ROAD SAFETY STRATEGIES IN GERMANY: FROM ACCIDENT DIAGNOSTICS TO ACCIDENT PREVENTION

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ABSTRACT

The number of road accident victims, particularly of those killed and seriously injured, in the world justifies the offensive undertaken against this social plague. In Germany, the road safety strategies have been adjusted in the last years. They include a system of diagnosis and therapies which consist of an analysis of the safety potential of road networks and the local accident investigations, and a road safety prevention system whose principal elements are road safety audits and road safety inspections.

1. INTRODUCTION

In 2006 the road traffic accident assessment in Germany is summarized as follows: 2.23 million accidents were recorded by the police, of which 327,600 had personal injuries; 5,094 persons were killed; and 421,000 were injured [1]. In spite of the encouraging results obtained in the last years, especially with regard to the reduction of the number of killed and seriously injured persons caused by road traffic, the number of victims still remains high. On average 14 persons per day were killed in Germany by road traffic. Road traffic accidents represent a social plague, a “chronic disease”, which requires adjustable and controllable strategies along with its treatment: from diagnosis to therapy to road prevention (figure 1).

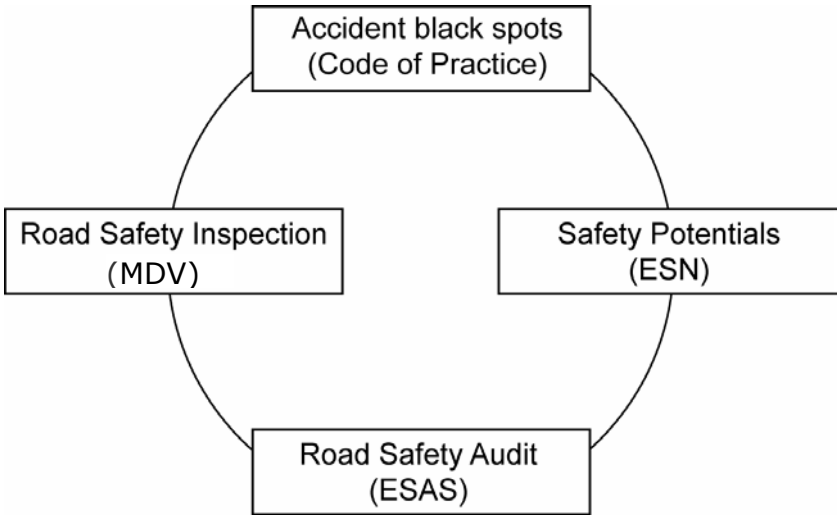

Figure 1 – Road safety strategy elements

The experiences gained by nearly 30 years of doing local accident investigations in Germany constitute a fundamental base of the adopted road safety strategies.

2. DIAGNOSTIC AND THERAPY

2.1. Safety analysis of road networks

On each road, there is always a risk of being an accident victim. This risk varies according to the characteristics of the road (category, geometry, intersection type, road signs, road traffic and road user composition, the use and equipment of the road side, road environment etc.). Even roads which were designed and constructed in accordance with recent design guidelines and construction standards have an accident risk: this is considered as the basic accident risk.

From the accident composition of all road sections in a particular road network during a defined observation period (one or three years) and of the victims recorded by the police, it is possible to determine the real economic accident costs of this road network as well as the cost of each road section. Those road sections with a relatively higher safety potential can be easily recognized (figure 2).

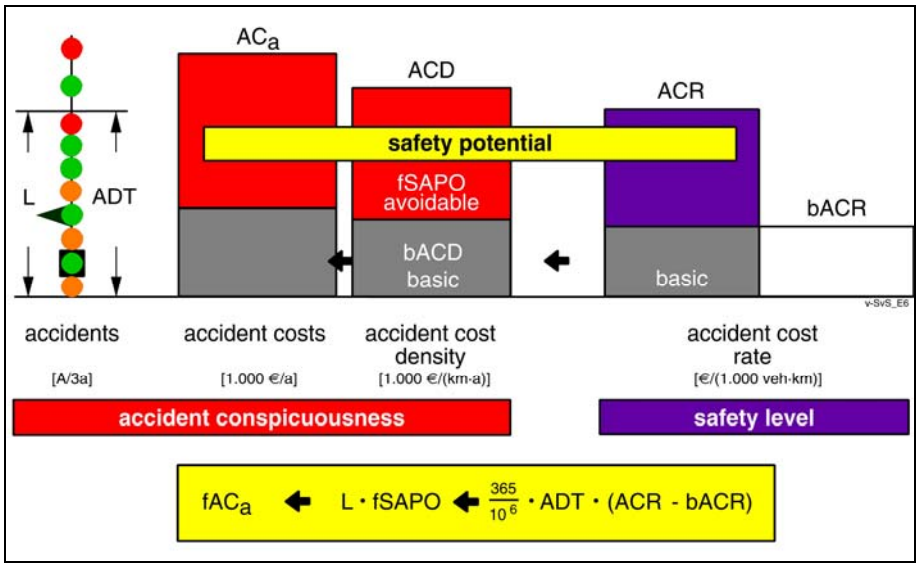

Figure 2 – Determination of safety potential

The results obtained can be represented on maps such as the ones shown in figure 3 and the sections with a very high safety potential can thus be easily distinguished. Figure 3 also shows that road sections in non built-up areas with a low traffic volume are generally sections with a higher accident risk. One of the principal causes is the inconsistency between the characteristics of the road and road user speeds.

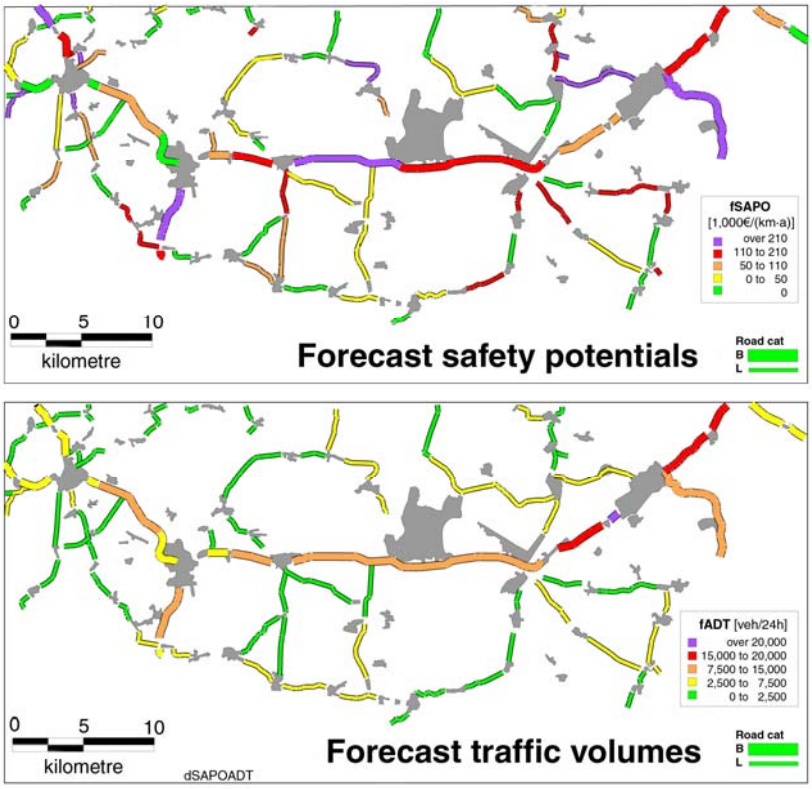

Figure 3 – Safety potentials of a road network

The systematic treatment of road network sections with a relatively higher accident risk (sections with very high safety potential) in high priority generally leads to a significant reduction of accident costs. The responsible road authorities must consider this data by establishing the road network planning and maintenance programmes. The Guidelines for Safety Analysis of Road Networks (ESN) [2] contain the methodological follow-up by analysing the safety of road networks. (Figure 4).

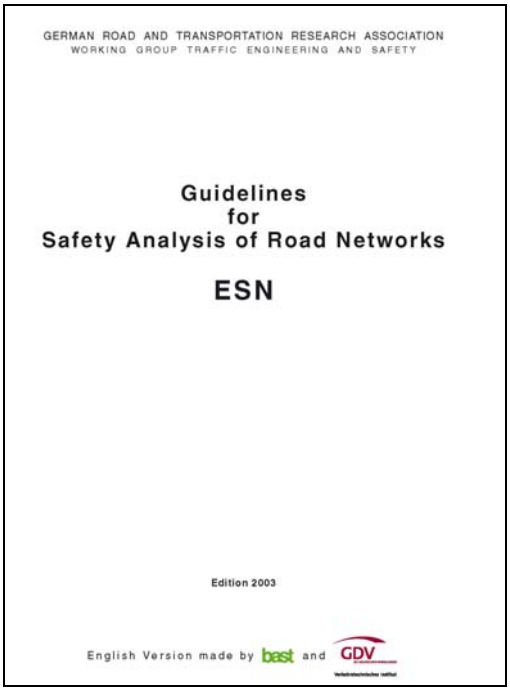

Figure 4 – Guidelines for Safety Analysis of Road Networks

2.2. Identifying, examining and combating black spots

Sections with a relatively higher accident risk detected by the road network analysis generally contain accident black spots. Their analysis requires a systematic methodology, which is described in the code of Practice [3] shown in Figure 5, whose essential points are the topic of this section.

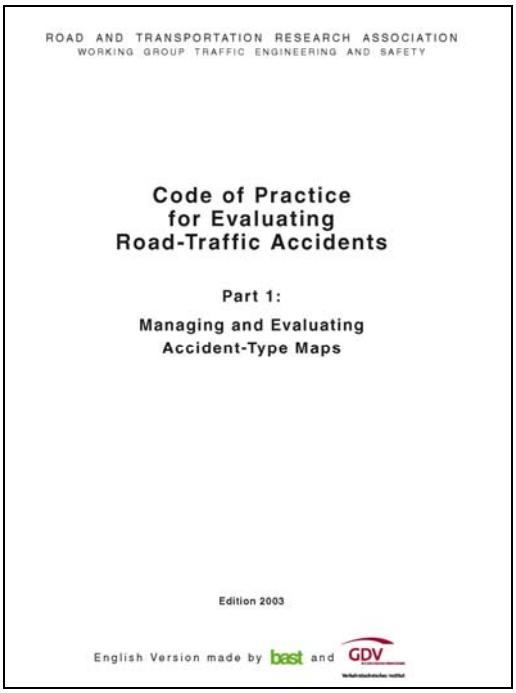

Figure 5 – Code of Practice for Evaluating Road-Traffic Accidents - Part 1: Managing and Evaluating Accident-Type Maps

2.2.1. *Basic material – accident-type maps*

For identifying black spots on road section accident-type maps are required. Accident-type maps are generally available from the police office which is responsible for that road network. In Germany 7 accident types are defined (figure 6): Each accident type describes characteristics of the conflict in the traffic circulation which led to the collision (accident). Thus the accident type makes it possible to systematically recognize the technical relations between the accident and the road infrastructure and facilitates the preparation and elaboration of investigations required. These investigations, called local accident investigations, are generally carried out by the members of the accident commission.

Accident type	Colour	Description
1	Green	**Driving accident (D)** The accident was caused by a loss of control of the vehicle (due to inappropriate speed or incorrect judging of the road ahead, the condition of the street, etc.). Others were not involved in the accident. Uncontrolled vehicle movement can then, however, result in a collision with other road users.
2	Yellow	**Turning-off accident (TO)** The accident was caused by a conflict between a turning vehicle and another vehicle (or even a pedestrian) travelling in the same or opposite direction at an intersection, junction, or an entrance to a property/car park.
3	Red	**Turning-into/crossing accident (TC)** The accident was caused by a conflict between a vehicle which had to give way when turning into a road or crossing the road and a vehicle with the right of way at an intersection, junction or exit from a property or car park.
4	Pale red / White	**Crossing-over accident (CO)** The accident was caused by a conflict between a vehicle and a pedestrian on the street, as long as the pedestrian was not walking along the street and the vehicle was not turning off the road. The accident is still a crossing-over accident even if the pedestrian was not hit.
5	Light blue	**Accident caused by stopping/parking (SP)** The accident was caused by a conflict between a vehicle in moving traffic and a vehicle parking/stopped or attempting to stop/park.
6	Orange (pink)	**Accident in longitudinal traffic (LT)** The accident was caused by a conflict between road users moving in the same or opposing directions, provided the conflict does not correspond to any of the other accident types.
7	Black	**Other accident (O)** An accident which cannot be classified as one of types 1 to 6. For example, u-turns, reversing, collisions between parking vehicles, obstacle or animal on the road, sudden vehicle damage (brake failure, tyre damage, etc.)

Figure 6 - Descriptions of accident types

Each recorded accident can be directly distinguished on the accident-type map through its colour (accident type), its size (Figure 7 – accident category (worst accident consequence) and other indicators for recognizing additional specific characteristics (pedestrians, cyclists, alcohol etc.) such as indicated in figure 8.

Worst accident consequence (accident category)		
	One-year map 1-YM	**Multi-year map 3-YM**
Fatal accident (1)	= 8 mm/ 10 mm	= 8 mm/ 10 mm
Accident with seriously injured persons (2)	= 8 mm	= 8 mm
Accident with slightly injured persons (3)	= 6 mm	= 4 mm
Accident with seriously material damage in the narrow sense:		
- (Criminal) offence reported, **(4)** vehicle not operatianal	= 4 mm/ 6 mm	
- Other accident with material damge **(6)** under the influence of alcohol	= 4 mm	
Other accident with material damage (5)	= 4 mm	

Figure 7 - Descriptions of accident categories

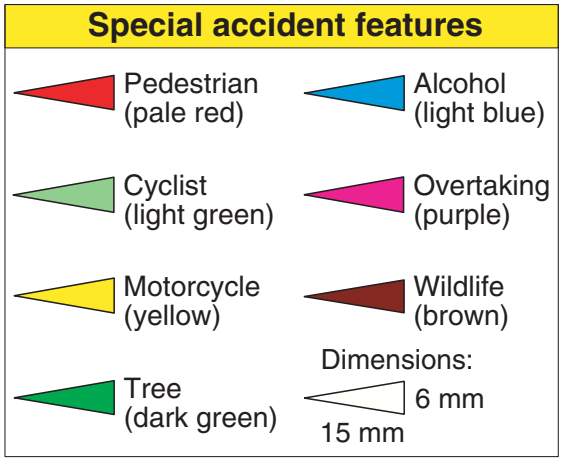

Figure 8 – Identifying special accident features

2.2.2. *Criteria for identifying black spots*

For identifying black spots all accident-type maps available have to be analysed. Generally the one-year accident-type map which contains all accidents recorded during the last 12 months period and the two three-year maps (for the last 36 months period): the three-years map with all accidents with personal injury and the three-years map with accidents with seriously injured persons. The criteria for identifying black spots depend on the layout of the site concerned. Black spots are distinguished in:

- « **frequent-accident spots (FAS)** », which are accident concentrations at specific points on a road. They can be identified in the one-year map or in one of the three-year maps.

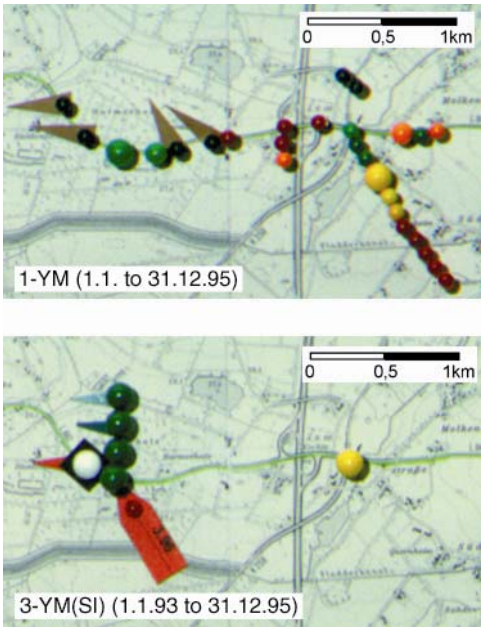

Figure 9 – Example of frequent-accident spots (FAS)

- « **frequent-accident lines (FAL)** », which are accident concentrations along a lengthy road section. They have to be identified in the three-year accident-type map of accidents with serious personal injury.

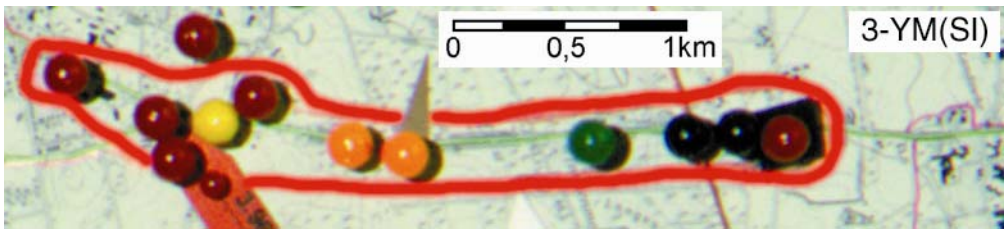

Figure 10 – Example of a frequent-accident line (FAL)

Table 1 indicates criteria for identifying black spots on each accident-type map as well as the observation periods required.

Tableau 1 – accident-type maps, observation periods and criteria for identifying black spots

Accident-type map	**Limit value** No. of accidents	**Observation period** [Months]
1 - Year map	**5 (of comparable nature)***	12
3 - Year map (I)	**5**	36
3 - Year map (SI)	**3**	36

* If accidents involving offences for which a caution can be given are not included on the one-year map, the limit value decreases to four comparable accidents in twelve months

2.2.3. *Methodology for investigating black spots*

To carry out appropriated investigations and to propose adequate schemes the accident commission has to be informed by the police when black spots are identified,. The main points of the investigation consist to:

- Determination of the black spot length and, if necessary, its influence zone,
- Establishment and analysis of accident lists as well as the common factors of recorded accidents – e.g. the accident evolution during the investigation period(figure 11),
- Drawing and analysing accident diagrams (figure 12),
- Preparing a ranking list for each black-spot type (FAS or FAL) and defining the priorities,
- Making detailed investigations for each prioritized black spot: this means analysing the common factors of recorded accidents which are particularly remarkable, examining the characteristics of the road and its environment, the road traffic regulation and signalization and the particularities in road users behaviour which could be a relevant accident cause,
- Inspecting the black spot sites and, if possible, deducing the accident causes through the observations made during the inspections (road traffic composition, road traffic conditions and regulations, road conditions, road users behaviour, visibility etc).

Place: Anytown

Location: Road 123 between Road X and Road Y

Investigation-period end date: 31.12.96

Non-built-up/built-up area: Built-up

Black-spot
Category

[ ] FAS
[X] FAL L= 1,3 km
[ ] FAA L= km

Accidents

Number	1	2	3	4	5	6	7	8	9	10
Year	1994	1994	1995	1995	1995	1996				
Month	Mar	Okt	Apr	Aug	Nov	Dec				
Day of week	Sat	Sun	Mon	Tues	Sat	Mon				
Time	2 p.m.	8 p.m.	12 a.m.	6 p.m.	11 a.m.	5 p.m.				
Light	Li	Da	Li	Li	Li	Da				
Road conditions	Dry	Dry	Dry	Wet	Icy	Dry				
No. fatalities	0	0	0	0	0	0				
No. seriously injured	1	1	1	1	1	1				
No. slightly injured	0	0	0	0	0	0				
Road user 01	Motor-cycle	Car	Car	HGV	Car	Car				
Road user 02	Car	Car	Car	Car	-	Car				
No. road users involved	2	3	2	2	1	2				
Accident category	2	2	2	2	2	2				
Accident type	LT	O	TC	TC	O	TO				
Kind of accident	2	5	5	5	8	9				
Accident cause	14	36	28	28	49	35				

Map:	3-YM A(SI)	3-YM A(I)	1-YM A	Summary
	6	9	13	No. of accidents
Month	2	3	6	Dec - Mar
Day of week	3	5	3	Sat/Sun
Time	2	2	5	6 - 9 a.m./4 - 7 p.m.
Light	2	2	4	Dusk/dawn/dark
Road conditions	3	4	8	Wet/icy
No. fatalities	0	0	0	No. fatalities
No. seriously injured	6	6	1	No. seriously injured
No. slightly injured	0	3	1	No. slightly injured
Road user 01	0	1	0	Ped./cyc.
Road user 02	0	1	0	Ped./cyc.
No. road users involved	1	1	3	Single-party accident
Accident category	2	2	5	Most common
Accident type	TC	TC	TC	Most common
Kind of accident	5	5	2	Most common
Accident cause	28	28	14	Most common

Figure 11 – Example of an accident list with common factors

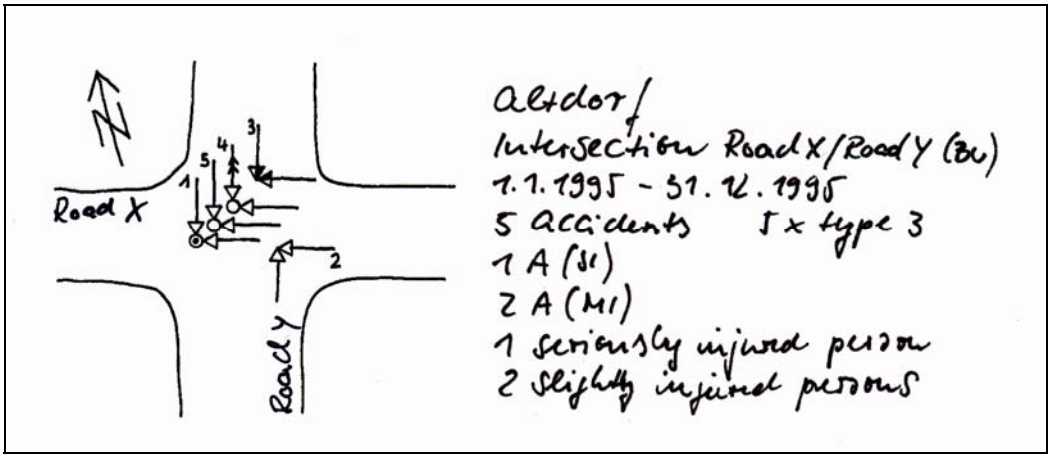

Figure 12 – Example of an accident diagram

2.2.4. *Choice of schemes*

The accident commission close its investigations by proposing effective schemes which are able to reduce the insecurity of the black spot considered. Its members discuss all the various solutions suggested during the meeting and decide upon the schemes which are appropriate and necessary. They usually use the code of practice called “Auswertung von Straßenverkehrsunfällen - Teil 2: Maßnahmen gegen Unfallhäufungen” [4]. This contains a repertory of schemes where important accident reduction on similar black spots are shown scientifically. If necessary they can also refer to new scientific publications related to the road accident analysis: for example “Mitteilung 40: Sicherheit von Landstraßen-Knotenpunkten” [5] if it concerns accident problems on intersections of road in non built-up areas. For any scheme adopted, it is important to control the scheme's effectiveness at the black spot; generally during the next three years after the scheme realization.

Figure 13 – Code of Practice for Evaluating Road-Traffic Accidents - Part 2 : Schemes against Accident black spots

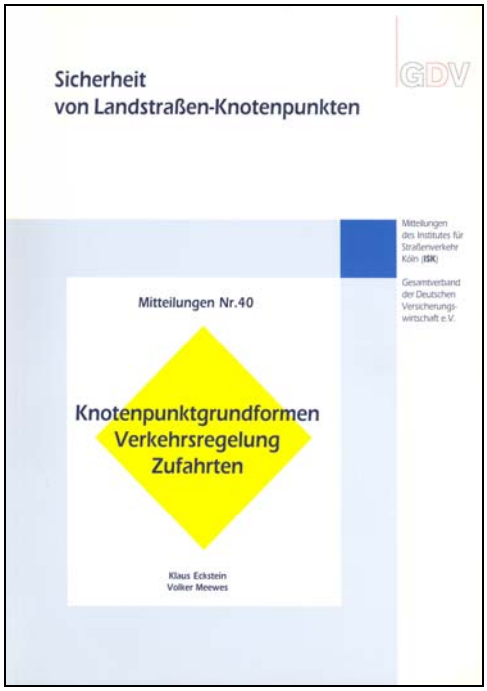

Figure 14 – Safety of intersections on roads in non built-up areas: intersection types, traffic regulation, access

The experiences accumulated during several decades of investigating and inspecting black spots as well as road network sections with a relatively high accident risk allowed for the adjustment of the strategies of road safety prevention policies in Germany during the last five years.

3. ROAD SAFETY PREVENTION

For any social plague the prevention is one of the more effective strategies because it prevents or reduces the impacts of the problem. Generally it permits the avoidance of enormous useless costs and thus helps finance more profitable investments in the road network management. In term of prevention in Germany, road safety audits during the planning and design stages for new roads and road safety inspections for existing roads are important.

3.1. Road safety audits

Since August 2002, the guidelines for road safety audits (ESAS) [6] (figure 15) has been applied. Road construction authorities must provide without any exception the reports of road safety audits for all schemes on Motorways and federal trunk roads (Bundesstraßen) to the ministry for transport, construction and urban development. The ministry also recommends the federal states to make safety audits for projects on their road networks.

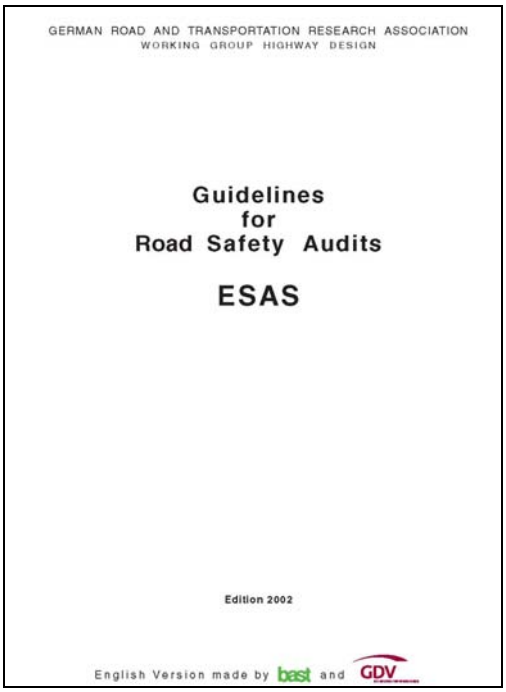

Figure 15 – Guidelines for road safety audits

Currently safety audits are an integral and obvious part of the planning and design process in several federal states. Their road construction authorities have safety auditors (intern auditors), who examine the planning and design results in which they were not directly involved. Several of these safety auditors are trained for approximately six months by the department for accident research of the German Insurance Association in collaboration with the “Partnership of University Professors (Auditpartnerschaft der Hochschullehrer: AdH)” and the “Road and Transportation Research Association (Forschungsgesellschaft für Straßen- und Verkehrswesen: FGSV)”. Some were formed by the staff from their road authorities, which preliminary followed the formation above. Some of them were nominated by their own road administrations.

Several road construction authorities are requesting more and more the realization of road safety audit to justify the need and the consideration of road safety aspects along the planning and design process in opposite of aspects such as project costs, traffic flow (capacity) or environment effects. The analysis of almost 300 audit reports and the respective comments of the responsible road authorities between 2002 and 2004 [7] confirm this acceptance. On average more than half of all deficiencies in audit reports are accepted. In the “feasibility studies” stage the deficiency acceptance reaches 66% of all noted deficiencies and decreases to 35% during the “pre- and post-traffic opening” phase.

3.2. Road safety inspections

The guidelines for road safety inspections (MDV) (figure 16) [8] closes the circle of manuals (handbooks) for the implementation of road safety strategies. Three principal groups of road safety inspections are distinguished:

- Regular inspections: examining vertical and horizontal traffic signs, dangers and road equipment on the roadside which are important for the road safety. On classified roads in non built-up areas and main urban roads they must be made every two years and every four years on communal and secondary roads.

- Subject based inspections such as at night, in tunnels, for railway crossings or direction signalizations. They must be made every four years.

- Inspections of the rest of the traffic signs, which must be done every four years or if it is necessary (by special cause).

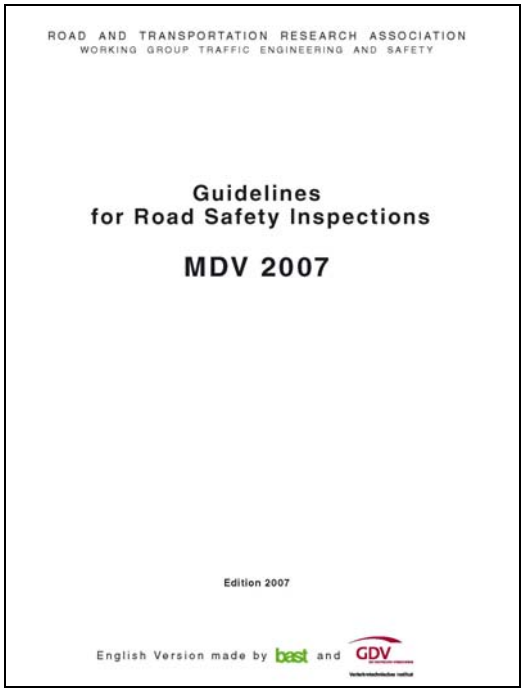

Figure 16 – Guidelines for road safety inspections

4. LEGAL BACKGROUND

The basis for local accident investigations is provided by the General Administrative Regulation (VwV-StVO) [9] concerning Section 44 of the “StVO” Road Traffic Regulations [10]. The Administrative Regulation states that local accident investigation is necessary “because it is the only means by which the administrative agencies can obtain documents that can be used to remedy local hazards”.

The duty to maintain road safety is enshrined in Sections 823 and 836 of the German Civil Code (“BGB”) [11]. Essentially, they stipulate that parties who permit traffic on roads which are under their control must ensure that such roads are safe for traffic. It is for this reason that the General Administrative Regulation (VwV-StVO) concerning Section 45, Sub-section 3 of the “StVO” Road Traffic Regulations prescribes periodic road-safety inspections, to be arranged by the road-traffic authority with the involvement of the road-construction authority and the police. The purpose of such inspections is to assess, by way of precaution, the condition and visibility of the road signs and the traffic devices as well as to eradicate potential hazards in the public road environment.

The ministry for transport, construction and urban development recommends the federal states to conduct safety audits for new road projects and road network safety analyses for existing roads. For all schemes on motorways and federal trunk roads (Bundesstraßen) road construction authorities must provide without any exception the reports of road safety audits.

5. CONCLUSION

The road safety strategies in Germany are based on experiences accumulated over three decades – particularly by doing local accident investigations, whose fundamental principles were developed by the Department of Accident Research of the German Insurance Association. The road accident database (with current and actual data) is an important condition for carrying out local accident investigations, which could lead to substantial results.

The Department of Accident Research of the German Insurance Association developed software for recording and analysing road-traffic accidents “EUSka” [12], which has been placed at the disposal of police services and road administrations. At the beginning of 2007, this software was used by the responsible services of almost seven federal states, five others are currently preparing its integration into their structures.

To work out a road safety diagnosis and deduce the suitable therapies for a black spot, knowledge in engineering and local accident investigation is required; therefore it is important that road administrations have qualified personal who have adequate professional training.

The safety analysis of existing road networks makes it possible for road administrations to systematically detect those road network sections with a relatively higher accident risk; thus they can establish effective planning and maintenance programs. Road safety audits and road safety inspections play a preventative role in the road safety strategic system. They do not only improve the road infrastructure quality, but also avoid the investment costs which could be caused by future road-traffic accidents.

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