Courses have been developed and a series of workshops have been completed in several states. Even universities in New South Wales and Victoria have included the safety audit as a component of their traffic safety studies. Another way of getting experience is participating as a trainee in an audit team. This is a very practical way of developing skills.

6. New Zealand

6.1. Introduction

The need for a comprehensive policy for pre-construction safety audits surfaced after a series of post-construction audits in 1990. In 1993, Safety Audits concerning roads were introduced in New Zealand by Transit New Zealand. This is a Crown Agency for the control of state highways, and provides financial assistance for local roads and passenger transport, which was established in 1989. These Safety Audits emerged after studying principally UK and Australian practice by Transit New Zealand. They set up a working party who comprised representatives from Transit New Zealand, the Land Transport Safety Authority, private consultants, and local authorities. They produced a 'policy and procedures' after some pilot studies on state highways. Transit New Zealand adopted it with the status of advice and guideline. After that, safety audits were planned and made mandatory on state highways on a 20% sample of projects. In July 1996, Transfund New Zealand was created after a restructuring of Transit New Zealand, and became responsible for the funding and the audits.

6.2. Definition

Transit New Zealand defined (Road) Safety Audit as a formalised process to:

- identify potential safety problems for road users and others; and
- ensure that measures to eliminate or reduce the problems are considered fully.

A safety problem is defined as a feature which has been identified from a drivers perspective which gives a misleading or confusing message.

The goals, like in most countries, are accident severity and rate reduction by prevention. This should be done by an audit team whose task it is not to redesign, or to rebuild the road section, nor to make decisions whether to apply the solutions to the problems located by themselves.

6.3. Organisation

Whether to conduct an RSA mostly depends on the project costs. A huge project for instance requires an early stage RSA, and applying an pre opening four-stage RSA on an 'cheap' project is 'only' optional. In New Zealand initially, a four-stage Road Safety Audit system was developed, but later on a fifth stage RSA has been developed as well.

1. A stage **one** RSA (feasibility) should at least consider the following: scope of the project, route choice, impact on and continuity with existing network, number and type of intersections, design speed and speed environment, environmental constraints.
2. A stage **two** RSA (project assessment) should at least consider the following (including the list mentioned under stage one when there is no stage one RSA):

changes since stage one, geometry of horizontal and vertical alignment, location and layout of intersections sight distances, effect of departures from standards and guidelines, implications for cyclists and pedestrians, roadway layout, lighting, implications for construction and operation, typical cross-sections.

3. A stage **three** RSA (final design) should at least consider the following (including list mentioned under stage one and two when there are no stage one and two RSAs):
   changes since stage two, detailed horizontal and vertical alignment, detailed layout of intersections, sight distances, signs and their markings and locations, lighting, traffic signals, provisions for cyclists and pedestrians, implications for construction and operation which includes temporary traffic management and control, cross sections, drainage, delineation, median barriers, poles and other obstructions, landscaping, bridges and culverts, batter stability, guard railing.
4. A stage **four** RSA (pre opening) should at least consider the following: changes since stage three, translation of design into practice, detailed local horizontal and vertical alignment, intersections, visibility and positioning of signs, provisions for cyclists and pedestrians, lighting, drainage, delineation and road marking, median barriers, poles and other obstructions, landscaping, bridges and culverts, any natural features affecting safety.

The audit team also performs a night visit and could use (aerial) photos. It is not clear whether night visits contribute to more identified potential problems; they are probably useful.

6.4. Safety audit of existing roads

The original four-stage system was enriched with a completely different fifth stage which was developed using the Queensland and New South Wales (Australia) practice and was made suitable for New Zealand practice, primary using New South Wales' practice. It is pointed out that a fifth stage RSA still can reduce the whole life operating cost of a road. The speed of Auditing on rural roads is dependent on the complexity, approx. 70 - 110 km/day and it is advised to divide this in sections of 7 - 13 km. In addition to the 'Policy and Procedures' RSA manual there are a few comments:

- The minimum team should be three people and not regular users of the subject road.
- Additional members of the AT could be a person representing the Road Controlling Authority and or the Network Maintenance Consultant.
- The pre-inspection should contain the day's programme, a description of the road being audited, and some organisational agreements.
- The report format must, in addition to the 'Policy and Procedures' manual, include a general description of the route, including traffic volumes, geographic features, function, accident trends and inspection format.

A difference has been made between two kinds of inspection on rural and urban roads. Type one is 'maintenance deficiency inspection' and could be carried out by own personnel on a six monthly basis. Type two is a less frequent (3-5 yearly) RSA and is carried out by independent personnel. This second type focuses on inappropriate standards as well as maintenance problems. For both kinds of rural and urban inspections different sheets have been developed. i.e. the maintenance deficiency sheet for six monthly

inspections and a Inappropriate Standards or Safety Problems sheet, for a 3-5 yearly RSA.
The reporting of comments and problems differs from the one used in 'Policy and Procedures'. The report should contain a section dealing with the application of design standards and a section dealing with maintenance standards, both first in general terms followed by site specific items. Also there must be no 'four star approach' (using asterisks to indicate the severity of the problem), but one should use a risk level matrix containing both severity (rows) and probability (columns) to be sign of the severity of the problem.
As an RSA on urban roads is more difficult, only two lists are mentioned: the urban prompt list and the traffic signal audit prompt list. These are checklists with only a few highlights.

6.5. The audit team, concerning stage 1-4

An independent audit team may be appointed by the client, or the client may approve an AT nominated by the consultant. The client may have one staff member in the AT, where there are two ore more members on the team, but not the team leader. Two and sometimes three or one person(s) is a recommended minimum of the number of people joining an AT. The main arguments about using few people are the scale of the project. On the other hand, using more people means it is less likely that a problem will be missed, the range of knowledge will be increased, and ideas can 'bounce around'. Nevertheless everyone agrees that experience is very important and strongly recommended. Another issue concerning the AT is its duration as a team. Mixing auditors establishes a process of cross fertilization of ideas and thus develops a broad base of skills.

6.6. Reporting

At each stage the audit team reports to the client and consultant. The consultant informs the client about the recommendations made by the AT, the costs involved, and whether and why they should (not) be adopted. Thereafter the client instructs the consultant whose recommendations should be applied. The leader of the AT receives copies of both reports mentioned. There is some monitoring by TNZ on this RSA process, which consisted of a review after one year and a review four and a half years after the audits started.
The AT should have the following information before the actual auditing starts: the name of the contact person in the consultancy firm, a list of appropriate documents, accident history and listings, traffic volumes, a list of guidelines / standards that have been used, a plan or plans of the project, previous audits and responses, description of known safety problems and issues which constrain their satisfactory resolution. These safety problems should be commented upon in the audit report.
The 'four star approach' can be used as a report presentation style. '**PROBLEM**' indicates a serious problem, 'PROBLEM' without the asterisks indicates a less serious problem and in other cases *'comment'* is used. It is valuable to mention the location and essence of each problem, and preferably in the header. Wherever possible problems and recommendations should be numbered separately.
Due to some pilot projects, a few considerations are made about the reporting. Consider:

- a preamble with background information about the project;
- a pro forma order for reporting;
- abandoning the difference between intersections and non-intersections, because many topics are shared in common;
- to note what issues have not been audited by the audit team;
- appending a list with (not) used documents.

6.7. The checklists

The checklists used in TNZ 'Policy and Procedures' are mainly based on the original UK 'Highways safety and traffic advice note HA 42/90 Road Safety Audits' which was published by the UK Department of Transport. Each stage has a list of its own, and a 'master checklist' combines all checklists into one A4 page which can be used as a quick reference. After several RSAs on urban roads, the auditors mentioned a few points which could be added to the lists. The following four points are told to be glossed over and may be added to the lists:

- priority controls as a separate topic;
- 'speed environment';
- kerbside activity, and
- road surface.

The checklists are not exhaustive and appear to be no more than an aid to see if anything has been missed out. They are no substitute for thinking, but could be used as a guide tool. In the evaluations of pilot RSA there are some comments on both the layout (grouping) and the possible increase of detail in the column 'issues to be considered'. Also another way of allocating topics is mentioned.

6.8. The pilot projects

On local roading projects, seven teams (one experienced team leader plus four local authority engineers) audited thirty nine projects. The principal findings are that local authorities liked the RSA, but the managing process must be a flexible one. Also ongoing training and promotion (financial support) of the concept is essential. On local roading RSA need not to be compulsory al least at this stage, and stage five should be considered.
On state highways, regional managers were requested to undertake RSAs on a 20% sample of projects during one year. In these cases the client was TNZ and during these pilot RSA unfortunately there has been no feedback to the ATs. Some principal findings and opinions are, that in programming projects the clients and the consultants need to allow sufficient time for the audit, including the provision of documentation and a briefing, and any subsequent modifications resulting from the RSA. It is remembered that there should be enough different auditors in the region. The pilot RSAs caused no important changes to the present RSA Policy and Procedures. The stage two audits are seen as the most important of all stages.

6.9. Common problems and comments

During the pilot projects some remarks upon, and additions to, the 'Policy and Procedures' came out into view. One of them is that there must be no unnecessary bureaucracy and an RSA must not slow down the development of projects. This requires a solid planning about when and how to adopt an

RSA. Other pilot audits about local roading projects point out that an RSA should be included in future National and Regional Land Transport Strategies. Another bottleneck during the introduction of RSA was be the 'stock' of auditors. This was in the beginning of he introduction. Later on TNZ produced guidelines for the appointment of auditors.

6.10. Education

A series of workshops and short courses have been held throughout the country, and a longer 'safety audit and accident investigation for practitioners' course is being developed. Some evaluations of safety audit reports point out that another way of education and promotion of RSA could be the controlled publication of RSA documents by Transit New Zealand. Thus a library of knowledge and examples could become more assessable for (inexperienced) safety auditors.
Another issue in education could be the consultant or clients counter report. The responses of the Consultants replying to the RSA report appear to be varied. This would appear to be an area where some training may be required. Perhaps an example about 'How to reply' could be included within the 'Policy and Procedures'.

7. USA

7.1. Safety audits in the USA

According to American safety practice, emphasis has been placed mainly on the improvement of single locations with high accident occurrence. Programmes of accident prevention through engineering measures are not included. Thus, safety audits as a formal examination of the safety aspects of future projects, have not been introduced in the US. However the basic concepts that are related to the development of safety audits have been discussed in 'Safety Design and Operational Practices for Streets and Highways' issued by the U.S. Department of Transport in 1980 [1]. In this document, the following are stated regarding the application of traffic safety:

- Safety depends on administrative decision. This is a result of the fact that administrators establish the order of priorities and allocate the funds. In order for safety improvements to be achieved, safety issues should be given emphasis within the direction of the programmes.
- It is essential that safety is established as a principal criterion in planning, design, operation and maintenance of highway systems
- An efficient way of meeting safety objectives is by a cooperative effort, through safety operational and design review teams.
- Proper selection of review team is essential in order to ensure that the several different disciplines are represented and important safety factors are not overlooked.

During the last decade a number of agencies stressed the need of improving highway safety and the concept of safety management systems emerged :

- In 1990 AASHTO publishes 'Highway Safety Strategic Plan 1991-2000' and the 'Strategic Implementation Plan, A Supplement to the High (?) Safety Plan'
- In 1991 the Federal Highway Administration (FHWA) produces 'Management Approach to Highway Safety : A compilation of good practice'
- The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), requires that state departments of transport develop management systems in various areas. Highway safety is a field for which a management systems is suggested.

Deliberation over the efficiency and success of safety management systems revealed the following key issues [2]:

- Improvements in safety may require that agencies re-consider and re-evaluate their organisational structure, work process and qualification of personnel.
- It is necessary that the people within a safety management system who deal with safety, have traffic or safety engineering or have been formally trained.
- Safety should be considered as an important component of the decision-making process.

More recently safety audits were recognised as a cost-effective means of highway safety and a practical tool in safety management. In 1994 the Institute of Transportation. Engineers set up a committee with the purpose of reviewing the safety policy and practice in countries that use safety audits.

In the informational report produced, the committee proposed that American agencies encompass the safety audit process into their systems [3].
The concept of safety audit is expected to become widely known and it is most likely that the practice of safety auditing new schemes will be adopted by American agencies.

8. France

8.1. Introduction

In France there is no systematic procedure for checking safety on new or existing road facilities. The only procedure that exists is inspection of specific road equipment when some improvement projects on roads, owned by the state, are put into service. The 1982 Decentralisation Act abolished technical supervision by the state, thus suppressing RSA initiation conditions. Another 'obstruction' was the only just recent collection of road safety related knowledge in 'sécurité des routes et des rues', 1992.
However, an analysis was initialized by the Directorate of Safety and Traffic of the Ministry of Public Works. A two-phase experiment was launched in which phase one was a prototype project to finalize methodology, and phase two was a pilot phase which focussed more on stimulating a safety check.

8.2. The prototype projects

The aim of this safety checking would be to detect configurations involving obvious infrastructural anomalies liable to generate a safety hazard. Technical investigations into fatal accidents point out that the infrastructure factor is mentioned in 40% of the cases. Another aim of this safety checking is to bring these configurations to the knowledge of the road authority. Thus four methods concerning this safety checking were evolved:

1. checking that the safety rules comply with legal obligations;
2. analysing deviations from accepted recommendations, instructions and know-how;
3. safety expertise based on accident research;
4. checking that the infrastructure production method complies with established practices and specified procedures.

A mixture of methods one and two was used, using existing roads. A few problems were acknowledged; which road items and roads to check and what is the 'standard' to use, what kind of methodology could be used, what are the legal aspects? The economic dimension also exists: this (postconstruction) safety check must be put into financial proportion with blackspot analysis. So this new kind of checking must be cheaper and more preventive than blackspot analysis, even more when you want to do it periodically. The safety check contains two parts: a mandatory legal conformity checking and advisory on non-legal issues.
The prototype projects were conducted by volunteering authorities in 1993. This initial experimentation showed that malfunction was very frequent. The assessment committee found out that there were three limiting conditions to safety checking:

1. It must be complementary to other methods.
2. There should be a 'reference frame of safety rules'.
3. There must be some sort of identification of the networks to be checked.

8.3. The pilot projects

The pilot projects were conducted in 1995. Two important issues were reproducibility and generalization. The reference framework which was mentioned earlier in the prototype phase was screened in four categories, thus reducing the large number safety rules into a small list of 'operational' rules:

1. repair ability; measures must be consistent with the owners resources.
2. measurability; it must not be too subjective.
3. safety issues; the relation with safety must be evident.
4. frequency; for the classification of rules.

Consistency of road type appeared to be alongside with visibility very important for road safety. So three categories of roads were used: motorways or assimilated highways, major rural roads and major urban roads including expressways. The teams contained a supervisor and checkers. These checkers were selected on the basis of infrastructure road safety skills. A major problem was how to select the roads on which this safety check could be tested; where the speed is highest? where there is most traffic? where most accidents occur? The roads were selected on a voluntary basis.

8.4. Reporting

The results were presented in two stages:
The provisional report grouped together all the safety checking team's observations and an initial summary report that assessed the resulting road risk. This was communicated with the owner for discussion.
The final report described the operation, analysed the observations, and described the contact and interactions with the road authoroty/-ies.

8.5. Conclusions

The pilot experiments brought many deficiencies to light, many of them concerning road signs. On this subject in March 1993, a circular from the Ministry of the Interior and the Ministry of Public Works was published but with little result. The local owners were too much bound to local practices. This illustrates the need for an independent team and compulsory regulations. This system of post-construction deficiencies / safety checking is not 'common practice' in France.
There are not many similarities with a Road Safety Audit as they are conducted in other European countries like the UK, Norway, and Denmark.

9. Comprehensive list

9.1. Introduction

In the preceding chapters some countries using Road Safety Audits have been highlighted. In this section the differences and similarities between those RSAs are summarised. France and the USA do not have an explicit RSA system and are thus not mentioned in this overview. For a more precise description of the following, see the previous chapters.

9.1.1. *Definitions*

The definitions of a Road Safety Audit used by the different countries are more or less the same. They all concentrate on road safety as one separate aspect of road use/design. The various definitions are summarized below. It should be mentioned that the definitions referring to Denmark and Norway are of course translations.

UK
A Road safety Audit is a formal procedure for assessing accident potential and safety performance in the provision of new road schemes, and schemes for the improvement and maintenance of existing roads.
(source: *Guidelines for The Safety Audit Of Highways IHT 1996*)

Denmark
A Road Safety Audit is a systematic and independent road safety review of road and traffic schemes. The purpose is to make new and reconstructed roads as safe as possible - before the schemes are built and before any accident occurs.
(source: *Translation from Manual*).

Norway
A Road Safety Audit is a systematic and independent evaluation which ensures that the products (roads, traffic systems, traffic control) have the quality desired with respect to road safety. The audit should not primarily control whether the planning is in agreement with traffic regulations, but should also be concerned with the auditor's knowledge and assessment techniques and implementing of the checklist.
(source: *Road safety in the scheme - inspection and audit of plans. 1996*)

Australia
A Road Safety Audit is a formal examination of an existing or future road or traffic project, or any project which interacts with road users, in which an independent, qualified examiner reports on the project's accident potential and safety performance.
(source: *Road Safety Audit 1994*)

New Zealand
A formalised process to identify potential safety problems for road users and others, and to ensure that measures to eliminate or reduce the problems are

considered fully. A safety problem is defined as a feature which has been identified from a drivers perspective which gives a misleading or confusing message.
(source: *Safety audit policy and procedures 1993*).

9.1.2. *Stages*

Different countries use different numbers and names of stages (*Table 3*). The UK Department of Transport Trunk roads auditing only requires stage 1-3, the other UK stages are used by different Counties and the IHT.

United Kingdom	Denmark	Norway	Australia	New Zealand
F Feasibility	1 Initial design	1 Planning	1 Feasibility	1 Feasibility
1 Preliminary design	2 Preliminary design	2 Details	2 Draft design	2 Project assessment
2 Detailed design	3 Detailed design	3 Construction work	3 Detailed design	3 Final design
3 Prior opening	4 Opening	4 Prior opening	4 Pre opening	4 Pre opening
4 Post opening	5 Monitoring (Existing road)	5 Announcing road marking / maintenance	5 Existing road	5 Existing roads
5 Maintenance / monitoring				

Table 3. *Stages of Road Safety Audits in different countries.*

9.1.3. *Status*

Only in the UK the RSA is mandatory for all trunk roads (*Table 4*). In New Zealand an RSA is mandatory on a 20% sample of new state highway projects. The status on other type of roads and in the other countries is 'recommended'.

United Kingdom	Norway	Denmark	Australia	New Zealand
Mandatory	Recommended	Recommended	Recommended	Mandatory (20% sample of state highways)

Table 4. *Status of the Road Safety Audit in different countries.*

9.1.4. *Types of road*

There are different types of roads on which an RSA is issued. These types are Rural (motor vs express or trunk roads) and Urban roads (*Table 5*). Another differentiating element is whether a proposed scheme of an existing road undergoing an RSA is known or unknown to the audit team. When the scheme subject to auditing is part of a periodical (or even annual) maintenance program it is more likely that the scheme is 'known' to the audit team. The Norwegian AT to be formed will probably consist of a group of county officials auditing a scheme from one of its members.

	United Kingdom	Denmark	Norway	Australia	New Zealand
Motor, Trunk or Urban	Rural, Urban	Rural Urban	Motor Trunk	Rural Urban	Rural Urban
Known or Unknown	Known and Unknown	Unknown	(Known)	AT should have 'Fresh eyes'	AT should be 'Not regular users' in case of a stage 5 audit

Table 5. *Types of roads subject to a Road Safety Audit in different countries.*

9.1.5. *Procedures*

The initiator of an RSA project, the one who 'starts' the audit, as well as the one who is finally responsible, i.e. decides whether or not to implement solutions to 'the remarks' made by the audit team, are mentioned in *Table 6*. The numbers in *Table 6* refer to the paragraph which describes the procedure of the audit. Also added in this table is, whether the results of an RSA are open to the general public. Norway and Denmark have not discussed the item in depth yet. In Denmark a general rule exists providing the general public access to documents produced in or at behalf of the public administration. In the UK and Australia, RSAs could be used in court cases. In New Zealand some audits become evidence in so called planning courts who decide whether a (usually contentious) project will proceed. The last row in *Table 6* indicates whether there is discussion between the auditors and designers regarding the RSA results.

	United Kingdom		Denmark	Norway	Australia	New Zealand
Initiator	Project manager		Designer	Road chief	Designer / client	Client
Person finally responsible	Client		Client	Road chief / Department leader	Designer / client	Client
Organisation	2 3.2		3 5 2	4.4	5 3	6 3
Public access	Available at public inquiries*		Yes	Pilot not accessible	Available at public inquiries	some
Discussion	Dpt of Transport	Possible **	Possible	Not necessary	Yes, with designer or client	Not intended
	consultant	sometimes				
	Various Counties	Yes				

*source: HA 42/94 Vol.5 Sec.2.2 **source: HA 42/94 Vol.5 Sec.2.29-30.

Table 6. *Initiators, persons finally responsible, organisation, public access and discussion regarding Road Safety audits in different countries.*

9.1.6. *The audit team*

Independence is important in road safety auditing. Yet there are many different ways to ensure this independence, and even within some countries there are differences. An audit team could for example come from inside or outside the 'designer's organisation'. The capability and the number of people in an AT also differ from project to project. The AT can even contain trainees. Independence, size and qualifications of audit teams are shown in *Table 7.* The qualifications / experience of the audit team do not vary much between the countries. It is has been found that an RSA could be carried out by one person, but in most cases more personnel is recommended. The New Zealand's audits of existing roads tend to be quite large; four members.

	Independence	Size	Qualifications
United Kingdom	DoT: outside the organisation, other cases: less strict.	1 - 7	DoT: Accident investigation Road Safety engineering
Denmark	Independent, can be from inside or outside the same organisation as the designer.	1 - .	Traffic accident reduction and accident analysis. Common knowledge of designing and construction work.
Norway	Independent, can be from Road Directorate, neighbouring counties, the same county, or consultant.	1 - ..	Knowledge of traffic safety, and the actual project.
Australia	AT from outside the organisation, or another design team, or the designer himself.	1 - ..	Accident investigation, traffic engineering, traffic management, design, human perception.
New Zealand	Independent, but the could have a staff member involved in the auditing	1 - ..	Different skills and experience

Table 7. *Independence, size, and qualifications of the audit team performing the Road Safety Audit in different countries.*

9.1.7. *Manuals*

Every country uses manuals of their own. Nevertheless all designers of manuals have looked at the UK manual. Except for the UK Department of Transport regulations and the TNZ procedures conducted on a 20% sample on state high ways, they are *guidelines* and do not have to be obeyed undisputedly (*Table 8*).

Manuals used		
United Kingdom	Dpt. of Transport	Compulsory RSAs
	I H.T.	Guidelines for the Safety of Highways
	Various Counties	
Denmark	Road Directorate	Description and instruction about structure of RSA system
Norway	Public Roads Administration	Guidelines for inspection and Quality Audit
Australia	Austroads	Principles and advice on good practice
New Zealand	Transit New Zealand	Guidelines to policy and procedures

Table 8. *Manuals used for Road Safety Audits in different countries.*

10. Concluding remarks and recommendations

10.1. Introduction and embedding

An increasing number of countries focuses on Road Safety Auditing. One of the positive ideas behind RSA is its preventive character. 'Getting it right the first time' is one of the factors that makes this RSA an appealing idea, for it seems that money and victims can be saved. Nevertheless RSA does not stand on its own. Besides knowledge of accident investigation techniques there should be some sort of 'natural audit environment'. This implies a few things. First there should be a top-down management commitment and bottom-up adaptation of the ideas for enthusiastic cooperation. Secondly it implies that there should be a political statement about accident reduction goals convenient for allocating resources. There should also be plans about, for instance, education and publicity. In the UK these things are summarised in Road Safety Plans. Another necessary political input for Road Safety Auditing are plans about predicted and intended use of roads and areas to develop. Thus an audit team can anticipate on the future use of the road subject to the audit.

10.2. RSA roots

In the United Kingdom RSA is compulsory for all trunk roads, and is also issued on voluntary basis in other road schemes. But it should be mentioned that not all counties which can apply an RSA on a voluntary basis are enthusiastic. Nevertheless there are many years of experience with RSA and many countries which have developed or which are developing an RSA system, have looked carefully to the UK. Another country which has a long history concerning road safety is the USA. In the USA a method exists called 'Safety Reviews'. This Federal HighWay Administration method is less formalised than the UK Department of Transport method and also emphasises more on incorporation of guidelines and compliance with standards rather than the use of checklists. On non-FHWA roads sometimes the local road authority conducts an informal check.

10.3. The checklists

One element of RSA is the use of checklists. It is pointed out that the status of these checklists should be nothing more or less than an 'aides memoire' just to check if nothing has been overlooked. Nevertheless they should not be used as some sort of 'tick-sheet'. For that reason items are preferably mentioned in general terms. The use of these checklists also provides the designers an insight in the audit process. The checklists should also be no substitute for real knowledge and experience. The more audits an auditor has done the more the use of checklists will be traded off against his experience.

10.4. Utilization

When conducting an RSA, the audit team should not try to redesign the scheme. Instead they should pay attention to road safety for all kind of different road users, and theirs suspected road user behaviour. The way this should *not* be done, is to compare the design with relevant standards and see if it matches, but the audit team should check if the design appropriately interacts with the design standards, for strict application of standard does not always lead towards a safe road.
Some other findings about RSA are mentioned below. It is important that a site visit is carried out. Both in daylight and at night. Thus the visibility for different road users can be checked in the context of the road and its surroundings. When an RSA is carried out in an early stage of the design process it is less likely that 'errors' become embedded in the design, thus becoming harder to correct later on. A RSA should not seriously delay a design process. Attention should thus be paid to the embedding of the RSA during the planning of the design process. Attention should also be paid to monitoring and feed back to the audit team after opening of the road when accidents occur.
The RSA process should be formally organised and its outcomes documented. Concerning the formalization and purity of an audit, it is to recommend that the audit results are documented before there is discussion (if any) with the client, and concessions could arise. Some say that a formalised RSA leads towards a more systematical approach and enlarges the chance on a consistent outcome. The ultimate grade of formalisation is to make an RSA mandatory. Relevant plans and documents should be available to the audit team and should be mentioned in the report. It should be clear what should be audited, which tasks there are and who is responsible for those tasks. It can be beneficial to use the same names and numbers of stages for less misunderstandings and for comparison with other RSA documents.

10.5. Aspects and levels

There are roughly speaking three aspects about conducting an RSA.

1. an administrative aspect, e.g. a country should decide whether an RSA is compulsory or not and how to fit in design regulating governmental guidelines.
2. procedural aspects on two scales; strategical, which is closely related to the administrative level concerning general procedures, and more practical, how an RSA should be carried out relating to checklists, site visits, detailed organisation, sight lines etc.
3. an intrinsic aspect, the utilization of current knowledge.

From a spatial point of view, there are three differentiating levels. These levels can be used to make comparisons possible between differences and similarities from a spatial point of view. On a decreasing scale, increasing similarities can be found.

1. European level, it is difficult to compare e.g. Australian and US roads networks with an European network, for there are many differences in design vehicles, road types, population densities, car possession per capita etc.

2. national level. On a national scale there are differences between national road design guidelines and procedures, road user behaviour and traffic rules as well. Even availability and status of guidelines differ.
3. regional / city level. Between regions within a country different responsible road authorities can be found and differences in road user behaviour.

Difficulties concerning a European road safety audit arise as there are behavioural differences between countries and even between regions. Nevertheless, it is important to have some consistency in design concerning cross border traffic on a European scale. In relation to this there are e g. already some regulations about E-roads.
In the UK non-mandatory RSAs are mainly carried out by regional Accident Investigation Units which have full access to accident records and do know much about 'local culture'. These AIUs do also have a monitoring function as well. Nevertheless there are also many RSAs carried out by consultancy firms which are believed to have a broader, nationwide in stead of local, experience and probably know more different solutions to road safety problems. So there can be a trade off between knowledge of 'local'culture and a more broader knowledge.
The question arises whether this trade-off can also be found at an European level. For there are more difficult differences on an international scale like road user behaviour, traffic regulations, language, different design guidelines, and environment. It is possible to let an interconnecting European road be audited by a completely foreign audit team, but this will be hard and probably not reach a certain level of acceptance. This with regard to their experience and thus to the remarks and comments they make. Therefore it is more desirable to let each 'nation' audit roads within its own country, but also supply them with foreign (European) experiences and introduce them to neighbouring guidelines.
Could European guidelines 'how to conduct an RSA'be established? It is probably possible to abstract an advise from current practices on how to conduct an RSA, on all three levels of an RSA as mentioned above namely administrative, procedural, and intrinsic. This literary review learns that many countries applying RSA have carefully looked to the UK way of applying RSAs, and that procedures can be transformed from one country to another. On a administrative nation wide level, it is necessary to make a statement about the mandatory, and formalizing regulating aspects on when, and how (in general terms) to conduct an RSA. This means that there can be some local variation. On the intrinsic level, much depends on the education and experiences with e.g. accident investigation of the audit team. Without qualifications on this intrinsic level an RSA system is not possible. There are many different countries who conduct RSAs. All define RSA in a slightly different way. Elements frequently mentioned are the auditors' independence, that it should be a formal procedure, and that road safety should be achieved for all road users during an examination along the design process before the road is open to the public. Thus the RSA concentrates on road and traffic engineering measures rather than on education or enforcement.

10.6. General conclusions

Some European countries develop a national RSA system. Many people involved in this development think of RSA as a promising way to improve road safety. RSA Pilot projects point out that design inaccuracies can be discovered in new road designs and RSA evaluations already carried out in some countries have been very positive; RSA seems to work.
The introduction of an RSA system can either be done bottom-up or top-down. A bottom-up approach can lead to a vast, enthusiastic participation whereas a top down approach can lead to a more explicit introduction.
Although road safety comprising design solutions can be tracked using an RSA, the precise effects are yet still unknown.
Quality is added to a national road system by using an RSA system.

10.7. Some discussion points

During the approaches towards a European RSA framework system, some discussion points arose. These point are mentioned below and deal primarily with different items concerning RSAs from a national or European point of view.

10.7.1. *Reflecting to standards or road user behaviour?*

It is hard to solemnly depend on a standard or road user behaviour to reason audit findings. The audit is no evaluation of a guideline. Guidelines for themselves often cannot provide safe solutions to specific situations when a road uncommonly interacts with its environment. Nevertheless, guidelines could be used as a framework for the setup of a checklist, e.g. follow the stages of a project as suggested in guideline. By doing so, the audit team can communicate more easily with the design team. On the other side 'the average road user' does not exist. And even when it is known how this average road user operates, standards deal with a dubiousness about which road user they should take for a 'model user'. For a 'model driver', should that be somebody who just passed his driving test? or a elderly person with cataract?
An auditor can either walk trough a design as a road user and / or refer to the standards but both ways prove to be somewhat unsatisfactory. The available standards also focus for a great deal on motorways and thus on motor vehicles and in many countries there also isn't a guideline available for all types of roads. And even when there is, they can be disregarded for they are not law. Also strict application of standards does not lead to a safe road. Therefore standards can act as the setting for a design, which recommendations have to be evaluated before taken into practice.

10.7.2. *Research versus policy; both entities work together on road safety.*

An TERN-audit to be developed can learn from experiences in different countries. On a short term the development of national audits can be beneficial to TERN roads. On a somewhat longer term audit procedures could be derived from the national audit procedures which prove to be applicable for all TERN roads. Experiences from different European countries could provide a continuous flow of information valuable for the TERN audits. Collection and redistribution of this knowledge could be an ongoing European responsibility. Thus national experiences and research

could led to European TERN pilots and learning from other countries could lead to improvement of national audits as well.

10.7.3. *National road network versus TERN; are there differences?*

Knowledge and skills obtained from conducting audits on all types of national roads can be migrated for audits to be conducted on TERN roads. It is evident that on TERN roads or other roads funded by EU, the EU decides what action to take. On national roads a national RSA-system could be operative as well. When conducting an audit on national roads or the TERN, some references should be available. This can either be a national standard, or an audit team can refer to a foreign standard when they need to reason their findings. Again it should be mentioned that standards by themselves can not prevent accidents. At some locations an interaction between the environment and surrounding of the road ask for special solutions not provided by standards. Knowledge of accident research and road user behaviour could prove to be useful. The TERN should be a network of roads recognizable for all road users, including cross border traffic. Therefore a minimum level of similarity should be accounted for. In order to get an minimum level of similarity, European recommendations should be referred to as well as to national standards.

10.8. Proposal for the development of a framework

A framework for the development of RSAs can be found in five points containing tasks for the different bodies responsible for different aspects of road safety.

- National governments;
  they should develop RSA procedures and methods
- National road authorities;
  they should perform pilot audits for all roads, including TERN
- National organisations which are responsible for design guidelines & manuals;
  they should integrate RSA in tools for improving road safety.
- National road research institutes;
  they should evaluate RSA.
- European Commission;
  it should initiate pilot audits on TERN roads. These pilots should point out how the audits for TERN roads will be performed, with regard to all previously recognized 'levels'; procedures, the audit team, and responsibilities.

10.9. What roads should be audited?

The Trans European Road Network is a network which purpose it is to optimize the national networks within an European perspective. The TERN crosses national borders and connects inter European centres of population. This TERN was mentioned in the treaty of Maastricht. It is this TERN that is subject to the audit. There are five different types of roads within this network:

- double carriageway express roads;
- single carriageway express roads (Interurban roads);
- rural roads (Interurban roads);

- motorways, and
- major urban roads.

In order to ensure that safety on this TERN is accounted for, all of these types of roads should be audited. Alongside the use of national guidelines, and reviewing the road from a road user perspective, the auditor could also refer to European sources concerning underlying considerations about design aspects. Nevertheless, these European sources indicate *minimum* levels on certain design aspects on which a new road should conform with in order to be labelled as part of the TERN. These design aspects usually are sub-standard to the national guidelines. It is even recognised that at this moment some of these sources still represent no minimum levels, they are rather a collection of current practice in different European countries. These publications, among others, can also be useful to a design team engaged with TERN.

Intersafe, Technical Guide on Road Safety for Interurban Roads, ERSF, 1996.

SAFESTAR (to be published)

OECD, Rural roads, Paris, 1998

Safety aspects of road design standards, SWOV, Leidschendam, 1994 & Annexes.

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12. Literature

Suggestions for further reading about Road Safety Audits:

Road Safety Audit **Austroads SAA HB43-1994**

The Institution of Highways and Transportation, 1996. 'Guidelines for The Safety Audit Of Highways', IHT.

Road Safety Audit **manual**
The Danish Road Directorate, Copenhagen.

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[7] *Safety Practice Note* Edition 1 'Safety Audit' Kent County Council, February 1994.

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Manual. Safety Audit - on Trunk Roads
The Danish Road Directorate, SSV, Copenhagen, August 1993.

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Schelling, Adriaan, Road Safety and Environment, The Danish Road Directorate.

Paper presented at the International Conference, Strategic Highway Research Program and Road Safety, Prague, the Czech Republic, September 1995.

/3/ 'Safety Audit in Denmark - a Cost Effective Activity'
Article by Wrisberg, Jacob and Nilsson, Puk Kristine, Road Safety and Environment,
The Danish Road Directorate, November 1996.

/4/ 'Hvad er trafiksikkerhedsrevision, og hvordan fungerer det?'
Schelling, Adriaan, Trafiksikkerhed og Miljø, Vejdirektoratet.
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The Danish Road Magazine, December 1994.

/5/ 2. Draft of a new Danish Manual of Safety Audit.
Road Safety and Environment, The Danish Road Directorate.
Edited by Gaardbo, Anders Møller, November 1996.

/6/ *Trafiksikkerhedsrevisionsprojektet - Evaluering*. Det eksterne panels rapport.
Jørgensen, N.O. et al.
Vejdirektoratet, København 1995.
The Safety Audit Project - Evaluation. The External Panel's Report.
Jørgensen, N.O. et al.
The Danish Road Directorate, Copenhagen 1995.

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Trafikksikkerhet i prosjektet - kontroll og revisjon av planer
Road safety in the scheme - inspection and audit of plans
Antonsen, Jan; Andersen, Øyvind; Hvoslef, Henrik; Skånlund, Anders, all from the Norwegian Road Directorate (Statens vegvesen Vegdirektoratet). Furthermore Rognerud, Magne, Public Roads Administration in Buskerud (Statens vegvesen Buskerud), and Nyland, Knut, Public Roads Administration in Rogaland (Statens vegvesen Rogaland).
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Statens Vegvesen, mars 1996.
Quality manual for the Norwegian Public Roads Administration, Level A.
Public Roads Administration, March 1996.

/3/ *Strategier for kvalitetsutvikling i Statens vegvesen i perioden 1996-2001, Nivå A.*
Statens vegvesen, Vegdirektoratet, September 1996.

12.7. **References France**

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[2] FERSI September 1996 Christian Machu . at the International Conference on Road Safety in Europe

[3] *Sécurité des routes et des rues* September 1992, SETRA et CETUR Instructions for design and management.

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Public Roads Administration, Road Directorate, September 1996.

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[5] *Review of a selection of rural safety audits,* July 1996 Review and Audit Division. Report No. 95/415S

[6] *Review of a selection of urban safety audits*, July 1996 Review and Audit Division. Report No. 95/416S

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[2] *Road Safety Audit* Austroads SAA HB43-1994

[3] Road Safety Audit *'its progress in Australia and New Zealand'*

[4] Philip Jordan, Ian Appleton, ITE annual meeting 1994

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[1] U.S. Department of Transportation, 1980. ' Safety Design and Operational Practices'

[2] M. A. Wallen, 1990. ' What makes a Good Safety Management System ?', *Institute of Transportation Engineers (ITE) Journal*, January 1993.

[3] Institute of Transportation Engineers Technical Council Committee 4S-7, 1995. 'Road Safety Audits: A New tool for Accident Prevention'. *Institute of Transportation Engineers (ITE) Journal*, February 1995.

13. Annex A Checklists

In addition to this report, we would like to summarize the locations were you can find the different checklists in relation to the different countries. As in the previous chapter we will not locate the France and USA checklists, for France and the USA do not have an explicit RSA system.

United Kingdom
Design Manual for Roads and Bridges Vol.5 Section 2 Part 3 HA 42/94 Road Safety Audits ISBN 0 11 551281 0 Annex A, B, and C. 24 pages.
The Institution of Highways and Transportation, *Guidelines for The Safety Audit of Highways* (1996). ISBN 0 902 933 22 1 London 5 pages.

Norway
Statens Vegvesen (1996)
Trafikksikkerhet i prosjektet: kontroll og revisjon av planer. Sjekkliste.
Vegdirektoratet, Oslo

Denmark
Vejdirektoratet (1993)
Checklister til trafiksikkerhedsrevision; for hovedlandeveje
Trafiksikkerhedsafdelingen SSV, Copenhagen

New Zealand
Safety audit policy and procedures, August 1993 Transport New Zealand ISBN 0 478 04113 6 Appendix 1 page 2 (short) Appendix 1 pages 3-37 (long)

Australia
Road Safety Audit Austroads SAA HB43 -1994 ISBN 0 85588 455 X Pages 94-99 (short) or Annex 58 pages (long)

14. Annex B Workpackage 8.2: visit to the United Kingdom

14.1. Introduction.

In the United Kingdom conducting a Road Safety Audit is compulsory for all trunk roads and an RSA can be applied on a voluntary basis to other types of roads. Since this situation exists for many years, there is a lot of experience with conducting RSAs. In order to find out more about these experiences a visit has been made to the UK. Three organizations have been visited:
Visit nr. 1:
Kent County Council
Malcolm Bulpitt, Frank Nunneley, and John Payne.
Visit nr. 2:
Nottinghamshire County Council
Stewart Thompson and Gareth Coles.
Visit nr. 3:
TMS Consultancy
Steve Proctor.
Findings of these visits are mentioned below briefly. These findings are put together in both common findings and slightly more differentiated subjects. The indices relate to the visit number 1, 2 or 3

14.2. History

A long time ago many accidents happened on new roads, which urged the need for an early design improvement. It then more or less started in Kent years ago, with an internal course and procedures provided by Malcolm Bulpitt on which designers were asked to join in. From all over the country designers followed it and suggested to their management to let them use RSA. This 'bottom-up' approach was more or less made possible by the decentralisation and privatisation of the British community which started in 1979. Malcolm Bulpitt started the course with no 'hidden agenda', with an open mind, and with photos of horrible crashes 'caused by' design mistakes (1). RSA was thus gradually put in a framework and there were more training courses, organised by Steve Proctor & RoSPA on a national basis.

14 3. Checklists

Checklists play only a minor (1;2) role in the process or are only used in the training courses (3). They certainly should not be used as a tick box, but you should put yourselves in the shoes of road users like car drivers, pedestrians, etc. and try to give the driver a sound picture of the road. Using this approach, two 'golden rules' appear to be: 'less is more' (keep it simple) and 'Safety is in the details' (1). Checklists appear to be not very important. The usage of checklists decreases as the knowledge of Road Safety Audits increases.

14.4. Road safety plans

RSA has become, together with other components like research and continuous education (and as early as possible), a part of a safety culture. This safety culture is some sort of natural audit environment. The components, of which RSA is one, are united in a Regional Road Safety Plan, which purpose it is to establish local casualty reduction targets and to develop a strategy for achieving those targets.[3] Some other measurements described in the Road Safety Plan, are safety officers delivering knowledge to the road user, for instance bus drivers, thus focussing on education. 'Safety practice notes' are also produced, just to explain to the public how things work (1). There are also regional meetings of traffic engineers (1). In Nottingham once every two months there is a meeting with a group of professional road users, i.e. bus drivers and ambulance personnel as feedback from a consultative group (2). Even TMS Consultancy gives courses (e.g. RoSPA, Royal Society for the Prevention of Accidents) and thus places RSA not 'above' but alongside education and research (3).

14.5. Position in (local) organisation of audit team and RSA.

Should an RSA be carried out by a large or small construction - or consultancy firm or by the local authority? There are big firms working on design and audit. And auditing is also conducted by small consultancy firms. They do a 1/3 part of the Motorways. But the larger part of the Trunk roads is audited by the local authorities. These Local Authorities have more detailed local (accident) information and probably know more about the local user characteristics of the road. They have a countywide overview of local concerns (1;2). This local knowledge is important, and collected by Accident Investigation Units, a section of the local authority. On the consultancy side, broader experience and slightly more general information are advantages (3). On roads audited by local authorities there is quite a lot of communication between the audit team and the designers. The danger of financial ties and pressure exists and independence is traded of against education and compromises (3). There are some bad examples of RSAs carried out by consultants due to little communication between them and the design team. At the local authority office everybody knows each other, there is a firm interaction between designers and auditors. This is called education and assistance. But they only have a talk when there is a problem, for in other cases the designers grab a book and do it themselves (2).

14.6. About the process

The British motorways are organised in four HA (Highway Authority) sections: London, North, Midlands, and South. Every section has many agents who in turn screen a network from about five to ten roads. In the past there have been some bad agents delivering cases of bad consultancy work. Thus, local authorities want to protect themselves against that (3).
It is pointed out that a good management system is very important. The system they use, a flow chart, contains loops and when there are problems, that can be very time consuming. So along the process there is communication between designers and auditors. When there is a difficulty they could look at it together and thus learn from each other (1). In Nottinghamshire RSAs are handwritten and there are no fancy reports, they

use carbon copies. By doing so, the speed of the process is increasing. There are also arguments like 'spotting the problem is important, not the layout of the report' (2).
The road section or object being audited is placed in its setting and environment, so the planning borders are not really closed. If a section adjacent to the road section which is being audited interferes and troubles this section, this adjacent section can also join in the audit (2).

14.7. Qualifications

Experience in design and implementation, designing remedial measures, and knowledge of accident figures, are highly desirable (2). Experience with accident investigation techniques is a necessity for an AT. It is also important to know what is going on in the designer's world, and stick to known practice (2).
The police assistance is used in stage three, thus most of the time only minor modifications are made by them (1;2). It is preferable to ask them to join in at stage two, but this seems to be difficult to arrange (1). Training courses are necessary to pick up problems, but not enough on their own; one also needs experience (3). Two members of staff can also join in the team and one person always visits the site at daytime and at night (3).

14.8. Introducing RSA

Probably the best way of introducing RSA is 'top-down' (management and governmental) approval and 'bottom-up' training (3). In this introduction stage the use of checklists could be useful (3). When introducing RSA, knowledge of accident investigation techniques (2) or safety engineering (3) is necessary, and computers are not really necessary (2). Another crucial point in RSA is to tell when a designer is wrong. The best answer dealing with this problem is probably an increase of accidents (1). On a European level, the procedure could perhaps be used in a highly aggregated level, using local knowledge of road safety when performing an RSA (1).

14.9. Legal issues

In a court case, an audit team is not personally held liable but a client can be (2). Technical appraisal of phases in a project is not the same as an RSA. The project manager signs and can overrule an RSA comment. This is not likely to happen because along the way there is close communication between designers and auditors, but when it happens and an accident occurs, and a court case is made of it, it is advisable for the manager to have his decisions documented. (1). In such a case the court probably adopts 'a best practice' (1). There has never been a court case (2).

14.10. Some financial issues

Another difficulty is that it is hard to measure an RSA's cost effectiveness. A consultant RSA can price up to max £ 10,000. - an accident probably costs about £ 40,000. - (3). In Kent, they think of a 5 - 10% cost reduction, for RSA is a proactive technique (1). When you are proposing a solution to a recognised problem it is advisable not to ask too much of the client's financial possibilities, and in some way stick to local best practice (2). In Nottingham,

an RSA is carried out when a project costs more than £ 5000. - and in many cases, just before the elections, there is more money available (2). Financial problems are a little relaxed by the safety culture currently present in Kent. This means that safety is a must; otherwise, there is no money at all (1).

14.11. Monitoring

In Kent, there is a Road Safety Unit which is monitoring safety, which collects all accident information (quote: "this keeps you rolling, motivated") directly from the police (1). For monitoring Nottinghamshire, there is also a close link between the police and the Accident Investigation Bureau (2). Roads which have been audited at the last stage, are monitored for one year, and after that period they are evaluated (2). Monitoring seems to be necessary because one designs for its use, but the usage changes, so the design probably should also change (1). Monitoring in the consultancy branch is poor, probably the result of a lack of willingness (3).

15. Annex C Opportunities and constraints

The following chapters show an image of the opportunities and constraints for road safety audits in various countries.

16. Czech Republic

16.1. Introduction

This chapter deals with the introducing of road safety audit for decrease of consequences of traffic accident on all newly designed roads including Trans European Road Network roads in the Czech Republic.

16.2. The audit need

There has been an distinct increase of accident rate and especially an increase of traffic accidents with fatalities or injuries which have resulted in many casualties during the last years. From this altering situation results a necessity of creating a methodology of economic loss evaluation from these accidents, creating a systematic set of recommendations and preventive arrangements.

Development principles are specified for individual elements generally and for the safety of newly proposed roads. Strict observance of norms does not always guarantee 100% safety. That is why it is desired to execute the safety audit.

16.3. The RSA on roads in the Czech Republic

The Transport Research Centre was appointed by the Ministry of Transport and Communications to elaborate the research project 'Road Safety Audit on Roads in the Czech republic' in 1997. After finishing this project (at the end of 1998) its result should be implemented also into Czech law, and the process of RSA introduction into practice begins.

16.4. Stages of RSA

Today's suggestion of the pilot project is to divide the RSA process into three stages:

Stage 1
In this stage the proposal from the point of view of proposed communication incorporation into the network of current roads, including their affiliation (junctions) are estimated. This stage doesn't need to be always fully enforced for all types of projects.

Stage 2
During this stage (implementary project) horizontal and vertical placement of proposed communications including junctions are estimated. Furthermore, traffic equipments and accessories, bus stops, parking and siding areas, drainage, surface type etc. are estimated.

Stage 3
This stage runs before putting the communication into operation (approval) attended by construction workers of building firms and local traffic police. Appreciation needs to be obtained also in the form of vehicle driving, cycling,

or by walking. The whole project should also be estimated during night time to also verify the required safety rate at night.

Communication monitoring after its opening should not be called an 'audit' but an 'observation'.

16.5. The procedure of RSA

We recommended to provide the RSA the following three methods:

Method 1 - Specialist and audit team
A formal agreement is requested from the determined team before the proposals can pass to the next stage. Only the officer responsible for the whole project can skip over these requirements. The independent safety specialist and the audit team don't need to project at all, and they can only execute the safety audit of projects prepared by other staff involved in this activity. The team can also examine the accidents and provide an advice for correctional measures.

Method 2 - Specialist and independent project manager
The project is audited by safety specialists and the prepared report goes to a third independent party which determines what measures will be accepted, and instruct the designer (first party). The third party should be experienced specialists without direct managing relation to the first two parties. This independent access reduces the possibility of conflict rising between audit and projection team.
This method was used in Great Britain for main roads. The safety audit was reported to the client (investor) who decided what measures will be accepted. There should be provided the report which explains why any proposed measures were not accepted.

Method 3 - Specialist and designer
The audit runs like in the second method but the report is sent to the original designer who will decide which measures will be accepted. In these circumstances there have to be the reasons for refusing or accepting only a part of audit team advice formally documented by the designer responsible for decisions. In the present situation the projection teams have a few or no experiences with accident investigation and its prevention. The projection team is able to control the project from the point of view of norm compliance, but a full safety audit will never be achieved.
Our current norms are more oriented in road capacity etc. than in its safety. That is why there can be some safety mistakes left out in the project.

16.6. The checklists

The first version of RSA checklists has already been elaborated. In this period there are continuous discussions about its content. The checklists harbour the judgment of problem areas e.g. :

- Geometrical settlement
- Communication surface
- Traffic signing
- Traffic equipment

- Transport control
- Work zones and servicing

16.7. Conclusion

The particular using of the RSA method is planned just after finishing the pilot project. But it is necessary to solve a lot of problems e.g. the training of special staff for providing RSA in the Czech Republic.

17. France

17.1. Introduction

This chapter deals with the possibilities for introducing a road safety audit in France and the way the road safety audit might be introduced in France.

The SAFESTAR report 'Road Safety Audit tools, procedures and experiences: a literature review and recommendations', explains that an analysis was initialised by the French Directorate of Safety and Traffic of the Ministry of Public Works about a safety audit, but only on existing roads. A two-phase experiment was launched in order to determine a procedure and a safety check.

This report refers only to the introduction of a safety audit on new road schemes, and schemes for modifying and improving existing roads, in general, in France.

17.2. Historical background and context

An Interministerial Road Safety Committee Meeting was held on 26 November 1997. It set a target of reducing road accidents by half within the next five years. At that moment, there were on French roads some 8,000 fatalities per year. To fulfill this ambitious objective, one of the most ambitious in Europe, a new policy had to be introduced.

The measures proposed at this Committee Meeting consist of:

- improving the training of young people at school and new drivers in the first years after they pass their driving test (more than 28% of people killed are under 25);
- making penalties heavier for severe speeding offences and simplifying enforcement procedures;
- improving safety infrastructures.

This last point includes the aim of systematically introducing a safety audit for new road projects and improving existing roads projects. A brief note outlines this new concept in France. 'The aim of this audit is to ensure that, when new road infrastructures are put into service, they offer an optimum level of safety to all road users, by being included in the very early stages of projects'.

17.3. The pilot project

The Interministerial Committee has decided to proceed in three stages:

1. preliminary studies in order to identify the key stages in the road project study. For each of these stages, it is planned to define a technical reference system stating the elements to be checked. The different stages of the audit should be determined in accordance with existing instructions, in particular the circular of 5 May 1994, which defines the methods of

developing, preparing and approving the investment operations on the national freeway network.

2. experimenting on projects of different types (road improvement work or new infrastructure projects), that concern all project owners (national network, county network, and communal network). This stage will enable the procedures and organisation of road project safety audits to be finalised, and the necessary qualifications and competence to be defined for the person or people who will make the audit.
3. the obligation of a safety audit for projects. It is planned to draft a bill for the progressive implementation of this systematic audit as from the beginning of 2000.

17.4. Which activities should be audited?

It will likewise be necessary to determine the nature of the projects to be audited. However the most important projects, and consequently the roads belonging to the TERN network, will certainly be subjected to the road safety audit. The nature of the audited projects will be determined at the end of the pilot project.

17.5. At which stages should the audit be carried out?

The circular of 5 May 1994 states the contents of the different study stages of a road project, which are as follows:

- preliminary studies (decision on a development scheme, an estimated appropriation, the route option, the number and the type of junctions);
- draft design phase (choice of alternative, and the general outline of the scheme);
- project studies (the detailed scheme, detailed definition of works and cost of project);
- safety inspection prior to opening (checking all aspects liable to affect road safety).

This circular outlines the contents of the opinions and decisions that punctuate the progress of the studies, and clarifies the roles of the many people involved. Lastly, it states the conditions of going into service.

In principle, the safety audit will probably by applied to the same stages, which are:

- the preliminary studies;
- the draft design phase;
- the project studies;
- the safety inspection prior opening.

17.6. The procedure

The French Directorate of Safety and Traffic of Ministry of Public Works might choose the most common existing practice, that is the following one: the project manager initiates the audit, selects the auditor, and decides the final modifications of the scheme instead of the designer.

17.7. The audit team and the qualification

An important problem will be to indicate the status and quality of the auditors at the different stages of the projects as there is a strong political will for the safety audit to be introduced quickly. However it is obvious that the auditor or the audit team should have experience in road safety , in traffic accident reduction, and knowledge in conception.

17.8. The checklists and the manual

The first work has already been started. It consists in developing an initial reference system in the form of questions for each of the stages. However, the form and content of the reference system will be adopted during a consultation with the relevant project owners. The checklists will be included in a manual that will describe the procedure and the organisation for the introduction of a safety audit.

17.9. Conclusion

With a view to introducing a road safety audit in France, there still remains a considerable amount of finalising work to be done in 1998 and in 1999, particularly concerning the procedure. Foreign experience will provide a useful reference to enable this work to be performed more quickly. The application of a road safety audit, particularly for road projects belonging to the TERN network, should be gradually phased in from the beginning of the year 2000 onwards.

18. Greece

18.1. Introduction

This report is an overview of the (by NTUA) perceived possibilities for introducing road safety audit (RSA) in Greece. It refers to the application of RSA principles and procedures (a) in general and (b) for trans-European Road Network (TERN) roads in particular. The report is based on a review of the issues analysed in the SAFESTAR report Road Safety Audit Tools, Procedures and Experiences: a Literature Review, considered vis-a-vis Greece's road safety / highway design policy environment.

18.2. Overall prospects

A number of factors have been acknowledged to contribute to Greece's relatively poor safety record (among the worst in the European Union), including - among others - infrastructural / maintenance deficiencies, insufficient driver education and enforcement, and peculiarities in the traffic mix (such as high percentage of motorcycles). Given the increasing levels of mobility and vehicle ownership, road safety issues are receiving increasing attention among the general public. However, this has not yet been translated into a consistent and coherent national road safety policy.

Public awareness of road safety traditionally increases in a periodic fashion, i.e. after the comparatively heavy 'death tolls' of the Christmas, Easter, and mid-August holidays (the result of correspondingly high exposure, in terms of vehicle-kilometrage, during those days). During the ensuing 'publicity waves', some policy initiatives, campaigns or concrete measures are commonly agreed upon and - often - materialized (although not always durably). In the mid 1990's, discussion of road safety issues has been somewhat more intense and more widely publicized, including some mass-media initiatives as well as the setting-up of a Parliamentary Committee for investigation of the road safety problem and proposal of consensus measures. Among the Committee's suggestions was the introduction of 'road safety audit', based on the recognition that it is important to aim for accident prevention alongside the effort for reducing / eliminating accidents where they occur.

Importantly, another proposal of the said Committee was the creation of a single (national) authority responsible for road safety, as well as of a (research) institute for road safety. The suggested authority (or 'Council'), which has not yet been materialized, is apparently envisaged as a 'horizontal' coordinating body, made up of representatives from the multitude of public and other bodies having an interest in road safety. The absence of a coordinated approach is blamed as a major shortcoming of Greece's road safety policy environment. For example, responsibility for key ingredients of road safety is currently split among several government ministries, including: Ministry of Environment, Planning and Public Works (road infrastructure planning, design, construction, signing, marking, safety accessories, signalization and maintenance); Ministry of Transport and Communications (driver education / licensing, vehicle standards); Ministry of Public Order

(enforcement), etc. Thus, it is very difficult to formulate and implement a national road safety policy, due to a) inefficient decision-making procedures and b) inflexibility in taking legislative action. It has not even been possible to specify broad quantitative targets for medium- or long-term accident reduction.

Due to the above-described incoherence, the non-existence of road safety as a distinct policy 'item' also implies budgetary constraints, since there is no explicit provision of road-safety-targeted funds in the national budget.

Given the above constraints, it can be deduced that it will take some time before road safety audits are an integral element of a well-defined, coordinated and consistent road safety policy in Greece. However, the concept of road safety audit (as a 'successfully applied elsewhere' measure) has been discussed, and some initiatives are already underway, including the following:

- The Ministry of the Environment, Planning and Public Works is considering, following a proposal by NTUA, a pilot project on the implementation of Road Safety Audit in Greece. (NTUA is already cooperating with the Ministry on a safety-engineering study of the Vouliagmenis Ave. arterial, which is incorporating elements of existing-road RSA in identifying potentially dangerous sites.)
- The authority responsible for construction of the Egnatia Road in northern Greece is interested in applying RSA on the project (which is part of the TERN) and recognises the need of relevant RSA guidelines.

Thus, the years 1998 / 1999 are expected to be crucial for the definition and pilot-testing of the RSA concept. A successful completion of this stage can lead to a more widespread application in the early 2000's.

18.3. Prospects for TERN roads

The Greek portion of the trans-European Road Network (TERN) comprises a significant part of the country's primary national road network. Since the late 1980's, large sections of the road system are upgraded or constructed anew, as part of the 'Grand Projects' programme. These include:

- the PAThE (Patras - Athens - Thessaloniki - Evzoni) highway, upgraded to motorway standards;
- the Egnatia Road, including mostly new construction, spanning northern Greece from the Ionian Sea to the Greek-Turkish border;
- the Ionian highway (along Greece's west coast);
- the northern road axis of Crete.

All schemes, as is the case for all of the (primary, secondary or tertiary) national road network, are the responsibility of the Ministry of the Environment, Planning and Public Works and of the corresponding regional highway departments. However, to increase the effectiveness of their implementation, the management was delegated to special quasi-autonomous authorities / bodies, that have been set up for this purpose. Such authorities (subjects of the Ministry) exist for a number of projects - or groups of projects.

Two of the most important such bodies are responsible for the PAThE and Egnatia projects, respectively. In the absence of pre-specified national

standards or guidelines, these authorities have, among other things, developed / adopted separate design standards and approval procedures, and may plan to proceed independently of Ministry specifications.

Moreover, the above authorities employ project managers / construction managers, which means the existence of an in-built quality system (incorporating quality control and quality assurance procedures), partly / indirectly addressing some of the issues that should form part of an RSA. In this direction, it is worth mentioning the initiative by the Ministry of National Economy, under which a selection of public projects (including some TERN and non-TERN road schemes) will be pilot-tested for adherence to quality / management procedures and standards.

In addition, some links of special importance have been awarded as concessionary (e.g. DBFO) schemes to private-sector operators. These include the Rion suspension bridge and the Athens peripheral motorway (Attiki Odos). Provisions for application of state-of-the-art procedures guaranteeing a high level of safety have been expressly included as clauses of the concession contracts; however, the private operator is otherwise granted flexibility in defining details of the chosen procedures.

The above facts amount to an apparent 'decentralization' and diversification of RSA application as regards TERN roads. It is important to note here that a large portion of Greek TERN roads is currently under design or construction, aided by European funding (ERDF, Cohesion Fund, EIB, INTERREG), which has a limited time-horizon (in the order of five years). This amounts essentially to a 'crash-programme', expected to last until approximately the year 2010. Given the existing implementation structure and time constraints, and in order to attain the high safety standards requested within the funding framework, it may well be difficult to introduce and establish a well-thought-out, long-term, consistent, formalized and centralized RSA framework, applicable to all stages of a project (from conceptual to opening). Instead, if - as suggested earlier - such a framework is in place by the early 2000's, the ongoing design / construction of TERN projects provides an opportunity for its application. In the context of Greek TERN roads, it may be most beneficial and realistic if the framework is applied in a focussed manner, i.e.:

- emphasis on the detailed design and pre-opening stages: for many of the eligible projects, preliminary design has already been completed;
- consideration of construction and funding timescales: avoid delays without sacrificing integrity of procedure;
- provisions for the monitoring stage (operational phase).

The experiences from application at TERN-level may, later, be transferable to a subsequent adaptation of the RSA principles and procedures to the non-TERN national and lower-level road network.

18.4. Implementation aspects

18.4.1. *Road Safety Audit status (mandatory / recommended)*

If RSA is to be made mandatory, international experience suggests that this should be a) for a limited upper class of roads (e.g. the primary national road network, or the system of TERN roads), b) for projects above a certain value, c) after an initial (trial) period. These suggestions obviously arise from considerations of possibly limited resources and of the need for introducing and fine-tuning the RSA concept.

The importance, size, budget, and quality requirements of TERN projects would justify the mandatory character of RSA. However, given the lack of national safety policy and coordinated effort for introducing safety measures, it is most likely that the application of RSA would be left entirely at the discretion of the client or the special authorities that are responsible for the management of the projects (some of which, as is the case for the Egnatia highway, are already interested in introducing RSA).

Given the presence of separate authorities for the major projects, it may not be feasible to define and 'impose' a uniform RSA framework. On the other hand, a purely 'bottom-up' approach (building an RSA framework based on existing practices) will most likely take many years to materialize (use of RSA is not expected to become spontaneously widespread). What appears more preferable is to proceed with a centrally-defined RSA concept, to be tested and developed into guideline ('recommended') status. This could be further enriched by whatever experiences are gained from individual projects/ authorities or from other audit-like procedures.

18.4.2. *Audit stages*

An issue to be taken into account in deciding the stages at which RSA should be carried out at TERN roads, is the fact that a number of TERN projects are in the stage of materialisation, with most parts being already past the feasibility stage (and many will be past the preliminary design stage in the early 2000's). Thus, it would be more realistic to put more weight to the later RSA stages (detailed design, pre-opening, monitoring).

Assuming that RSA should not be introduced as an ex-post requirement into ongoing contracts, it is important that relevant guidelines should be developed as early as possible (possibly not long after the year 2000), in order to make it possible for a significant number of new TERN projects to be audited at one or more stages.

18.4.3. *Procedures*

As mentioned earlier, in the case of TERN projects special structures in the funding / construction / operation are adopted. Apart from the 'client' (a definition including a 'directing authority' and a 'supervising authority'), a project manager also exists, to whom certain decision-making functions are delegated from the 'client'.

In existing international practice there are two main decision-making structures regarding RSA. In the standard case, it is the 'client'/project manager that initiates the audit, selects the auditor and makes the final decisions; alternatively, the designer / contractor may be involved in some or all of the above actions (pending on the 'client's' approval). The decision between one of the two structures, as well as provisions for discussion / public availability of results, might well be taken on a case-by-case (or project type-by-project type) basis, depending on the trade-off between a) the need for formalized / transparent procedures and b) the need to avoid delays in project completion by (partly) 'internalizing' RSA into the project itself.

The fact, however, that the RSA concept is new - and its function not always well understood - should not be overlooked. At the phase of introduction, in order to ensure that integrity of RSA procedure, it would be more appropriate that the former structure is adopted for TERN roads: i.e. that the client or the managing authority should assume the responsibility for undertaking the RSA.

Consideration of public opinion (e.g. heavy-vehicle drivers) or bodies that are indirectly involved in road safety (e.g. police) is another issue regarding the procedures. Consultation (even of an informal form / manner) would be a valuable aid, and it would be advisable to integrate it in the RSA process.

18.4.4. *Audit team*

One obvious constraint arises from the absence of local experience with RSA and the need for some international assistance in the initial phase of application (including training); however, there are sufficient human resources as concerns specialization / experience in the background fields considered to be relevant, i.e. accident investigation, road safety engineering, and highway design.

In what concerns independence and special training of the auditors, a further probable constraint is related to the possible lack of available personnel within 'client' organizations for carrying out audits; this will make necessary either to employ RSA consultants or to commission RSA by contract (as an external service).

18.4.5. *Manuals / checklist*

Adaptation of international experience / practice to Greek conditions may be hampered by limitations regarding empirical data on: a) validation of safety measures' effectiveness with respect to driver behaviour, accident reduction, etc.; b) accident records at road sections / locations.

In addition, development of a manual and checklists for RSA may be further delayed due to the diversity of authorities responsible for completion of the major projects. A common (national) guideline is eventually desirable; however, authorities wishing to proceed sooner with RSA could well rely on existing guidelines from other countries or develop their own (ad hoc) recommendations / checklists.

18.5. Conclusions

It is apparent that, in deciding on an RSA framework, what is considered to be 'common practice' should be weighted upon real-life conditions / needs and applicability / feasibility considerations. Taking into account the issues discussed in the previous paragraphs regarding the opportunities and constraints associated with application of RSA for TERN roads in Greece, the following summary of relevant suggestions is presented in *Table 9* below.

Item	Proposal
Form of procedure	Top-down introduction of formal, centrally-defined RSA concept, alongside with possible initiatives by managing authorities of major individual projects
Stages	Emphasis on detailed design, pre-opening and monitoring
Status	Recommended
Organisation	Client / managing authority should be responsible for undertaking RSA, including initiating the audit and selecting the auditing team
Final decision	Client / managing authority
Audit team	RSA consultants (with an engineering / accident investigation background) from an independent organisation (outside client / managing authority)
Manuals / checklists	A national guideline should be the eventual target; *ad hoc* guidelines may be developed for individual projects in the interim

Table 9. *Summary of suggested road safety audit framework for TERN roads in Greece.*

19. The Netherlands

19.1. Introduction / historical background

Road Safety Audits in The Netherlands were first mentioned in a SWOV report about Road safety Impact Assessment (RIA) in which RSA was introduced alongside a - more strategic - scenario technique which uses traffic intensities, different road networks, and risk profiles of the roads to be used. Thus, a comparison between different networks could be made.

There is a national road safety policy statement about accident reduction goals in The Netherlands. Target figures for 2010 should be a fraction of what 'actually happened' in 1986. The goals are 50% less casualties and 40% less hospitalized victims in 2010 compared with 1986. However, there is no indication that these goals will be reached easily.

In The Netherlands not many new TERN roads are planned. Four out of these five projects concern short road sections near the Dutch / German border. All new sections together total 70 km. All levels of government, together with research centres and engineering firms, arranged a task group to introduce RSA in The Netherlands. They started the introduction of RSA in The Netherlands as a top-down process.

19.2. Road authority organisation

In The Netherlands, four public bodies regulate the road network: the National Government, Provinces, Local Authorities, and District Water Boards. In 1993 a law reassembled the control over roads between these public bodies. Since then, the road network under control of a certain body is more homogeneous. The national body is mainly responsible for the motorways whereas a local authority is responsible for local roads within its borders. Primary TERN roads are controlled by the national public body.

19.3. Relevant publications

There is no official checklist or audit manual available yet. However, there are guidelines available for all types of roads. Guidelines for motorways are more restricting than those for local roads. There are quite a few different organisations active in infrastructure and safety in The Netherlands, e.g.; AVV (The Netherlands Transport Research Centre, part of the ministry) and SWOV (Institute for Road Safety Research). AVV for instance aims to facilitate political decisions as a part of the national road authority, whereas SWOV acts as an independent institute, advises and publishes on all kind of road safety related subjects to numerous parties.

19.4. Procedure

An Audit initiation will be the responsibility of a Road Authority. The decisions about what action to take in reaction to an audit report will be taken by the Road Authority, with consultation of the design team. The Audit

findings should be realistic, well motivated, and comply with political decisions taken earlier on in the design process. The development of an audit protocol started in 1997. An audit secretariat will be formed during period the pilots take place. It will be stationed at SWOV. Its task will be to provide information about audits, inform road authorities about available auditors, and assist with the quality aspects of audits to be conducted.

19.5. Stages

At this introduction stage before the actual pilots have taken place, Dutch RSA procedures consist of five stages. The following five stages are to be recognized:

1. road categorization plan; working out of the road network structure in order to facilitate the allocation of activities. At this level, general ideas are worked out and road safety aspects can have greatest impact on a plan.
2. global design; decisions about alignment cross sections and layout of intersections;
3. detailed design; e.g. detailed layout, delineation, and illumination;
4. before opening; primary to insure that the translation from design to realisation is done well;
5. after the opening took place; after a couple of months, the section will be evaluated primarily to check whether the road use complies with the general ideas utilized during the design process.

19.6. Audit team

The pilot projects to come, will be conducted by teams to be formed out of a small pool of people who will get a brief practical course about how to conduct an audit. Candidate-auditors, to be invited to this course preceding the pilots, should have both extensive experiences with road design and road safety. The results from these pilot projects, and the small course preceding to the pilots, may be used to create a course which should lead to a pool of qualified auditors.

19.7. Pilots

There has been a tiny survey, whose purpose it was to examine the timing of RSA in the design process. These results complied with other European audit experiences about the timing of stages. The 'second' round of pilot projects with audits in subsequent stages, will start in 1998. This handful of projects will be selected in order to alter different project scales. These projects are not necessarily TERN roads.

19.8. Conclusions

The Dutch government wants to adopt RSAs. By means of a team with representatives from different public bodies and organisations, the introduction will be more efficient. There is a chance that one or some of the Dutch Pilot projects can be a road which is part of TERN. For Dutch road safety goals are not easily reached, new tools to improve road safety are encouraged. This enlarges the chances for a Dutch RSA system.

20. Portugal

20.1. Introduction

This report describes the possibilities and constraints for introducing road safety audits (RSA) in the design process of Portuguese roads, with a special emphasis on Trans-European Road Network (TERN) roads.

An overall description of the administrative organization of the public road system is made in the next chapter. In chapter 3, implementation aspects are discussed.

20.2. Public road management organization

Public road construction and maintenance in Portugal are regulated by a National Road Plan, since the beginning of the century. Currently, the existing Road Plan (introduced in 1985) is being revised and should be replaced by the new Road Plan in the near future. The existing Road Plan divides public roads in two main groups:

- the national road network (NRN), which is under the administration of the Ministry of Equipment, Planning and Territory Administration, through the Portuguese Road Administration (JAE), a central government agency;
- the local roads, which are under the administration of 305 municipalities in which the country is divided.

Trans-European Road Network (TERN) roads are included in the national road network.

According to the Road Plan, the National Road Network (NRN) comprises the links whose functions were considered of national or international interest, with a total length of around 10,000 km. The implementation of the Road Plan had the following main objectives:

- an appropriate performance of the transport system;
- a well-balanced development of the regional potentialities;
- a reduction of global transport costs (in economical and financial terms);
- an increase in road safety;
- an improvement of the network's management procedures and organization.

The NRN is divided in two sub-networks of national roads:

1. the Fundamental Sub-Network - RNF
2. the Complementary Sub-Network - RNC

The Fundamental Network comprises the Main Routes (IP) which are the roads with a major national function, serving as the basic structure for the whole network of national roads. These routes provide the connections among the most important urban centres and to the main ports, airports, and border links.

The Complementary Network comprises the Complementary Routes (IC) and Other Roads (OE), which establish the connection between the RNF and

medium important urban areas. The Complementary Routes include links of regional interest and the high capacity access motorways to the *Lisboa* and *Porto* Metropolitan Areas. Other Roads (OE) connect the IP to the IC, and these to medium sized towns

The accomplishment of the Road Plan was carried out and programmed through a medium term (1987-90) and a long term (1991-95) plan. In 1995, only 53% of the planned Main Routes and 29%of the proposed Complementary Routes were already constructed. As for the Other Roads of the RNC, the interventions that took place were mostly limited to the routine maintenance of the existing roads, because of a reduced capacity for intervention due to scarce human and financial resources. These interventions did not improve the old geometric design of those roads to comply with the demands of modern traffic, which reflected negatively in the driving and safety conditions.

Presently, the implementation of the current medium term plan (1996-2000) calls for the construction of more than 1200 km of Main Routes and 670 km of Complementary Routes, of which about 1200 km will be concessioned motorways. Additionally, it is foreseen that two more concession contracts for toll motorways (360 km) will be signed, and nine concession contracts for 730 km of new roads, under the design-build-finance-operate (DBFO) concept.

Through this programme it is expected that until the year 2000, the Fundamental Network will be completed, most of it with motorways. Also half the Complementary Routes (IC) will be finished.

Financing and construction of the NRN is managed directly by JAE. However, as reported above, the construction and management of some stretches of this network were granted by the Portuguese Road Administration to private sector consortia. In fact, since the early seventies there has been a motorway concessionaire. Starting in 1997, design-build-finance-operate concessions (DBFO) of some stretches of Main Routes (IP roads) are being auctioned by the Ministry of Equipment, Planning and Territory Administration.

The design of national roads is usually carried out by private consultants and design teams, which have to comply with the road design standards (and other technical requirements) issued by JAE (see References). The Portuguese Road Administration is responsible for the approval and quality control at all stages of the road design process. Moreover, JAE is responsible for the quality control of the construction of non-concessioned stretches of road, as well.

Local road construction and maintenance are the responsibility of each municipality. Financing these roads can be raised in the local budget or in Central Administration transfers (sometimes with some European funding).

For these roads, there are no nationally applicable general guidelines or design standards. On non-urban environment, local road administrations usually require overall compliance with JAE design standards (although easily accepting relaxations due to financial reasons).

20.3. **Implementation aspects**

20.3.1. *Scope and status*

The absence of uniform technical rules or guidelines for local roads and the local administration's readiness to accept minimum values, suggests RSA of local roads to have an especially favourable cost-effectiveness ratio. In fact, international comparisons of accident rates lead to the conclusion that, the farther we descend in the road hierarchy (motorway, IP, ..., local roads), the greater the difference between accident rates in Portugal and the accident rates in other European countries.

It must be reckoned, however, that the explanatory reasons for the low safety standard of local roads, lead to strong difficulties with the introduction of the RSA in their design process. Therefore, it is suggested that RSA should not be applied to local roads, right now.

Following the international experience, RSA procedures should obviously be first applied to major routes in the NRN, following an initial experimental period for fine tuning the adaptation of the procedure to the Portuguese road environment.

It seems natural that RSA should be initiated by the Road Administration, since JAE retains authority over the whole NRN (be it concessioned or managed directly). In this sense, guidelines for RSA of NRN's roads can be centrally developed. On later stages, as experience is gained and complementary safety studies completed, the original guidelines can be improved and better adapted to the Portuguese road transportation system.

According to the Road Plan, IP and IC roads have an important function in the transport system and quality requirements that fully justify a national mandatory status for RSA.

Further justification can be invoked in favour of a mandatory status for RSA of those IP and IC roads included in TERN: being part of the European master plan for the road network and traffic, safety concerns should be harmonized with the rest of Europe to help foreign drivers' task. This is especially relevant in countries with an important tourist industry, such as Portugal.

Moreover, as it is expected that DBFO operators will emphasize the reduction of the initial investment (construction costs), it seems especially important that RSA isapplied to these projects, to ensure that road safety will not be seriously affected.

20.3.2. *Stages*

As stated above, the Road Plan calls for the completion of the planned IP and IC roads. This means that all TERN roads will be constructed (or at least in the final design stages) by the year 2000. As a result, RSA of new TERN

roads has to be made at later design stages (detailed design and pre-opening), if the relevant guidelines can be developed on time.

Application of RSA on earlier design stages will be limited to delayed projects, only.

20.3.3. *Procedures*

The centralized management of the NRN by the Portuguese Road Administration, reported above, points towards the advantage of RSA being initiated and followed by JAE. In this way, a formal procedure should be followed, in which JAE should select the auditor and decide the need to comply with the RSA results. In the case of DBFO auctions, RSA results can be used as another criterium for evaluation of the proposals.

20.3.4. *Audit teams and manuals*

The successful application of RSA requires combined expertise in the related fields of road design, road safety engineering, and accident investigation. As for Portugal, there are enough human resources in the field of road design. Road safety is a recent concern in the Portuguese society, resulting in not many experts in road safety engineering and accident investigation. As a result, in the initial phases of RSA application, some difficulties may arise regarding the capacity of the available teams. However, developing suitable RSA guidelines and a short term comprehensive training program seems feasible, if adequate cooperation is agreed between the Road Administration and research institutes or universities.

It is recommendable that clear and adequate separation between design teams and safety audit teams are set up.

Full adaptation of the international experience and 'good practice' to the conditions of the Portuguese traffic system will require the increase in research activity on safety issues, namely the relations between the infra-structure, driver behaviour, and accident risk.

20.3.5. *Pilot tests*

JAE's interest on the possible application of RSA in Portugal is displayed by the co-financing of LNEC's activities in the *SAFESTAR Workpackage 8 - Safety Audits*.

Following the participation in the October Safety Audit Workshop, in Copenhagen, pilot tests are being carried out on two stretches of NRN roads:

- stage 3 RSA on IP6 (Peniche-Óbidos), a two-lane Major Route stretch 20 km long, starting in an urban zone (and port);
- stage 4 RSA on EN 379 (variante a V.N. de Azeitão), a two-lane road 5 km long, bypassing a small village.

The tests are integrated in the study plan on Road Safety Audits, to be presented at the Technical University of Lisboa (IST) to obtain a Master's degree.

Following the presentation of this work at the University, a draft manual for RSA (in Portuguese) willbe proposed to JAE, as an auxiliary tool for more widespread pilot tests. This manual, together with LNEC's experience gained with SAFESTAR Workpackage 8, will be very useful to launch training courses on RSA.

20.4. Concluding remarks

Road safety has become an increasingly important social issue in Portuguese society, especially since the beginning of the present decade. Greater public awareness of the issue, was accompanied by political emphasis on the implementation of a coordinated approach to road safety and the establishment of formal ad-hoc working groups; thus joining together the different agencies with active responsibility on road safety.

From the institutional and political point of view, the time seems appropriate for RSA implementation.

Finally, as regards the NRN and TERN roads, it should be mentioned that the latest draft of the new Road Plan (also designated as the *PRN 2000*), in preparation, explicitly requires that new national roads should be subject to road safety audits.

20.5. References Portugal

1. JAE - Norma de traçado. Junta Autónoma de Estradas, Almada, 1994.

2. JAE - Norma de intersecções. Junta Autónoma de Estradas, Almada, 1993.

3. JAE - Norma de nós de ligação. Junta Autónoma de Estradas, Almada, 1994.

4. JAE - Norma de sinalização vertical de orientação. Junta Autónoma de Estradas, Almada, 1992.

5. JAE - Norma de marcas rodoviárias. Junta Autónoma de Estradas, Almada, 1995.

21. Spain

21.1. Introduction / historical background

At the State level, some sort of safety control procedures are applied to both existing and new roads.

The State Road Network existing roads are subject to annual safety inspections to identify hazards and potential accident risks factors, and design preventive safety improvement schemes that are implemented as part of DGC Annual Safety Improvement Programs.

New road design projects for the State Road Network are subject to an internal inspection procedure to ensure that they meet all applicable standards and regulations. This procedure, known as dynamic inspection, is carried out by DGC engineers who are not involved in the designing team. The procedure is not specifically designed to control safety features. Recently, it was decided that all safety improvement, maintenance and rehabilitation projects will incorporate a Road Safety Assessment in which the designer will analyse the safety implications of the project and justify the design from a safety stand point. This new procedure is intended to be a first step towards introducing Safety Audits. At this stage, it is the designing engineer himself who is responsible for auditing the safety of his project, and making sure that all safety aspects are taken into account. The DGC is preparing guidelines for the process defining minimum report contents and safety review criteria.

21.2. Road authority organisation

In Spain, three main public bodies regulate the road network (165.000 km.): National Government (14% length; 54% interurban traffic) and two Local Governments, Comunidades Autónomas (45% length; 31% interurban traffic) and Diputaciones-Cabildos (41% length; 5% interurban traffic). TERN network is under national government regulation.

21.3. Relevant publications

Actually there isn't any checklist or audit manual available. Hopefully this situation will change in 1999 when the Spanish Road Association is expected to publish a detailed checklist together with a guidelines for each type of road.

21.4. Procedure

Auditing a road requires a systematic process that might be simplified by using checklist designed for that purpose. Checklist items vary depending on the type of road that needs to be audited and the stage on which we want to apply safety audits.
As designing parameters vary depending on the type of road (motorway, highway, interurban, etc) and if this road is already built or not, we understand that different checklists must be applied for each case.

In order to assure that checklist are applied correctly, and in the same way in all cases, even if different teams are used, we understand that creating a safety audit manual is necessary.

21.5. Stages

- feasibility: at this stage audits must be focussed toward alternative itineraries, road sections, road equipment, and high accident stretches. Interaction with other roads and traffic increase consequences must be considered at this point.
- preliminary design: the main task at this stage must be assure that the new road will have similar parameters with adjacent ones in order to create an homogeneous network.
- detailed design: detailed layout, delineation, road equipment, illumination will be audit in order to get safe and efficient roads.
- Before opening: main purpose of this stage is to verify that the road was built as designed.
- After opening: as initial conditions (taken into account when designing) might vary, we must check periodically that condition changes don't require redesigning. If they do, redesigning must be considered.

21.6. Pilots

Although some efforts have been made in order to apply safety audits on pilot stretches, either on national or local networks, safety audits haven't been applied yet on any road in Spain. This situation is expected to change in 1999 when cooperation with local and national authorities will probably be obtained.

21.7. Conclusions

Road authorities (both national and local) are concerned with road safety and they see safety audits as an effective approach to reduce the number of accidents.
Even though knowledge of safety audits is not widely spread, checklists and manuals are expected to be available next year so that pilot projects might start by the end of the year.

22. Annex D Road Safety Audit Workshop in Copenhagen

Road Safety Audit Workshop

Copenhagen 27-28 October 1997

SAFESTAR WorkPackage 8

Content

Enclosed

The Danish Road Safety Audit Manual (English version)

Introduction

At the SAFESTAR WP8 meeting at SWOV the 2 July 1997, the Danish partners proposed to organise a workshop. The workshop was supposed to give the partners confidence, ideas and practical sense of how a Safety Audit is carried out in Denmark, and how it can be carried out in their country.

The Workshop was carried out in Denmark on the 27 and 28 October 1997, and each of the SAFESTAR WP8 partners attended the workshop with two representatives:

George Kanellaidis & Anastasia Flouda, The Technical University of Athens (NTUA), Greece; Atze Dijkstra & Robert van der Kooi, Institute for Road Safety Research (SWOV), The Netherlands; João Lourenco Cardoso & Luis Bairrao, Laboratório Nacional de Engenharia Civil (LNEC), Portugal; Pavel Tucka & Josef Andres, Centrum Dopravního Výzkumu (CDV), The Czech Republic; and Lene Herrstedt & Puk Kristine Nilsson, The Danish Road Directorate (DRD), Denmark.

Furthermore, Asociacion Española de la Carretera (AEC), Spain, and Service d'Études Techniques des Routes et Autoroutes (SETRA), France, had expressed their interest to participate in the workshop. Jacobo Díaz Pineda and Guénaëlle Bernard presented Spain and France.

The two Danish experienced auditors Adriaan Schelling and Anders Møller Gaardbo conducted the workshop. A. Schelling and A. Gaardbo are the key figures of the team, whom in 1992 introduced the English Road Safety Audit system in Denmark, and organised and developed the Danish system.

First Day of the Workshop

The workshop was opened by the Danish host Lene Herrstedt, who bid everyone welcome and presented the agenda of the workshop – see *Annex 1*. After which, each of the participants introduced themselves.

Introduction to Road Safety Audit in Denmark

The second item on the agenda consisted in an introduction to road safety audit in Denmark. In this introduction, the workshop leader A. Gaardbo presented the following topics:

- *The Danish Road Safety Policy*
  - Road safety in Denmark (accident statistics).
  - Road safety targets as described in The National Road Safety Action Plan of 1988.

- *The Progress of Road Safety Audit in Denmark*
  - 1992: Establishment of a project group.
  - 1993: Initiation of the pilot project, first edition of the RSA-handbook.
  - 1995: Evaluation of the pilot project.
  - 1996: System specification of the implementation of RSA.
  - 1997: Launching the new RSA-system, second edition of the RSA-handbook, pilot education of road safety auditors, English version of the Danish RSA-handbook.
  - 1998: Establishment of a road safety database on the internet.

- *Definition of Road Safety Audit in Denmark*: What does safety audit concern, what does it deal with, and how is it done.
  - A number of photos showing five different examples of places were presented. Technically the examples all followed the Danish road standards, but the problems arise because the road users point of view had not been adequately kept in mind during the road planning.
  - The five audit stages, the three parties, and the audit process were briefly summarised.
  - The question of whether road safety audit is useful was answered in the light of the conclusions drawn from the evaluation study of the Danish Pilot project. The evaluation consisted of a cost-benefit analysis based on a number of selected schemes, together with an evaluation of the organisation, the procedures, and the qualifications of the auditor. The main conclusions and recommendations from the evaluation panel were presented: "...the road safety audit procedure is profitable; the quality of the completed schemes was improved; the procedures were generally positive for the parties involved and should be continued and expanded to encompass all larger schemes by the State, counties and municipalities. Furthermore, a distinct education for road safety auditors should be organized.".
  - Finally A. Gaardbo showed a simple example of a road safety audit (a bypass scheme with a single carriageway). Solutions and recommendations to the problems were presented.

Case 1: The Kværndrup Bypass – Stage 1

Third item on the agenda was an example of a road safety audit on stage 1 (the initial stage). This example was more complicated than the above mentioned, and should be carried through by the participants.

Each of the participants were supplied with a plan drawing – see *Annex 2* – and were grouped together with persons sitting next to them, and asked to consider a number of circumstances:

- The influences on the existing network
- Sight distances
- Speed
- Traffic flow
- Road user groups
- Number and type of intersections

The considerations of each of the groups were discussed in plenum. The main conclusions were:

- The shoulders of the bypass should be reduced, as they invite driving at very high speeds
- The speed limit should be kept to 80 km/h
- Too many intersections
- Crossings should not be at the same level
- Where the bypass meets the through going road, roundabouts should be established
- Crossings by cyclists and pedestrians should be safer
- Depending on the traffic in the T-junctions, left turns should be prohibited, or the minor road should be closed

Case 2: The Hillerød Expressway - Stage 2

Case number 2 consisted in a road safety audit on stage 2 (the draft design stage) of the extension of the Hillerød Expressway – *Helsingevejen*. The participants were divided into two groups, to which a workshop leader was assigned.

The two workshop leaders introduced this case by telling the participants that the Danish auditors' comments should be structured on two levels: *problems* and *remarks*.

- *Problems* (!) are the conditions that can be documented as entailing an increased accident risk. Problems must lead to project changes that can eliminate this risk or reduce it decisively. It is the auditor's job to formulate solutions/proposals for alleviating problems. The proposals must illustrate that it is possible to improve the road safety of the project; however, it is not the auditor's job to design the changes.
- *Remarks* (i) concern the conditions experience has shown should be given further consideration in continued designing, but for which it is not possible to document an increased risk to road users at the current audit stage.

Depending on the size of the scheme, additional levels of comments can be necessary. In this way reports concerning large schemes often will be divided into *general comments* and *specific comments*. At each of these two levels, *problems* (!) and *remarks* (i) are pointed out gradually.

The participants were introduced to the case in detail. The Hillerød Expressway Extension was planned as a 10-km long two-lane single carriageway scheme to relieve the north-southbound roads in a corridor. The southernmost part of the scheme (8-km) is designed as an expressway for motor vehicle traffic only.

Each of the participants were supplied with a folder, enclosing a map showing the existing main road network, a route map of the scheme, a map of the existing and expected motor vehicle traffic flows, together with a table of stopping sight distances - *see Annex 3*. Furthermore, scheme drawings: layout plans, longitudinal profiles, cross sections and layout plans of intersections and checklists for stage 2 were provided to each of the groups.

After about 2½ hours of group work, comments and specific problems were discussed in full. Below, the main points of the group discussion are summarized. *Problems* are marked with an (!), *remarks* with an (i):

General comments (South -> North)

(!) The road stretch is inconsistent: the cross section of the stretch varies with abrupt transitions, there are different types of intersections and different design speed. The 2+1 layout implemented on the trunk road to the south of the scheme should be continued.
(!) The ditches (drainage) are very steep. More flat slopes should be established.
(!) A radius of 2000 metres designed for 90 km/h is a very sharp curve when overtaking.

Specific points (South -> North)

(i) The second junction from the south is designed as a motorway interchange (a cloverleaf). This gives a false impression and tempts drivers to a higher speed than the speed limit of 90 km/h.

(!) The T-junction is not of the same high standard as the rest of the road. Furthermore, no traffic flow figures are available for the minor road.
(!) The roundabouts (the central island of the roundabouts) in the north should be visible. The line of sight rises in the air when coming from the south. The vertical radius seems to be too small before the roundabouts.
(!) Problems concerning cyclists arises at the first roundabout.

How to Proceed with SAFESTAR WorkPackage 8

The discussion of how to proceed with this SAFESTAR workpackage was discussed as the last item on the first day of the workshop. The main conclusions of the discussion have been summarized in a note – *see Annex 4.*

Second Day of the Workshop

Case 3: The Hillerød Expressway - Stage 4

Case number 3 consisted in a road safety audit on stage 4 (inspection of the road just before or just after opening) of the extension of the Hillerød Expressway – *Helsingevejen,* the same road which was audited on stage 2 on the first day of the workshop.

The participants were divided into three groups and each group was supposed to study a separate part of the road stretch. One group inspected the cloverleaf, one the T-junction, while the third group inspected the southernmost roundabout. All participants were supplied with checklists together with relevant plans.

After the field inspection, a summary of the main points was looked at in detail. Workshop leader A. Schelling initiated the group discussion by explaining to the participants that the Danish auditors distinguish between three types of comments in the road safety audit report on stage 4:

- Things to be done *now.*
- Things to be done when in the process of doing something (and wish to change it).
- Larger things which are expensive, and which should be done when possible.

A representative from each of the groups presented the observations of the group. Nearly all the observations done on stage 2 could also be found on stage 4!

Adriaan Schelling informed the group that in the particular safety audit of the Hillerød Expressway the findings on stage 2 were discussed with the designers, but not adapted, nor presented for the client for decision. The findings according to the safety audit on stage 2 were therefore never realized.

Implementation of Road Safety Audit in Denmark – The New System

Last item on the agenda consisted in a short presentation of the new road safety audit system in Denmark. The presentation included the following topics:

- *The General and the Local System*
  As mentioned earlier the evaluation panel recommended road safety audit to be continued and expanded to encompass all larger schemes by the State, counties and municipalities. In this way road safety audit should be generally available and usable. This resulted in the new manual in which a general system is described – *see the enclosed RSA-Manual.* The general system provides the background for a description of a local system. In addition a procedure to adapt the general system locally is described. Roughly, it is the local organisation (the client, the designer and the auditor), determination of the audit stages, types of

schemes to be audited, together with a description of the ordering and review, which should be adapted.

- *Qualifications of a Road Safety Auditor*
  The qualifications of an auditor were defined in the evaluation report from the external panel. The panel recommended among other things that an auditor should:
  - have knowledge of the road design process in general
  - be in possession of road safety knowledge in practice
  - know where to find knowledge and information about road safety
  - be able to negotiate/communicate knowledge in a convincing way including explanation of the technical documentation

  Finally the panel recommended implementation of a special education for safety auditors.

- *Results of the Pilot Education*
  A pilot education was conducted in September 1997. The education involved a pretest (in writing), and afterwards a three day course which was completed by a two hour written examination in road safety knowledge and the audit system. 15 out of 22 passed the pretest. All except one passed the final examination.

  The next road safety audit course takes place in March 1998.

- *The Road Safety Database*
  The establishment of a road safety database was briefly mentioned. The intention is that auditors and other users of road safety knowledge via the database should be able to find answers to questions concerning road safety. Road standards, manuals, research reports, expert interviews, articles and contributions from users will be accessible on the database. The database will be established on the internet.

Closing Remarks

The state of affairs and future plans for road safety audits in Portugal, the Netherlands, Greece, the Czech Republic, Spain and France were not specifically discussed at this time. On the other hand this subject was discussed occasionally during the workshop and at previous meetings.

The workshop ended with a general discussion.

Annex 1

Agenda of the workshop

Workshop on Road Safety Audit in Denmark 27 & 28 October 1997

SAFESTAR WP8

Participants:
George Kanellaidis & Anastasia Flouda - NTUA - Greece
Atze Dijkstra & Robert van der Kooi - SWOV - The Netherlands
João Lourenco Cardoso & Luis Bairrao - LNEC - Portugal
Pavel Tucka & Josef Andres - CDV - The Czech Republic
Guénaëlle Bernard - SETRA - France
Jacobo Díaz Pineda - AEC - Spain
Lene Herrstedt & Puk Kristine Nilsson - RD - Denmark

Workshop leaders:
Anders Møller Gaardbo
Adriaan Schelling

Agenda:

Monday 27 October 1997 Meeting rooms: Havnesalen and Meeting room 3

9.00-9.30	Welcome. Presentation of agenda and participants.
9.30-11.00	Introduction to Road Safety Audit in Denmark. (The Danish Road Safety Policy, Safety Audit, background, the pilot project, the evaluation).
11.00-12.30	Case 1: Example of a Safety Audit
12.30-13.30	Lunch.
13.30-16.30	Case 2: Safety Audit on stage 2 - the draft design phase. The safety audit will be carried out on a Danish scheme: Helsingevejen. (Group work).
16.30- 17.30?	How to proceed SAFESTAR WorkPackage 8 (Atze Dijkstra).
19.00	Dinner.

Workshop on Road Safety Audit in Denmark 27 & 28 October 1997

SAFESTAR WP8

Agenda

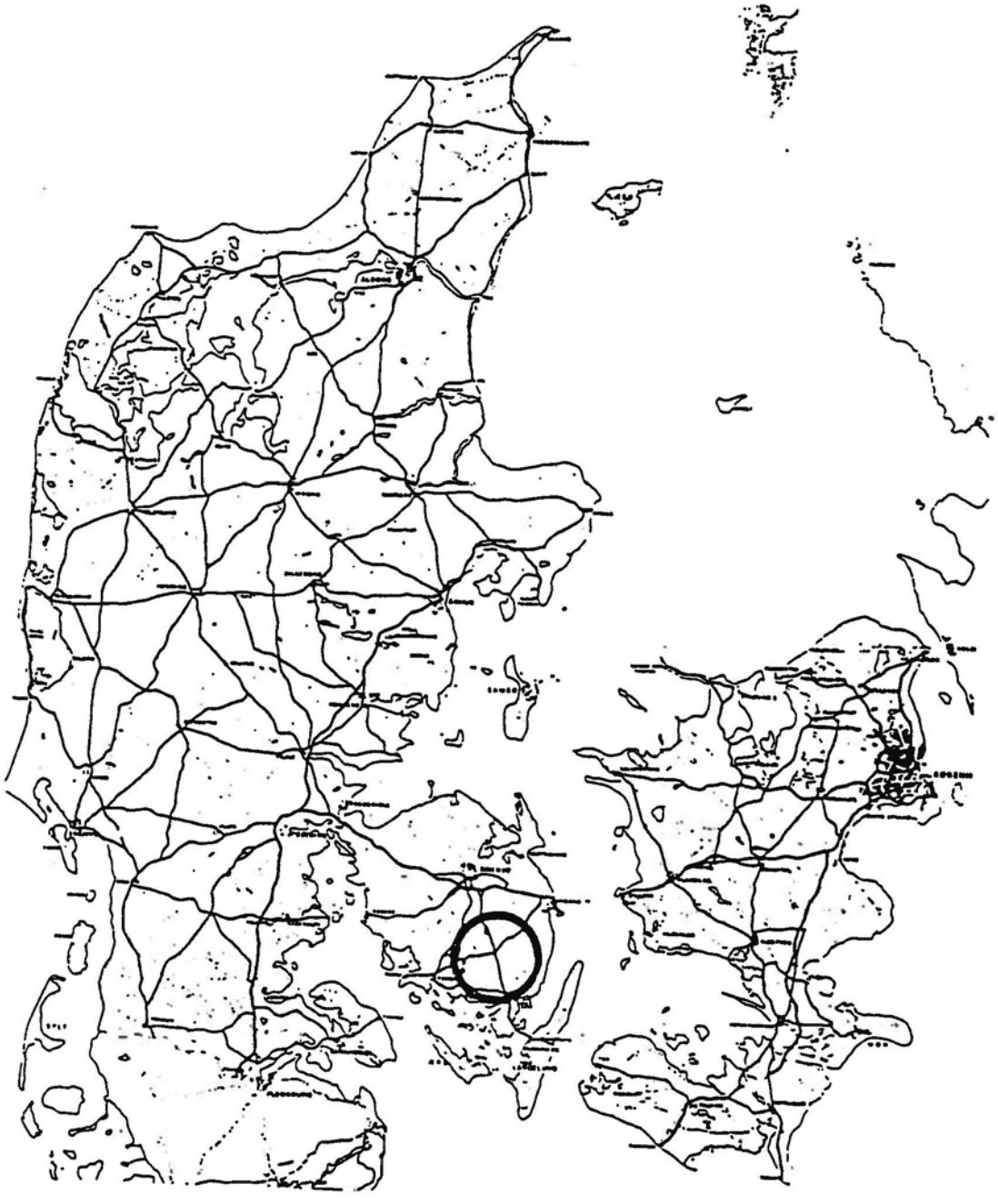
Tuesday 28 October 1997 Meeting room: TSM

9.00-12.30	Case 3: Safety Audit on stage 4 - opening. The Safety Audit will be carried out on a Danish scheme of current interest. (Field inspection /Group work).
12.30-13.30	Lunch.
13.30-14.00	Case 3 continued: Summary of the main points from the field inspection this morning.
14.00-15.00	Implementation of Safety Audit in Denmark - The new system. Including information about the Road Safety Database and education of Safety Auditors.
15.00-16.00	State of affairs and future plans concerning Safety Audit in Portugal, the Netherlands, Greece, the Czech Republic, Spain and France.
16.00	Closing remarks.

Annex 2

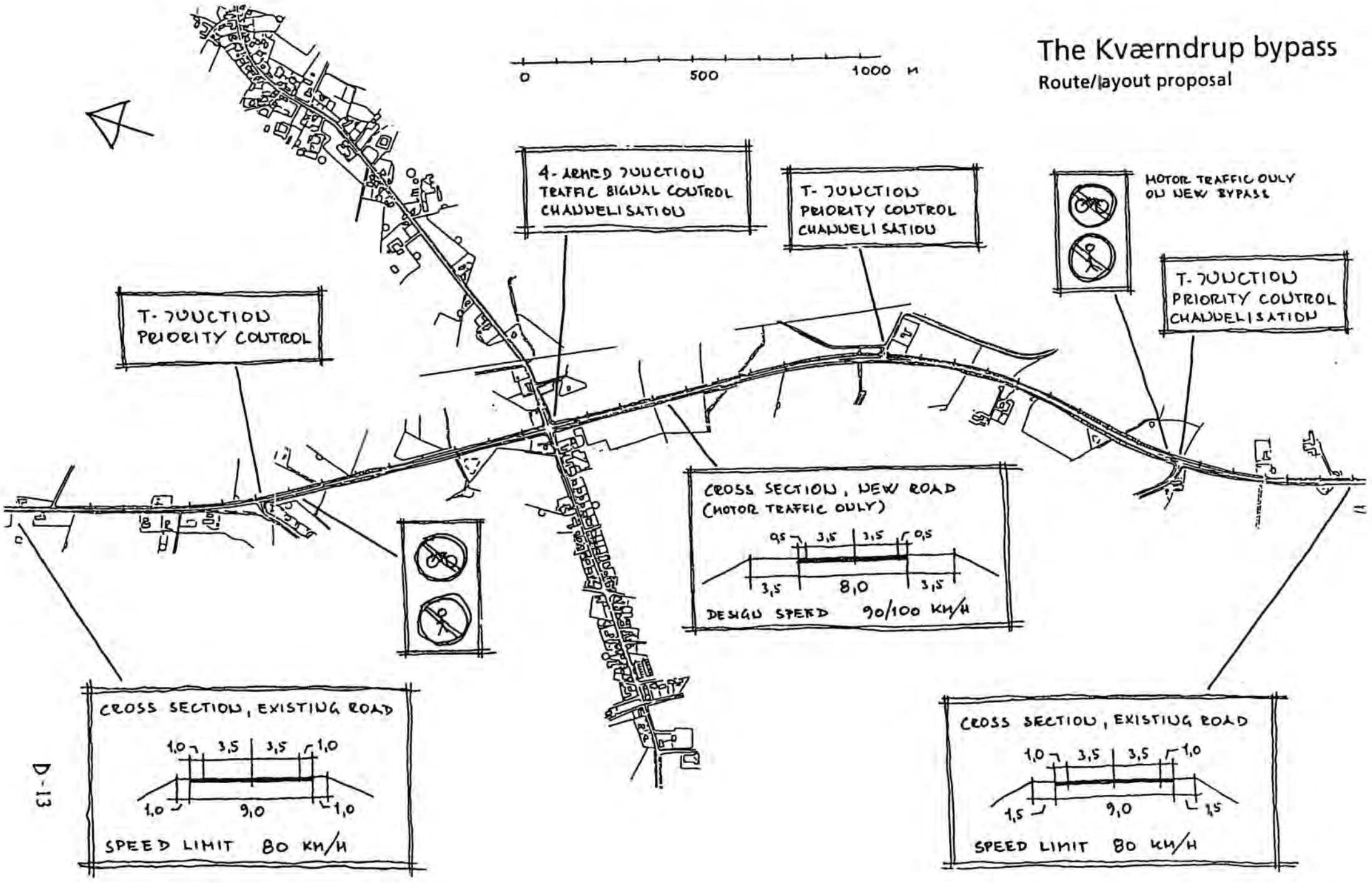
The Kværndrup Bypass (case 1) - Plan drawing

The Kværndrup bypass



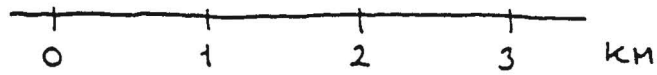
The Kværndrup bypass

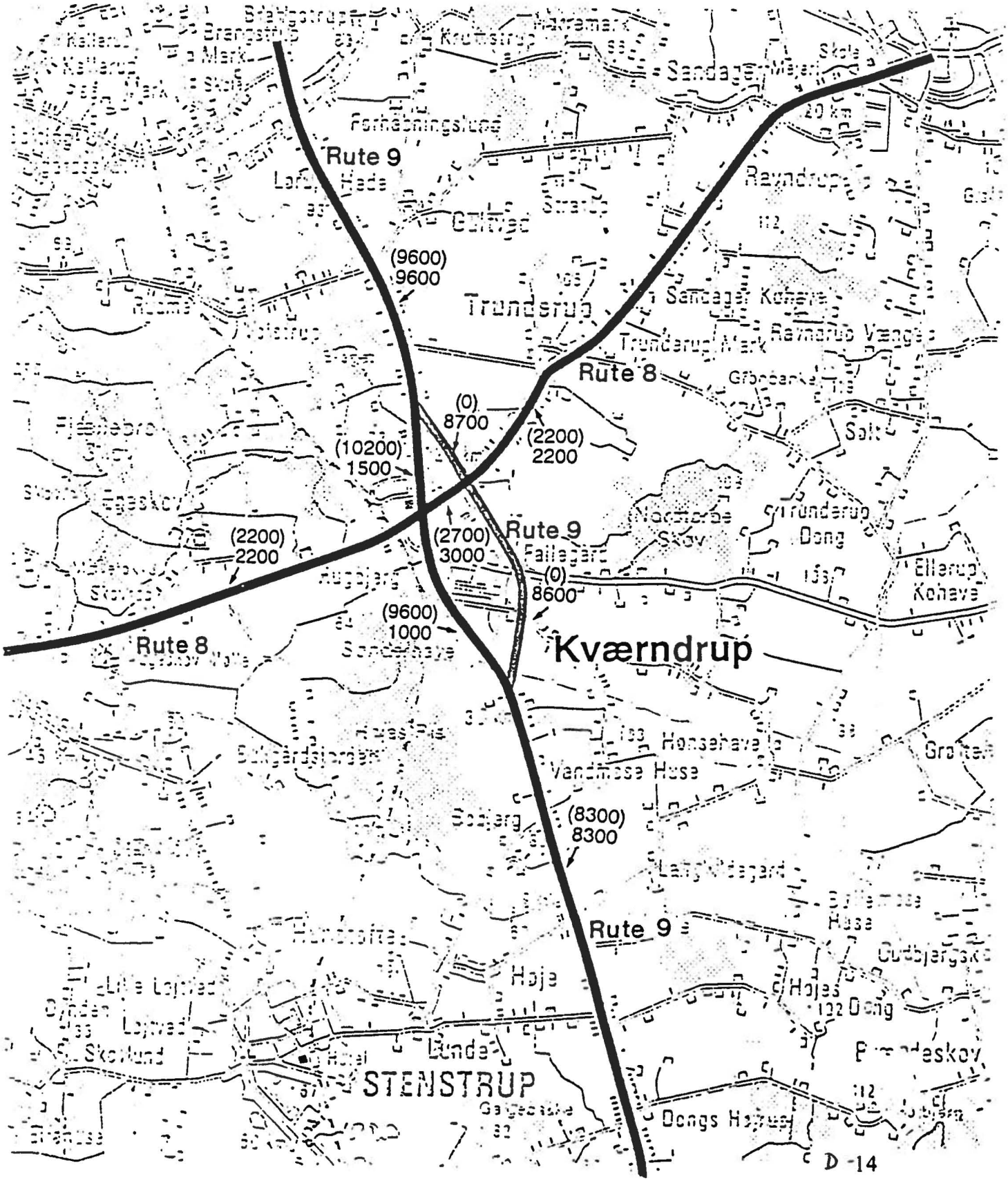
Route/layout proposal



Traffic Flows

(9600) AADF before opening
1000 AADF estimated after opening





Annex 3

The Hillerød Expressway (case 2) - Folder

Road Safety Audit Workshop

SAFESTAR WP8
27 and 28 October 1997

Case 2

The Hillerød Expressway Extension (Trunk Road 113)

Road Safety Audit Stage 2

The Hillerød Expressway Extension

The Task

You are commissioned to undertake a Stage 2 Road Safety Audit of the Hillerød Expressway Extension Scheme. The audit will be undertaken on the basis of this description and the enclosed scheme drawings.

Background Information

The Hillerød Expressway Extension was planned as a 10 kilometres long two-lane, single carriageway scheme to relieve the north-southbound roads in the corridor between the Arresø and Esrum Sø lakes. The southernmost part of the scheme (8 kilometres) is designed as an expressway for motor vehicle traffic only.

A map showing the existing main road network, and a route map of the scheme are enlosed, together with a map of the existing and expected motor vehicle traffic flows.

The existing part of the Hillerød Expressway has a three-lane, 2+1-layout and a speed limit of 90 km/h.

Design Standards

At the moment in Denmark we have no design standards for highway link design in rural areas. As a reference you may consider the enclosed table with values for stopping and overtaking sight distances (Ask your Danish group member or your workshop leader for explanation).

The Scheme

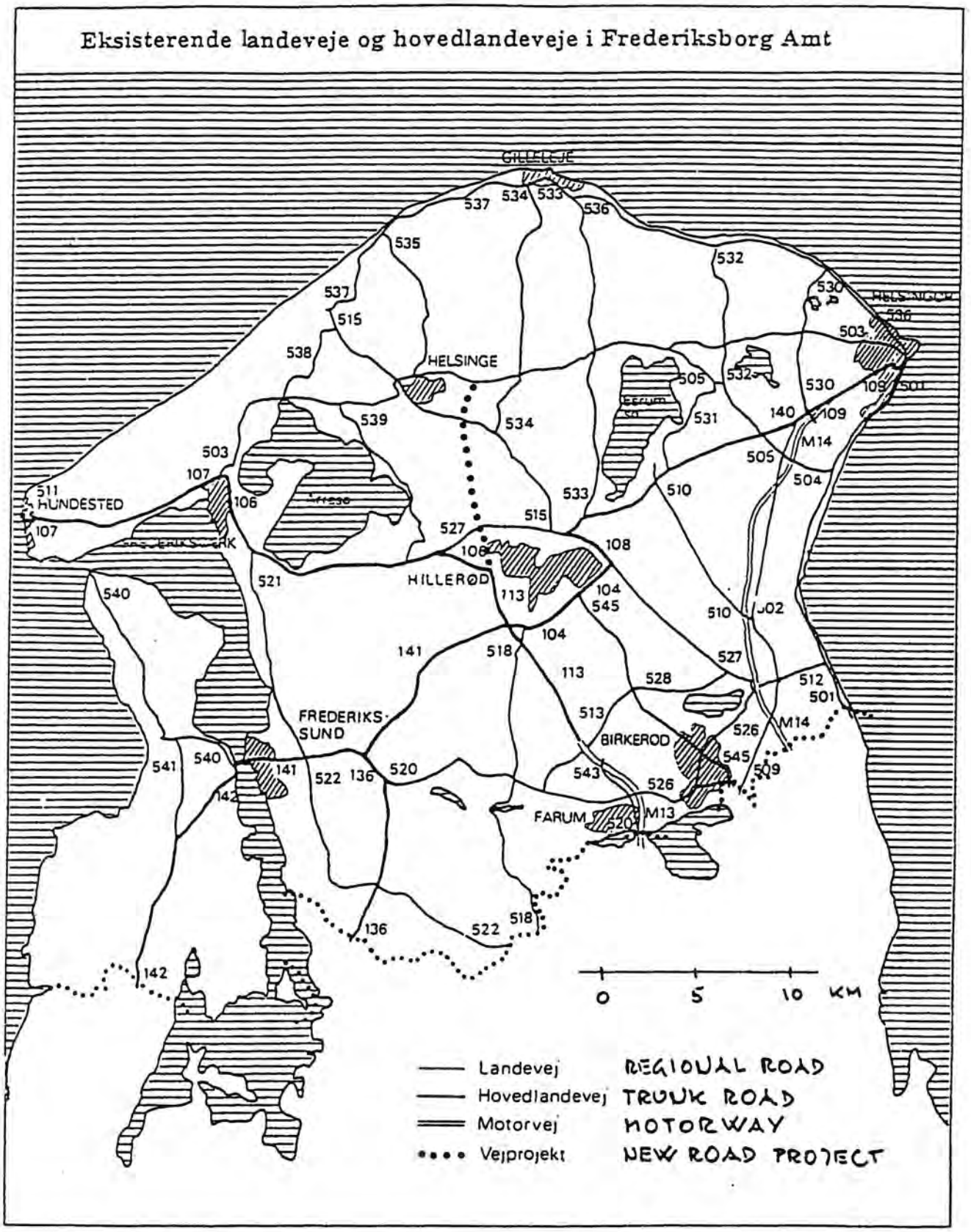
Design Speed

The following design speeds were used in the design:
120 km/h from road 106 (Herredsvejen) to road 527 (Isterødvejen)
90 km/h from road 527 to road 515 (Kildevej)
80 km/h from road 515 to road 503.

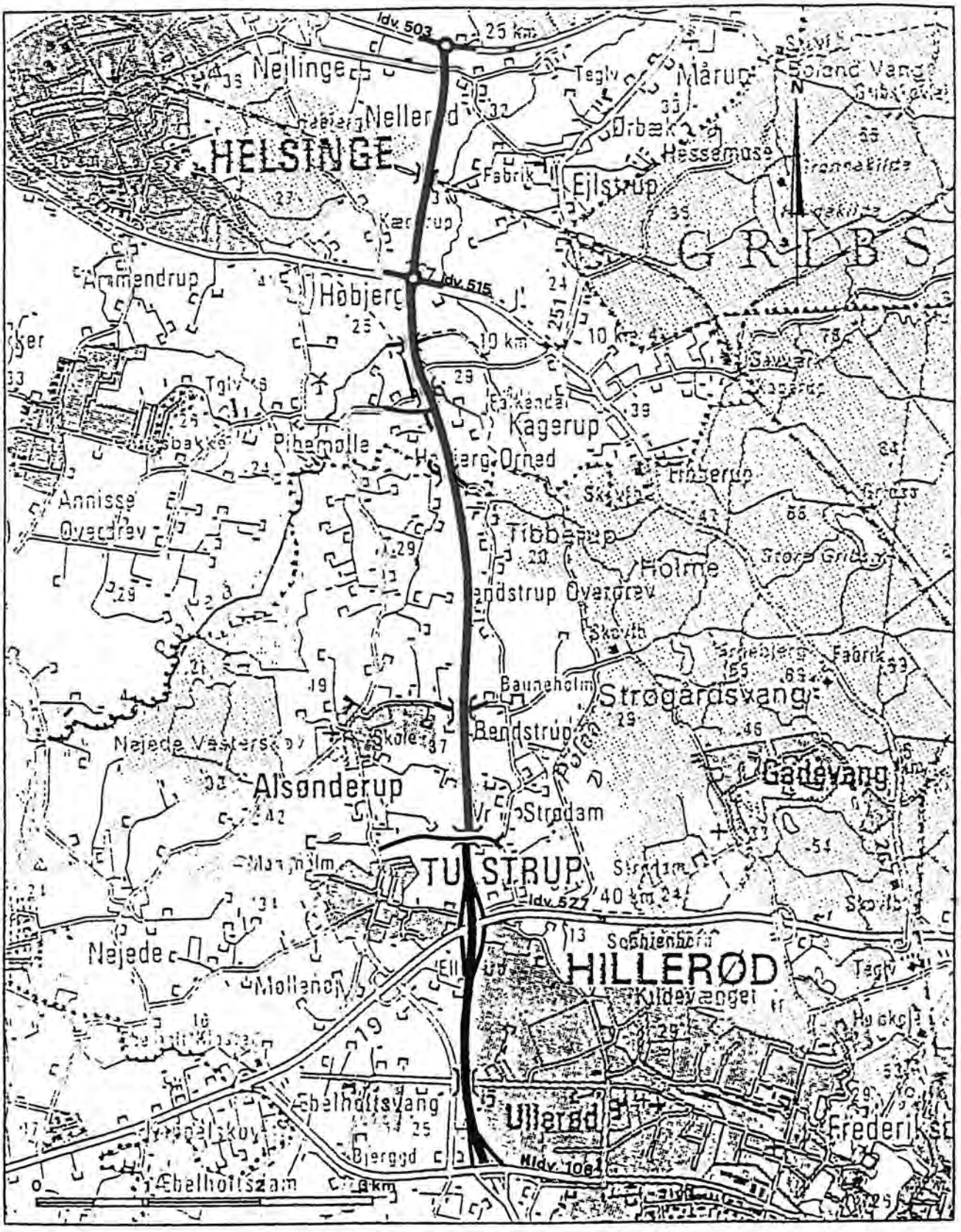
Speed Limits and Road Status

A speed limit of 90 km/h - and expressway status - is proposed on the southernmost 8 kilometres of the scheme, from road 106 to road 527. The northern part of the scheme is designed for normal highway status and 80 km/h speed limit. This implies access to the road for non-motorized traffic, as well as slow vehicles e.g. agricultural vehicles.

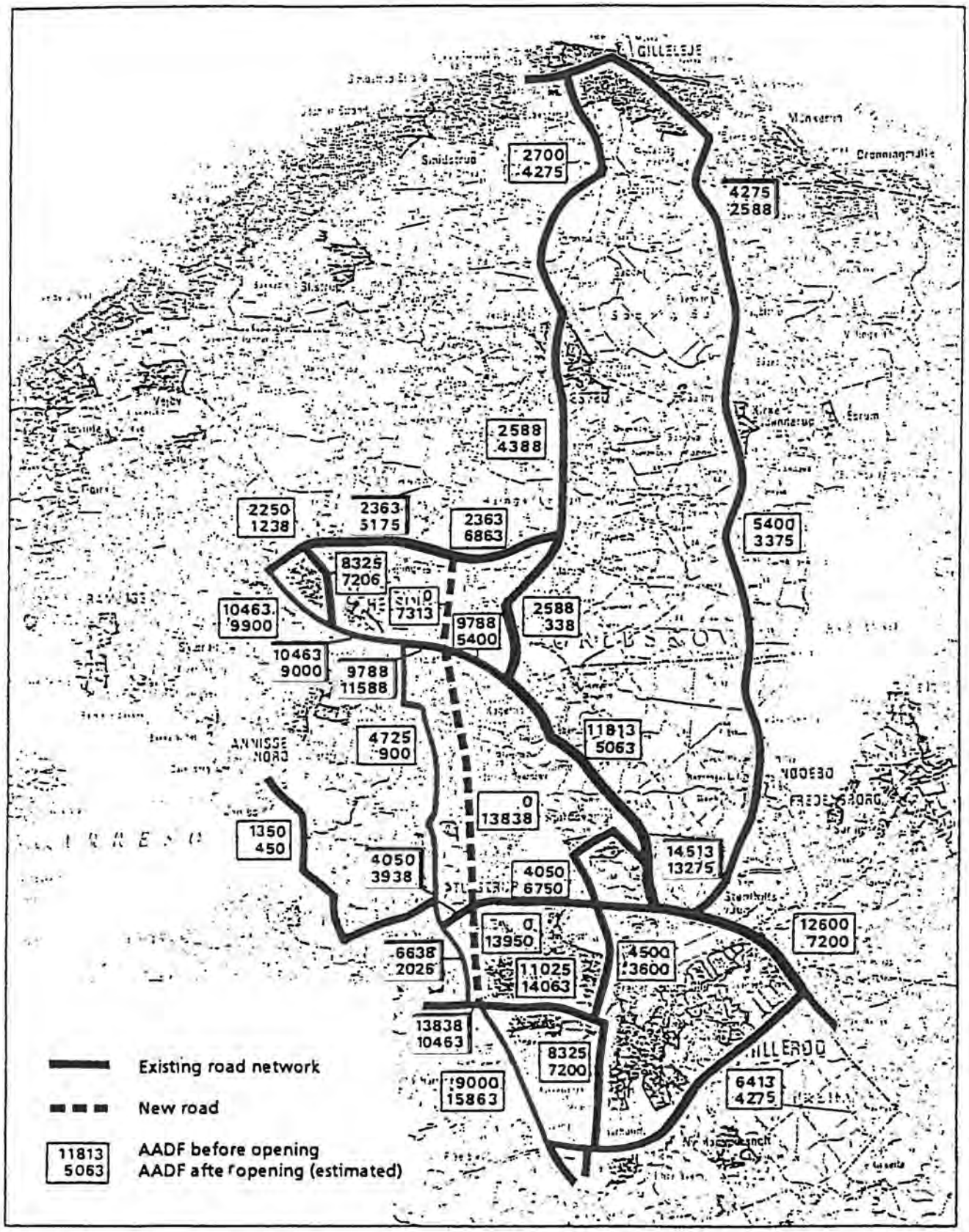
Existing main roads i Frederiksborg County



The Hillerød Expressway Extension - route



Traffic flows



Cross Section

Between road 106 and road 527 the cross section is prepared for widening to "wide two-lane" (i.e. 11 metres carriageway) as the existing bridge leading road 106 across the scheme already is widened accordingly.

Horizontal alignment

The minimum horizontal radius is 2000 metres (except for one curve of 1800 metres). In general, radii of 4000 metres are used.

Enclosures

Table of Stopping Sight Distances

Scheme drawings (1 copy per group):

Oversigtsplaner *(layout plans)* 1:4000, dateret 23.09.93

- tegn. nr. 113-p-081
- tegn. nr. 113-p-082
- tegn. nr. 113-p-083

Længdeprofiler *(longitudinal profiles)* 1:400/1:4000, dateret 02.05.94

- tegn. nr. 113-L-007
- tegn. nr. 113-L-008
- tegn. nr. 113-L-009
- tegn. nr. 113-L-010

Normaltværprofiler *(typical cross sections)* 1:100 og 1:20

- tegn. nr. 113-T-022, dateret 31.01.94
- tegn. nr. 113-T-017, dateret 25.06.93
- tegn. nr. 113-T-018, dateret 25.06.93

Planer af tilslutningsanlæg *(layout plans of intersections)* 1:1000, dateret 09.05.94

- tegn. nr. 113-P-084
- tegn. nr. 113-P-086
- tegn. nr. 113-P-091
- tegn. nr. 113-P-093
- tegn. nr. 113-P-095

BEREGNEDE STOPSIGTELÆNGDER

$$S = \frac{V^2}{2 * g * (f_{RES} + s)} + V * t_{REAK}$$

V KM/T	STOP M	MØDE M	OVERH. M
120	255	510	
110	215	430	
100	180	360	650 *)
90	145	290	
80	120	240	500 *)
70	95	190	
60	75	150	
50	55	110	

*) ANBEFALET I TYSKE VEJREGLER.
650 METER DESUDEN AUFØRT I UDKAST TIL "STANDARD AF VEJE TIL HØJKLASSET TRAFIKAFVIKLING" (POM 1988).

KONVEKSE VERTIKALKURVER

$R = \frac{S^2}{8h}$ ØBJEKTHØJDE = ØJEHØJDE = 1,0 M

V :	50	60	70	80	90	100	110	120	KM/T
MØDE :	110	150	190	240	290	360	430	510	M
R_{MIN} :	1500	2800	4500	7200	10.500	16.200	23.100	32.500	M
OVERH. :				500		650			M
R_{MIN} :				31.300		52.800			M

Annex 4

Further work in SAFESTAR WP8 - Main conclusions

25 November 1997

SAFESTAR WP8 - Road Safety Audit

At the Road Safety Audit Workshop in Copenhagen the 27 and 28 October 1997 the continuation of Workpackage 8 were discussed on the first day. The main conclusions of the discussion are summarised in the following.

How to proceed

At the Workshop Atze Dijkstra handed out a proposal, which includes three activities:

1. The Danish Road Directorate make a summary of the workshop, including examples and cases, and deliver an English version of the Danish Road Safety Audit Handbook.

2. Based on the review report and experiences from the workshop the SWOV Institute make a suggestion to the EU of how Road Safety Audit could be introduced to the TERN road network. The suggestion should consist in a framework referring to the overall principles of organisation (parts and responsibilities), the process (order of audit - scrutinization - report - meetings etc.), and stages in the Road Safety Audit.

3. The other partners (CDV, NTUA, LNEC, SETRA and AEC) explore the opportunities and constraints (organisation and procedures) in their own countries for introducing RSA within the design process of TERN roads.

All partners agreed to the proposal.

Deadline

It was decided that the deadline of the above-mentioned activities is in the *beginning of February.* The draft versions of the reports for the three activities should be send to each of the partners.

Additional meeting

The Danish Road Directorate, RD, suggested a meeting in the end of February. At this meeting the draft versions of the reports should be discussed.

The date has to be settled before Christmas to make sure that everyone has the possibility to attend. **February the 27th** is suggested - Please communicate with SWOV for final decision.