BENELUX TEST WITH DAYTIME RUNNING LIGHTS (DRL)

Master plan for an evaluation study into the effect of DRL on road safety in the Benelux countries

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SUMMARY

The Benelux test with DRL is regarded as a European pilot study. The results of the evaluation study will form the basis for the decision-making process at a European level. The International Committee for DRL (IC-DRL) has made recommendations for study in its report. These recommendations are as follows:

- a study into the more long-term effects;
- a study into observation and behavioural process as a consequence of DRL;
- a study into socio-psychological and socio-cultural backgrounds to the attitudes towards DRL;
- a study into the probability of accidents for people not using DRL, if the majority of the population does use DRL;
- a study into the development (or lack) of road safety for slow traffic and motor cyclists;
- a study into the searching behaviour of drivers and the changes in driving behaviour, based on the risk compensation theory with regard to speed;
- a study into energy consumption;
- a study into the optimal light intensity at which DRL is still "effective";
- a study into colour and colour contrast, DRL and the relationship of both factors to road safety.

This report offers an overview of the studies which are designed to meet the above described recommendations, as well as the criticisms of a methodological and analytical nature that were expressed by the IC-DRL in relation to all preceding studies into the effect of DRL. In addition, it is indicated in what way current objections and misgivings with respect to DRL can be investigated, and how this study may offer a response to questions that still remain unanswered. This has led to a total of 8 main projects, of which four are subdivided into further categories.

- Criticism of the methodology and analysis of the studies

This criticism is primarily of a scientific nature and relates to the methodological set-up of measurement programmes and accident studies. In addition, the criticism also relates to the fact that in the national

evaluation studies held to date, little or no attention is paid to exposure or to development in driving performance and mobility in traffic. These factors are fully taken into account in the following projects: A (accident analyses), B (measurement programme to measure the use of DRL), C (social support), F (explanation of the effect of DRL) and G (international cooperation between control countries and the Benelux). Any criticism of the small scale of previous studies does not have to be considered in the case of a test on the scale of the Benelux.

- Why hold a test if Denmark is already evaluating the effect of DRL?

Denmark is a member of the IC-DRL and has reported that the evaluation study in Denmark has grappled with a number of methodological and analytical problems, which have made it more difficult to attribute an effect to DRL on a statistical basis. For this reason also, the IC-DRL has concluded that a test in the Benelux is not only justified, but also essential for decision-making at a European level.

- In the long term, DRL will lead to negative effects

This relates to the fear that observational and behavioural processes will in time lead to a decline in road safety. This will have to be examined, particularly on the basis of a good theoretical foundation, coupled to an accident analysis of the effect, conducted at least two years subsequent to commencement of the test. Project F (theoretical explanation of the effect of DRL) and Project A (accident study) are also designed to reply to these objections.

- Driving behaviour may change in time as a result of DRL

Based on the risk compensation theory, a fear has been voiced that the average speed of drivers will increase in time, because they feel safer using DRL and will compensate as a result. Whether this fear is justified, is studied in Project D.d.

- DRL represents a threat to slow traffic and motor cyclists

The objections are based on the following arguments:

- DRL has a 'masking' effect for slow traffic. This problem is also studied in Project F (explanation of the effect of DRL).
- DRL will restrict the mobility of slow traffic, affect their level of safety and exert a negative influence on the feeling of security for these

groups. This is studied in Project A (accident analyses), C (social support), D.a to D.c (behavioural adaptations) and F (explanation of the effect of DRL).

- DRL will have a negative influence on the extra conspicuity and therefore feeling of security for motor cyclists. This is studied in Projects A (accident analysis), C (social support) and F (explanation of the effect of DRL).

- <u>DRL increases the likelihood of an accident for drivers not using DRL</u>

The fear expressed in this case concerns the situation in which many use DRL as against some who do not. This aspect is given special attention in Project A.b. (probability of an accident for non-DRL users with partial use of DRL). The analysis can only be carried out if a number of conditions have been met.

- <u>Light coloured cars represent an alternative to DRL</u>

The claim that lightly coloured cars offer an adequate alternative in terms of a reduction in the number of accidents is studied in Project A.c. (light/dark coloured cars with/without DRL). Here, too, a number of conditions must first be met in order for the proposed analysis to be feasible.

- <u>Environmental and cost aspects as a consequence of DRL</u>

The criticisms here relate to the following: by using dipped headlights in the daytime, fuel consumption increases and batteries and lamps wear out more quickly. The necessary response to this criticism is given in Projects B (measurement of the use of DRL), C (social support), E (environment, technical and costs) and F (DRL and the optimum illumination).

- <u>Increase in the number of defective lights</u>

The fear is expressed that, due to the accelerated wear and tear of lamps, more cars will drive on the road with defective lighting. This development would have a negative influence on night time accidents. To respond to this objection, night time measurements of defective lighting can be carried out (Project B: measurement of the use of DRL in the Benelux) and attention will be paid to this matter in the accident study (Project A: accident study). In addition, the opinion polls will investigate this development (Project C: social support), while the cost-benefit analysis will consider sales figures (Project G).

- <u>The general public will not cooperate sufficiently</u>

Some expect that the cooperation of the general public in response to the Benelux test will be low. Whether this true and why, will receive full attention in project C, where the study is described investigating the development in public opinion, also subject to the influence of information campaigns; acceptance through motivation. Public acceptance is of importance to ensure the success of the Benelux test.

- <u>Will DRL result in a sufficient added value</u>?

On the one hand, DRL will lead to a rise in costs, while on the other, an effect on road safety is anticipated. Project G describes how a cost/benefit analysis and a cost-effectiveness analysis will be carried out.

- <u>Will the scientific validity be sufficiently guaranteed</u>?

It has already been noted that retrospective criticisms of the scientific approach and performance of the various projects, and therefore of the entire evaluation study, will be prevented by delegating supervision to the International Committee (IC-DRL), consisting (primarily) of research experts who are responsible for the following tasks:

- Assessment of the study design prior to execution.
- Following the progress of the study closely.
- Assessment of the final conclusions.
- Writing a final report.

In this way, the scientific status/validity of the study is ensured and retrospective criticism in this regard is not anticipated.

CONTENTS

FOREWORD

In 1990, the Dutch SWOV Institute for Road Safety Research was asked by the Transportation and Traffic Research Department (DVK) of the Dutch Ministry of Transport to set up an International Committee for DRL (IC-DRL), consisting primarily of research experts. The Committee is subsidised by the Directorate-General of Transport of the EC. The first meeting was held on October 10, 1990 in Brussels. At this meeting, the question was put on behalf of the Dutch Minister of Transport, whether an experiment on the use of Daytime Running Lights by motor vehicles (DRL) was justified. Based on the study results available to date, the Committee arrived at the following conclusion:
"A new experiment with DRL is justified and necessary, to be able to estimate the effectiveness of DRL in Western Continental Europe. Especially when an international scientific consensus on the methodological questions has been reached and the studies are carried out under the supervision of the International Steering Committee, the investigation will lead, unlike most earlier studies, to reliable results. Those results will form a solid basis for further discussion in countries of Western, Central and Southern Europe" (IC-DRL, 1991).
Together with its recommendation, the Committee has associated recommendations for study, because:
"A new experiment carried out on the basis of a scientifically acceptable method can provide a more precise estimation on the cost-effectiveness of such a measure. Results and interpretations from different countries can provide answers to the important questions left open. These should provide important guidance for a possible European harmonisation".
Subsequently, the Committee has examined the analysis design submitted by the SWOV and has come to the conclusion that:
"The Dutch design has been judged to be a scientifically acceptable basis for the method to be followed".

Partly as a result of this recommendation and in order to enable a large-scale experiment, Belgium has proposed the other Benelux countries that the experiment be set up and conducted within the context of the Benelux. On April 14, 1991, the Ministers of Transport of the Benelux arrived at a basic accord on this matter.

Subsequently, the meeting of the Sub-Committee for Road Safety of the Traffic Commission of the EC appointed a secretary for this Sub-Committee, to act as coordinator and organiser for the necessary activities in the field of technology, information and research at Benelux level.
On May 7, 1991, the Directorate-General of Transport in Brussels convened a meeting of government experts from the EC member states and representatives from (industrial) interest groups, in order to discuss future road safety measures in a European context. During this meeting, the recommendation of the International Committee with respect to DRL was discussed. The Belgian initiative to conduct an experiment with DRL at Benelux level was - with a view to future safety measures - received favourably by all present.

In anticipation of definitive agreements at Benelux level, and also because the SWOV has been carrying out preparatory activities since 1989 for such an evaluation study in the Netherlands, the Transportation and Traffic Research Department (DVK) of the Ministry of Transport asked the SWOV to set up a master plan for an evaluation study into the effect of DRL on road safety in the Benelux. It was specifically requested that the recommendations of the IC-DRL be taken into account. Belgium, too, has urged the SWOV to give this assignment top priority. During the drafting of the plan, particular attention was paid to the following issues:

- criticisms of, and objections to, DRL;
- a study into the desirable and undesirable effects of the (compulsory) use of DRL, and the explanations for these.

The Benelux test is regarded as a pilot study, which is why the results of the investigation will be of importance in a European context. The master plan also deals with the nature, scope, duration and organisation of the experiment in the Benelux.

The master plan was compiled by Mrs J.E. Lindeijer. Mr. P.C. Noordzij has designed the study set-up into the searching behaviour of motorists with regard to slow traffic, and has made critical comments and recommendations for the description of the theoretical parts of the study. Special thanks is owed to Dr P.B.M. Levelt for his contribution towards the design of the study into the crossing behaviour of pedestrians and cyclists. Mrs M.P. Hagenzieker is gratefully acknowledged for her contribution towards the description of project F (theoretical explanation of the effect of DRL).

This report also makes use of:

- the master plan that the SWOV already published in 1989 (Lindeijer, 1989);
- the analysis design (Lindeijer et al., 1990);
- the experiences and results of the analysis of user data for DRL in the Netherlands, measured over a year (Lindeijer & Bijleveld, 1991).

1. INTRODUCTION

1.1. General

To date, much national and international criticism has been voiced on studies conducted into the effect of the use of daytime running lights (DRL) on road safety. Criticism was mainly directed at:

- the small scale of many studies;
- measurement programmes used to measure the use of DRL;
- accident analysis;
- likely negative effects for:
  - the environment;
  - slow traffic and motor cyclists;
  - the risk incurred by non-DRL users;
  - head-tail collisions;
  - blinding;
- the degree to which the use of DRL will be complied with by the public;
- a possible lowering in attention level of drivers as a result of DRL, because others will see them 'better' or 'sooner' and will respond accordingly;
- the fact that DRL would be a 'way' of demanding that others move aside;
- a possible increase in speed, once drivers think that DRL gives them an added measure of protection; this anticipation is based on the risk compensation theory;
- more rapid wear of lamps, causing people to drive more frequently with defective lighting; this is thought to influence the development of night time accidents;
- the fact that the size of an effect in one country does not necessarily lead to the same effect in another country;
- the claim that the intended effect (better visibility) would also be achieved if all passenger cars were light in colour;
- why a test if the effect of DRL is already evaluated in Denmark?

In order to respond to these criticisms, a large-scale (evaluation) study is required. Such a study has now become feasible, with the proposal for a test with DRL in the Benelux countries.

In addition, the International Committee (IC-DRL) has offered recommendations for study in order to respond to the objections given in the above. These recommendations are included in the report. This master plan offers an overview of the various study projects that must/should be carried out simultaneously and/or sequentially. Each project also aims to offer results that can answer the question of whether the objections voiced are justified. If this is the case, recommendations will be made on the basis of the result, indicating how such objections can be overcome.

For reasons of organisation, the study described here is divided into a number of main and subsidiary projects.
This choice makes it possible to arrive at proper working agreements at an international level with regard to:
- the study to be conducted;
- distribution of the activities;
- determination of responsibilities;
- overview of an interim cost estimate per area (insofar this can be evaluated).

For European purposes, the study will offer, if possible, an estimate of the costs associated with a DRL measure and the effects which can be anticipated for the development in road safety in other European countries. The question will also be posed concerning possible technical adaptation requirements for motor vehicles.

1.2. <u>Relationship between study areas</u>

The effect of DRL must in the first place be demonstrated by the number of accidents in the pilot area (Benelux) in comparison with control countries, or between experimental accident groups and control groups within the Benelux (Project A). However, a measurable effect is entirely dependent on the development in the actual use of DRL (Project B), which is again dependent on the willingness of the public to use DRL (Project C). An increase in the use of DRL can lead to behavioural changes amongst drivers and/or with slow traffic, so that the effect can be influenced indirectly in a positive or negative sense (Project D). The cost consequences for the environment will also be examined, so that recommendations can be issued to limit negative consequences as much as possible (Project E).

A theoretical foundation will have to supply the explanations for the effectiveness of DRL, in what situations, under what conditions and/or the side effects which may ensue (Projects A, D and F). In addition, a theoretical foundation (Project F) is essential in order to offer a sound interpretation of the results based on the behavioural adaptations (Project D), to enable estimations concerning the extent of the effect on other European countries (Project G), where other traffic conditions may be expected.
As part of the aim for European harmonisation, it is also important that the study carries out a cost-effectiveness and a cost-benefit analysis and offers recommendations concerning possible technical adaptations to vehicle specifications (Projects E and G). Project H deals with international cooperation. The following subjects will be considered:
- which data must be collected (by whom and when);
- proposal for the central processing of collected data (by whom and within what time framework);
- reporting (who, concerning what, to whom, in what language and when);
- the task of the International Committee (IC-DRL), when meetings are necessary/beneficial and when they could (best) be held.

The master plan concludes with a schematic overview of the relationship between the various main and subsidiary projects and the role of the IC-DRL in this context, as well as the relationship between the Benelux working groups and the study.

1.3. Policy and study consequences of a Benelux test

The Benelux test on DRL implies that an obligation will be imposed at an international level for a limited period (October 1, 1992 to October 1, 1993) with regard to the use of DRL by the public. A test period was chosen for the following reasons:
- There are still important questions outstanding with respect to the specific traffic conditions per country, in relation to an increase in the use of DRL, which can only be answered on the basis of empirically collected data.
- The scope of an effect can differ from country to country, so that the scope of the effect from previous evaluation studies cannot be calculated without a theoretical basis for the effect of DRL for the Benelux.

- It concerns a measure which is an emotive issue (and therefore politically sensitive);
- DRL implies additional costs for the individual.
- DRL leads to an increase in fuel consumption.

As noted previously, the Benelux test in a European context is regarded as a pilot study. This implies that it must be methodologically and analytically sound; an evaluation study that is able to draw scientifically acceptable conclusions. These results will be considered in the decision-making process at a European level.

The success of the pilot study into the effect of DRL on road safety in the Benelux will depend on:

- public cooperation;
- police cooperation;
- cooperation of control countries;
- cooperation of an International Committee of research experts;
- an intensive information campaign (repeated if necessary);
- the carrying out of reliable, regular measurements into the use of DRL in the Benelux, one year prior to the commencement of the test period and in the course of the study;
- the availability of accident data from the countries involved;
- the availability of financial support.

2. THE EFFECT OF DRL ON ROAD SAFETY IN THE BENELUX

2.1. Project A: Evaluation study on the basis of accidents

It was already noted in the Introduction that the effect of DRL must initially be demonstrated by a drop in the number of accidents. This means that the accident analysis must offer universally applicable statements about the relationship between the development in the number of accidents and the use of DRL in the Benelux (if possible, compared with control countries). The conditions required and the way in which the analysis must be carried out are described in para. 2.1.1.

Aside from establishing a (statistically significant) effect, it is important to investigate the probability of an accident for persons not using DRL, when many others are doing so. In order to answer this question, it must be established - aside from the use of DRL - whether motor vehicles involved in accidents were using DRL or not. The conditions and methodology of this aspect of the accident study are described in para. 2.1.2.

One of the criticism directed at DRL is that there is an alternative option, i.e. the application of colour contrasts to cars. The question one must ask here is: what added value (in terms of the reduction in the number of accidents) is offered by DRL over and above lightly coloured cars? Conditions and possibilities for study are discussed in para. 2.1.3.

2.1.1. Project A.a: The effect of increasing use of DRL on the development of accidents

1. Conditions

Scientific criticism of the studies conducted to date is particularly aimed at the methodology and analysis. This chapter indicates how this criticism can be met.
The likelihood of demonstrating that a noted (statistically significant) decrease in the number of accidents can be attributed to an increase in the use of DRL will depend on the degree to which the following nine conditions can be met.

A. Sufficiently detailed data on the use of DRL
The development in the use of DRL must be known, both in the before and in the after period (see Project B, para. 2.2). The initial results of the analysis over the year that DRL was used in the Netherlands during the period November 1, 1989 to October 31, 1990 (Lindeijer & Bijleveld, 1991) show that differences were noted in the use of DRL, influenced by:
- the amount of light (expressed in terms of a lux value);
- weather conditions;
- hour of the day;
- months, season;
- type of road;
- inside versus outside the built up area;
- location-related and regional differences;
- working day versus weekend day;
- type of vehicle.

Before the experiment commences, sufficiently detailed data on the use of DRL in Belgium and Luxembourg must be collected, so that a division into the abovementioned categories is possible. The reason why this is important for the accident analysis will be discussed further on.
Assuming a commencement date of October 1, 1992, the measurement programme in Belgium and Luxembourg will have to commence during the summer months of 1991. In Denmark, it was shown that under the influence of press coverage, the use of DRL prior to the commencement date was already over 80%. In order to prevent this occurring in Belgium and Luxembourg, i.e. that

the use increases while the before measurements are still taking place, it is recommended that the measurement period in both countries commences on August 1, 1991 at the latest.
Evaluating the effect at a Benelux level means that the collection and processing of data on the use of DRL in the three countries must be coordinated. The Netherlands will measure the use of DRL in the Netherlands on a monthly basis as from November 1989. It is therefore recommended that Belgium and Luxembourg shall carry out a measurement programme that corresponds to the Dutch system. The set-up and execution of the Dutch measurement programme will be discussed in Project B (para. 2.2).

B. Valid estimations of the use of DRL for the purpose of the accident analysis

For an analysis into the relationship between an increase in the use of DRL and a decrease in the number of accidents, it would be ideal if the use of DRL was known immediately prior to the occurrence of each accident. Of course, this is not possible, so it is necessary to make an estimation. This is also the reason why:

- there are stringent requirements laid down for the execution of the measurement programme;
- there are strict requirements set for the analysis of the user data;
- the various location types must be selected such that they are distributed as widely as possible across the country.

In order to link data on the use of DRL to accidents, the latter must be subdivided as much as possible according to the factors of influence for the use of DRL as listed under point A.
The amount of light appears to be an important intermediate variable. This variable is not recorded in the accident registration and must therefore be calculated with the aid of substitute variables. In the Netherlands, the use of DRL with accidents will be estimated with the aid of a formula for the theoretical sun altitude and the collected user data. This requires the following accident data:

- day, month and year in which the accident took place;
- geographical location of the accident site (latitude and longitude, based on the municipal code).

C. Use of control groups

It is assumed that, during the course of the Benelux test, other road safety campaigns will also be held. It may be anticipated that such campaigns will also have an effect on the development of accidents. It must further be taken into account that, during the test period, other road safety measures may become effective. These developments complicate the analysis into the effect of DRL on accidents in relation to an increase in the use of DRL. The problems referred to here can be minimised in the analysis by:

- making use of control groups;
- making use of control countries;
- developing a theory on the effect of DRL (see Project F);
- checking for disruptive influences; in any case for changes in the composition and scope of traffic (see point I).

D. <u>Use of control countries</u>

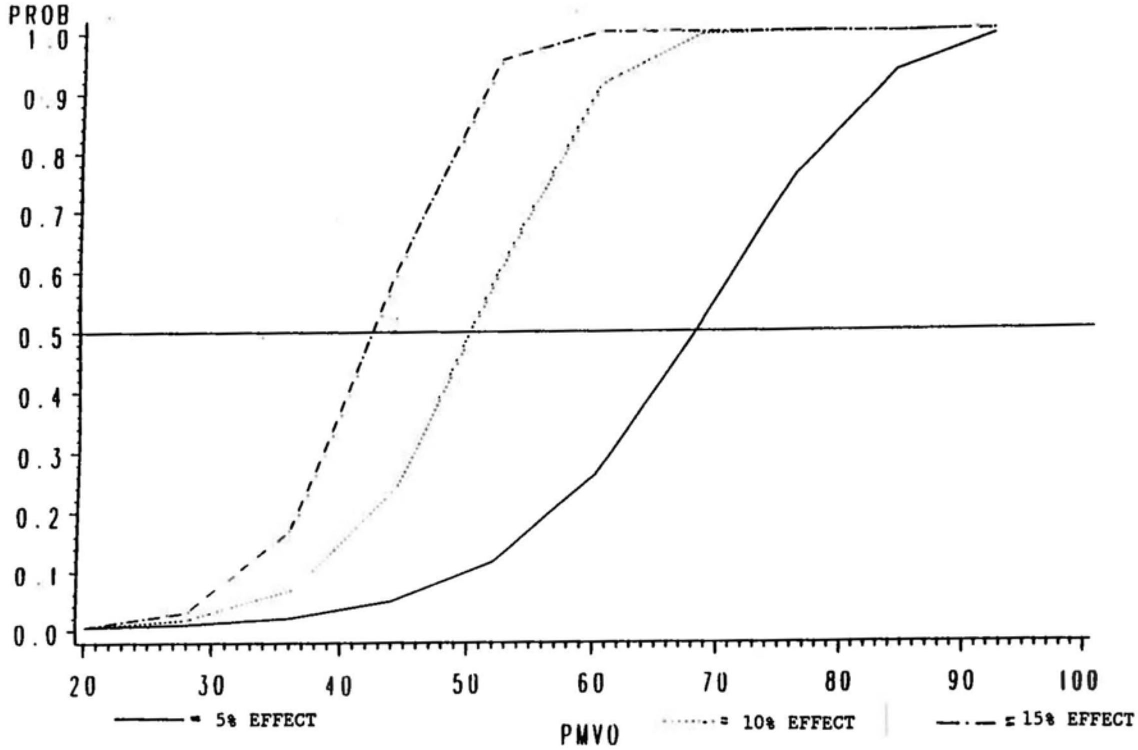
Based on a comparison between the road safety development in the Netherlands and other European countries, the following countries may be considered for the purpose of control: Denmark, Germany, the United Kingdom, France and Sweden.

- Areas must be chosen within these countries that are - with respect to environmental factors and traffic composition - geographically comparable to areas in the Benelux countries.
- Accident data in the control countries must be categorised in the same way as is true for the Benelux (see points B, F and G).
- In the control areas of the control countries the use of DRL must be measured during at least one working day in the summer and once during winter, for the duration of the test period;
- These countries will also demonstrate disruptions which must be corrected for (see point I).

Project H (para. 2.8) discusses international cooperation in this respect in more detail.

E. <u>The difference in the use of DRL when comparing the before and after period must be sufficient</u>

It was already noted that the accident analysis serves to enable statements about an anticipated relationship between an increase in the use of DRL and the associated development in road safety. If the use of DRL in the before period is low and increases fairly rapidly during the test period to a 'sufficiently' high level, the probability of demonstrating a



relationship will be more favourable than if this were not the case (e.g. because the use increases too slowly or does not rise to the required level). In order to give an impression of what percentage rise must be considered with respect to the user percentage for the before period, the following indications can be determined from the graph.
The graph is based on the estimated number of DRL-related accidents and one control country (Germany). The graph shows that if the use is 60% or more for at least six months, there is a probability of 80% that an effectiveness of 10% can be demonstrated.
Therefore, it would be realistic to assume that the result of a initial accident analysis should be possible within one year following commencement of the experiment, provided that:
- the use of DRL increases sufficiently;
- the accident data of the three Benelux countries are available in time.

F. <u>The use of accident data relating to material damage only (MDO accidents)</u>

In order to increase the number of accidents available for analysis, it is advisable to also include accidents with material damage only (MDO). For statistical purposes, these accidents are registered by Dutch police in exactly the same manner as is the case with injury accidents (the same registration form and the same processing procedure). MDO accidents have a number of disadvantages, however, i.e.:

- the degree of registration for police reporting of MDO accidents in the Netherlands is much lower than accident reporting where personal injury is involved;
- in the Netherlands, it has been shown that the registration of MDO accidents does not adequately represent accidents between fast traffic and slow traffic; on the other hand, there is no reason to expect that those disadvantages will be influenced by DRL.

It is unsure whether this type of registration is also carried out in Belgium and Luxembourg, and whether MDO accidents (as is the case with injury accidents) can be supplied on tape by these countries in time.

G. <u>Categorisation of accidents according to various conditions</u>

The accident data must also be divided into (see points A and B):

- weather conditions;
- types of accidents, such as head/tail, side and head-on collisions;
- inside or outside the built up area;
- type of road, such as: motorways, 80 km/hr roads and other roads.

One example of the relevance for the analysis of a distinction based on the type of accident is the following problem: by making use of dipped headlights, the rear lights are simultaneously switched on. This means that the contrast effect which is seen when the brake lights are used in the daytime is less marked than without DRL. The consequence may be that the reaction time of the driver behind (in response to the brake lights) is not as rapid, with possibly deleterious consequences (see also 'hypotheses', para. 2.1.1, part 5).

Data concerning the use of DRL in the Netherlands have shown that with rainy weather, between 40 and 100% of fast traffic is already using DRL. Therefore, the head/tail collisions quoted in the example should also be subdivided according to weather conditions.

H. <u>Variables to be used in the accident analyses</u>

For the sake of clarity, all variables are hereby listed that will be dealt with in the accident analysis:

- weather conditions at the time of the accident;
- hour of the day and day of the week;

- month and year;
- type of road (motorways and 80 km/hr roads);
- inside and outside the built up area;
- municipal code;
- type of participation;
- type of accident (head/tail, side, head-on collisions);
- number of persons involved per accident.

I. <u>Exposure data</u>

In the various analysis techniques, a correction must be made for exposure data, such as vehicle kilometres and traffic intensities, but also (if possible) for the development of travel behaviour.
The Netherlands keeps a record of such data. It must be investigated whether Belgium and Luxembourg can also supply these. If so, the exposure data from at least 1989 are required.
In addition, it is important for the purposes of analysis that these data can be supplied just as rapidly as the accident data.

2. <u>Differentiating between DRL-related and non-DRL related accidents</u>

Not all situations and/or circumstances will have an effect on the use of DRL on the development of rad safety. For example, the use of DRL will not have any effect on:
- the development of accidents during hours of darkness;
- daytime accidents where no motor vehicle is involved;
- the so-called 'single' accidents in the daytime.

These types of accidents are referred to as non-DRL related accidents, and represent the <u>control groups</u> for the analyses. All other accidents are therefore in principle DRL-related, and represent the <u>experimental groups</u>. Therefore, the following must be noted for each accident (see point H):
- hour of the day;
- night time, yes or no;
- type of traffic participation;
- number of persons involved per accident.

3. <u>Before and after study</u>

A before and after study will compare the total number of (relevant) accidents or groups of accidents that occurred before a measure was intro-

duced, against the (groups) of accidents recorded following implementation, where use is made as far as possible of a similar period before and after intervention. In order to take into account the influence of the novelty effect, a before and after study based on a four year period is desirable from a study perspective; the effect of DRL on accidents can then be analysed two years subsequent to implementation. The first results are therefore anticipated round about January 1, 1995.
From a policy perspective, such a longer period is problematic, particularly when there is question of an experiment. It is therefore proposed to carry out the initial analysis series within one year, provided the previously outlined conditions have been met. The analysis can then be repeated after the second year, so that definitive conclusions may be drawn.

Before and after studies imply that an empirical relationship is demonstrated in the development of accidents. The analysis is aimed at the following questions:

- Are changes seen in the various groups within and/or between test and control area and/or experimental and control groups?
- Do the noted differences relate to an increase in the use of DRL (e.g. an increase in the test area but no change in the control areas)?

4. Analysis model of the before and after study

The accidents must be divided into daytime, twilight and night time accidents. Insofar possible, the subdivision will be carried out on the basis of user data in the before period. The following accident categories can then be distinguished:

- Multiple daytime, twilight and night time accidents involving at least one motor vehicle (DRL-relevant versus non-DRL relevant accidents). Within these groups, a distinction is made according to:
  - fast traffic versus fast traffic,
  - fast traffic versus slow traffic.
- 'Single' daytime, twilight and night time accidents (non-DRL relevant accidents). Further classification within this group is also used to establish the influence of specific police and/or information campaigns with respect to speed and alcohol consumption.

It is attempted to make the distinction as great as possible. This is achieved by keeping the number of parameters for the purposes of estimation, or calculation of the number of accidents in the after period, as small as possible. In the most simple model, the following groups of parameters play a role:

- parameter for condition A: time effect (before and after period;
- parameter for condition B: relationship between experimental and control groups and test and control countries/areas;
- parameter for condition C: relationship between DRL-related and non-DRL related accidents.

Based on these parameters, the basic table for the (log-linear) analyses to be carried out consists of the following:
Year (before versus after period) * Groups/areas (experimental versus control/Benelux versus control countries) * DRL-relevance (DRL-related versus non-DRL related accidents).
The effect of DRL on accidents is given by the (third ranking) interaction between conditions A, B and C.

One example of a simple cross-reference table for the purposes of a limited analysis:

	Before period		After period	
	Benelux	Control country	Benelux	Control country
DRL-related accidents	A	A'	C	C'
Non-DRL related accidents	B	B'	D	D'

A and C = e.g.: multiple daytime accidents involving at least one motor vehicle
B and D = e.g.: multiple night time accidents involving at least one motor vehicle

The basic model is expanded by one variable at a time, such as 'location' (inside versus outside the built up area), 'type of day' (working days

versus weekend days), 'type of accident' (head on, side and head-tail), 'type of traffic participant' (e.g. passenger car versus cyclist/pedestrian) and the like.
The influence of specific conditions is also analysed, such as:
- weather conditions;
- time of year (winter versus summer months);
- regional (national) differences (between the North and the South/the West versus the East/mountainous versus flat landscape etc.);
- type of road (motorway, 80 km/hr road, polder (country) road, etc.)

Below, an example is given of an randomly selected cross-reference table, in which:
- <u>main hypotheses</u> describe the interaction <u>between</u> the tables (in the basic table: a to s');
- <u>sub-hypotheses</u> describe the interaction <u>within</u> a table, i.e. between the different cell contents (in the basic table: A to S').

	Before period				After period			
	Benelux		Control country		Benelux		Control country	
	ib*	ob*	ib*	ob*	ib*	ob*	ib*	ob*
<u>DRL relevant</u>								
fast-fast**	a	b	a'	b'	c	d	c'	d'
fast-slow**	e	f	e'	f'	g	h	g'	h'
	A	B	C'	D'	E	F	G'	H'
<u>Non-DRL relevant</u>								
fast-fast**	j	k	j'	k'	l	m	l'	m'
fast-slow**	p	q	p'	q'	r	s	r'	s'
	K	L	M'	N'	P	Q	R'	S'

* ib = inside the built up area/ ob = outside the built up area
** fast = fast traffic / slow = slow traffic

5. Hypotheses

The more conditions and variables are distinguished in the analysis, the greater the probability that even a marked reduction in the number of accidents will not be statistically significant because the number of accidents per cell is too small.
These problems can be taken into account by creating a framework within which as many arguments as possible are put, which together create a situation whereby it becomes likely that the measure has contributed to the noted development.
Such a framework can be offered by a hypothesis formulated in advance, concerning various anticipated drops in percentages for certain types of accident. Expectations concerning the drop in percentages must be derived from the theory formulated for the effect of DRL (see Project F) and/or formulated on the basis of results from previous studies. At present, however, a theory on the effect of DRL is still in the process of development, and it is difficult to 'translate' study results from other countries to one's own country (one of the points of criticism).
The analysis design from the relationship between the use of DRL and accidents have led to the following, interim hypotheses, albeit that no qualification as such is possible, and only a ranking can be indicated.

The effect of DRL (with regard to the severity of the outcome of accidents) will differ for fast traffic collisions on roads outside the built up area with respect to roads inside the built up area. Within the built up area, the average speed may be slower than outside, so that the severity of the outcome of accidents is less from a relative viewpoint, although the distance over which one is able to observe (observation time) is in most cases smaller within the built up area than outside the built up area.

The effect of DRL will be greater for confrontations between fast traffic and slow traffic than between fast traffic. One could state, for example: the effect of DRL will be greatest for fast traffic versus pedestrians, less marked for cyclists and least for mopeds (Helmers, 1988). This ranking is also derived from the differences in average speeds of the motor vehicles involved in a collision; the lower the speed, the greater the chance that a swerving manoeuvre can be successfully carried out by the slower collision party or pedestrian.

The effect of DRL between fast traffic will be greater for side and head-on collisions than for head/tail collisions (Helmers, 1988). In consideration of the divergent opinions concerning a diminished contrast between brake and rear lights in the daytime versus no use of DRL in relation to involvement in accidents, a hypothesis will also be tested that the effect of DRL between fast traffic will lead to an increase in the number of accidents involving head/tail collisions (KfV, 1989; Stein, 1985; Theeuwes, 1990).
As an extension of the hypotheses concerning head/tail collisions, it will be assessed whether no effect of DRL is found on the motorways, because on the one hand the number of accidents due to incorrect overtaking manoeuvres will decline, while concurrently, the number of head/tail collisions will increase by about the same number.

The effect of DRL will be greater during clear, dry weather than during rainy weather in the daytime, because under such conditions the use of DRL is already significant (Lindeijer & Bijleveld, 1991). Based on a similar consideration, the hypothesis can be tested that the effect of DRL will be less during the twilight period than in the middle of the day during dry weather. One can also derive a further hypothesis from this supposition, i.e. that the anticipated effect will be greater in the summer months than during the winter.

6. Time series analysis

With the aid of the time series analysis method, the development of accident patterns for groups of road users and single or multiple DRL-related and non-DRL related accidents will be analysed over time. On the basis of the 'pattern' established in the past, the pattern is calculated as it would appear if no Benelux test were held. A second possibility offered by the time series analyses is that on the basis of a previously quantified (anticipated) effect, it is calculated how the pattern will look in the future. This last application (and its validation: in how many cases did the anticipated effect agree with reality?) can be important if a prediction must be made concerning the scope of the effect in other European countries (see Project G).
Subsequently, the predicted, calculated pattern is compared with the actual development. Accident patterns can relate to, for example: monthly

totals, daily totals or time units within a day, over time.
The analysis can make use of analysis models, which can also incorporate non-linear trends. One example of such a model is the structural model of Harvey & Durbin (1986).

The time series analysis is directed at the following questions:
- How does the accident pattern of groups of road users and single or multiple (non) DRL-related accidents develop within the test area and between test and control area?
- How does this development relate to the development in the use of DRL?

Using accident data, empirical accident patterns can be distinguished for specific groups, such as:
- passenger cars versus pedestrians/mopeds/cyclists in the daytime, versus the night time/twilight ratio;
- accidents between passenger cars in the daytime, versus the night time/twilight ratio;
- passenger cars versus motor cyclists in the daytime, versus the night time/twilight ratio;
- multiple accidents between fast traffic in the daytime, versus the night time/twilight ratio;
- single accidents for passenger cars in the daytime versus the night time/twilight ratio;
- passenger cars versus lorries - DRL related versus non-DRL related.

These examples show that the analysis relates to the analysis of ratios. From a study perspective, this means that the existing computer programmes will have to be adapted or supplementary programmes will have to be developed, leading to an increase in cost.
In addition, specific patterns may be extrapolated for an increase in the use of DRL (specific analysis problems with the trend analysis of user data, see Project B). These problems also play a role in the 'Analysis for specific effects', described in point 7.

For the time series analyses, it is important that an accident pattern can be established on the longest possible time basis; this is carried out with the aid of the trend analysis, thus ensuring that a circumstantial fluctuation is not mistaken for a 'pattern'. Trend analyses also offer

important information about correction factors with the calculation of the number of accidents in the future, based on accident data from the past (also important in the before and after study).
In the case of the Benelux test, the accident data from at least 1987 (preferably from 1980) are required to distinguish between 'patterns' with reasonable accuracy.

The annual analysis of the use of DRL in the Netherlands shows that the use of DRL also differs according to time of day. Therefore, the categories of accidents will also be subdivided on the basis of time units. These time units (intervals) will be chosen such that differences in the use of DRL are as great as possible <u>between</u> intervals, while the differences in the use of DRL <u>within</u> intervals is as small as possible. One example of the time units chosen, based on the use of DRL in the before period, is listed under the next point.

7. <u>Analysis for specific effects</u>

One of the problems associated with indicating the effects of measures is that often, in retrospect, alternative explanations can be proposed for the effect ascribed to the measure. The more precisely the conditions under which the measure is considered to demonstrate an effect are defined in advance, the greater the probability of demonstrating an effect and the smaller the probability of an alternative explanation. The problem here is particularly seen in how, and with what degree of accuracy, the conditions with regard to the use of DRL can be defined in advance, in order to select groups of accidents for the before period. In other words, this analysis method uses DRL-related accidents that occurred in the before period, during times of the day when the use of DRL was at its lowest.
The use of DRL in the Netherlands, for example, appears to be the lowest over the period November 1989 to October 1990, during the following hours of the day:

November 1989 and December 1989	between	10.00 a.m. - 3 p.m.
January 1990	between	10.00 a.m. - 1 p.m.
February and March	between	9.00 a.m. - 4 p.m.
April/May/June	between	9.00 a.m. - 5 p.m.
July	between	7.00 a.m. - 8 p.m.
August	between	8.00 a.m. - 6 p.m.
September	between	9.00 a.m. - 4 p.m.
October	between	9.00 a.m. - 3 p.m.

During the other hours (between sunrise and sunset), the use of DRL drops or rises fairly rapidly, so that a reasonable estimate can only be given of the light intensity at which an average of 50% of motorists uses DRL. Even during rainy weather conditions it would appear, viewed over the entire day, that the use of DRL varies between approx. 40% and 100%, which does not allow for a reliable estimate of the use of DRL (Lindeijer & Bijleveld, 1991). This will be compensated for by averaging out DRL use per degree of sun altitude (measure of light intensity), for example.

8. Analysis of risk development

Risk is here understood to mean: the probability of a particular type of serious outcome with an accident, per degree of exposure (e.g. per 100,000 vehicle kilometres per year, and the like). This analysis investigates whether this risk diminishes subject to the influence of DRL.
The reasoning adopted here is as follows:

- the use of DRL allows motor vehicles to be noticed 'better' or 'more quickly';
- as a result, drivers will sooner react to a confrontation;
- if a confrontation still leads to an accident, the outcome of that accident will be less serious.

Based on this reasoning, it is anticipated that a decline will take place in the number of accidents with fatal outcome. This type of accident will then be found in the registration of injury accidents. However, there will also be a drop noted in the latter category. The proportion of accidents that moves from fatal outcome to injury accidents will, in an absolute sense, be smaller than the proportion of injury accidents that will shift to accidents with material damage only (MDO accidents). Finally, the number of registered MDO accidents will also decline for the same reason.

The methodology in the analysis is as follows:

- First, a 'damage measure' is determined per accident, based on the severity of the outcome. For reasons of practicality, we will select an economic damage measure here, as used in the cost/benefit analysis (Project G).

- Subsequently, the total damage for the before period can be calculated for accidents with fatal outcome, with injuries only or material damage only. This damage measure is divided through a measure of exposure (e.g. vehicle kilometres), and can be compared with the damage measure in the after period.

As this single measure may offer a too limited view, the development per 'type' of severity outcome will also be analysed separately.
in this way, an attempt is made to calculate a risk measure, which indicates the probability of being killed or injured during an accident, given an increase in the use of DRL. If possible, the risk measures will be calculated for:

- collisions between slow traffic versus fast traffic (for accidents with fatal outcome and accidents with injuries only);
- collisions between fast traffic (including MDO accidents).

Again, we wish to point out that it is essential that MDO accidents also be available for inclusion in the evaluation.

2.1.2. Project A.b: Probability of an accident for non-DRL users with partial use of DRL

1. General problem definition

In order to respond to the question of whether the Benelux test will imply greater danger for non-DRL users given an increase inb the use of DRL, this analysis has interpreted the following study questions:

- What is the probability of an accident, given a confrontation with or without DRL?
- Does the size of the effect differ if only one of the collision partners (between fast traffic) is using DRL, rather than when both collision partners are using DRL?

These questions can only be answered if it is known whether one or several of the motor vehicles involved in an accident did or did not use DRL. This information can only be obtained in the Netherlands via the police registration. At present, the use of DRL is registered in the municipalities of:

- Hoorn (30,000 - 100,000 inhabitants);
- Amsterdam (> 100,000 inhabitants);
- Arnhem (> 100,000 inhabitants);
- Sittard (30,000 - 100,000 inhabitants);
- three small towns in the province of North Holland (< 30,000 inhabitants);

It is likely that in Belgium and/or Luxembourg, it is possible to use other sources in order to access this information, or the police will also be prepared to register this information for the duration of the test (See Project H: International cooperation).

2. Conditions for study

In order to carry out a valid analysis, at least the following conditions must be met:

- The usefulness of the registration must be sufficient.

For the Netherlands, this implies:

- To what degree is the information actually registered by the police?
- Is there a relationship with specific types of accidents?
- Is registration carried out selectively?

- The reliability of the information must be significant.

To answer these questions, the following should be investigated in the Netherlands:
- In what way can the police confirm this information?
- For what proportion of accidents can the police determine this information at the site of accident (because the lights are still on, etc)?
The degree of usefulness and reliability are here only indicated in a qualitative sense. The Netherlands is presently conducting an investigation into the usefulness and reliability of police registration. When a report has been issued on this subject, this qualitative indication can be quantified.

- The use of DRL, at the site where the accident occurred and was registered by the police, must be known.
For this reason, cooperation in the Netherlands was only requested from police forces in those cities where the use of DRL is already measured on a monthly basis.

3. Analysis

The analysis will have to make use of injury and MDO accidents in order to have a reasonable number of accidents at its disposal.
The methodology is as follows: Based on the measured use of DRL in a town, the theoretical probability of an accident - given a confrontation with or without DRL - is calculated. It is then assessed whether the distribution of registered accidents deviates from that of the calculated probability (for a more detailed description, we refer to Lindeijer et al., 1990).

The basic table for, for example, the confrontation between fast traffic on intersections within the built up area could look as follows:

	Calculated distribution of the accidents		Actual distribution of the accidents	
	DRL on	DRL off	DRL on	DRL off
DRL on				
DRL off				

If it is possible to obtain this specific information in the control countries also, together with data on the use of DRL in those towns, it can probably be calculated at what percentage of DRL use an optimal effect is obtained. It may be that the optimal effect is already reached at a level of DRL use that is significantly lower than 100%. This is of importance when considering in what form DRL in other European countries can/will be introduced. Knowledge about the probability of an accident in relation to the use/non-use of DRL can offer an insight into the degree to which an effort must be demanded in the field of information campaigns and/or policy control.

If the conditions as outlined here can reasonably be met, the analysis will relate to accidents inside the built up area and between:
- passenger cars and slow traffic;
- between passenger cars;
- between fast traffic.

2.1.3. Project A.c: Light/dark coloured cars with/without DRL

1. General problem definition

One of the areas of criticism is that light coloured cars or brightly coloured strips on cars would offer a good alternative to DRL, in order to increase the conspicuity of cars. From 1972, the SWOV, in various publications, already examined the possibilities of increasing the conspicuity/ perceptibility of motor vehicles through colours and/or lighting. The conclusions found in the reports read as follows:

- A light colour enhances the contrast effect of the car with respect to the surroundings under many circumstances, but certainly not under all circumstances.
- The brightness of dipped headlights will virtually always be better than the contrast effect of even the lightest colours.
- With regard to the rear and sides of vehicles, it is still questionable whether dipped headlights in the daytime are more effective than light colours (Roszbach, 1972, 1974; SWOV, 1974). This conclusion is based on lighting characteristics as they were observed in practice in the early 1970s. Whether these are still valid for the situation in 1991 is not known as yet.

In other words, it must be established what the relationship is between colours of cars, the use of DRL (yes or no), and the involvement in accidents. An analysis of the involvement of light-coloured cars can already be examined in 1991, albeit that the results must be corrected for the use of DRL in the before period.

2. Conditions for study

For the Dutch situation, it would appear possible to examine the involvement of light or dark coloured cars with accidents. If the police registration of the DRL aspect proves to be useful, it can also be investigated what the probability is of an accident, given a confrontation with or without DRL and given the probability of a confrontation with a light coloured car (see also para. 2.1.2). This study would be feasible in the Netherlands, based on the following considerations:

• In the Netherlands, each new car sold is given a unique registration number. Unique, because the number plate associated with that vehicle remains the same for the entire life of the car. Therefore, when the vehicle is put up for scrap, the number plates are destroyed, so that the registration number is never passed on to a subsequent vehicle.
• The car registration also states the colour of the vehicle (at the time of delivery, or with import from abroad). The colours that occur are classified into ten or thirteen main groups.
• With the national registration of accidents, the police note the registration number of vehicles involved in accidents.
• The Road Accident Records Office VOR keeps a separate registration file on this subject.

The SWOV conducted a test link-up between the registration numbers of motor vehicles that were involved in accidents with a fatal outcome and the registration number database of the Department of Road Traffic RDW. This Department control the issue of number plates and registration nationwide. The results show that the reliability of the data to be linked was high and was determined on the basis of: the linking percentage (approx. 99%), the comprehensiveness of registration data at the RDW and the degree to which the 'type' of vehicle recorded by the police and the 'type' of vehicle denoted by the RDW correlated (approx. 95%). The validity of the test linking was greater than 95% (Lindeijer, 1987).
The question is whether these high percentages for the reliability and validity of the test linkup are also found when the severity of the outcome of an accident is less. This will have to be determined on the basis of a pilot study.

Whether the study can be carried out at Benelux level will depend on whether the issue of number plates in Belgium and Luxembourg is also linked to the vehicle, and whether the registration number also reports the colour. If this is not the case, the study can in any case be carried out in the Netherlands, provided the SWOV has disposal of the registration numbers of motor vehicles involved in accidents (on tape) from the VOR, and the SWOV is able to link this tape to the registration of number plates by the RDW.

Before an investigation into the relationship described in the above can be realised, the following conditions can be defined:

- via number plates of vehicles involved in accidents, it should be possible to determine the colours of the vehicles involved;
- an overview must be provided of the distribution of colours on a nationwide basis (this would allow calculation of a correction factor if the proportion of one or several colours in the nationwide registration is different from other colours);
- it must be investigated whether the reliability and usefulness of the registration numbers recorded by the police diminishes as the severity of the outcome of an accident becomes less.

The study can be conducted both on a nationwide basis and on a limited scale, i.e. restricted to those accidents occurring in towns where the police are already registering the DRL factor (see para. 2.1.2).

3. Analysis

The analysis makes three assumptions, namely:

- It is assumed that the colour given on the registration number agrees with the actual colour. If necessary, this assumption can be confirmed or repudiated on the basis of a practical pilot study. In such a study, for example, a number of people involved in accidents can be selected at random and approached with the question: what 'colour' does your car have? This information is then compared with the colour as given for the number plate registration.
- It is assumed that there is no relationship between the colour and the length of the journey (people driving light coloured cars (annually) cover more/less distance than people driving dark coloured cars), nor that there is a relationship between colour and driver motivation (reason for the journey).
- It is assumed that the proportion of the different colours, as they prove to be distributed in the nationwide registration, are also evident in the same proportion within the built up area, should an analysis on a limited scale be carried out there.

The reasoning applied in the analysis is as follows: First, it is calculated what the probability is of a confrontation with a light coloured car, given the proportion of this category in the overall nationwide registration. Consequently, after including the colour of those vehicles involved in accidents, the calculated distribution can be compared with the actual figures.

This is an analysis that can be carried out during the before period. However, it is necessary to correct for the use of DRL in the before period, e.g. by making use of weighed accident numbers, based on the use of DRL. In order to exclude the influence of DRL during this period, the analysis can, for example, be conducted for those units of time when the use of DRL is low, analogous to the analysis for specific effects.
In addition, an analysis can be carried out between times of day where the use of DRL is already high (e.g twilight), with times of the day where the use is still low. This results in a ratio (twilight/middle of the day) that can then be compared with the ratio calculated for the after period.
In the analysis of accidents where the DRL data per vehicle is known, it can also be calculated what the probability is of such a meeting, given use or non-use of DRL by one and/or both vehicles.

After linking the colours to the accident data and calculating the probability of a meeting with a light coloured car, given their proportion in the national registration, the hypotheses can be tested.
Examples of hypotheses are:

- At intersection accidents, the proportion of light coloured cars in accidents observed in the before period will be lower than that of dark coloured cars. For the after period, it may be added that any difference will have been eliminated.
- With head-tail collisions, the before period will show that the proportion of light coloured cars hit from the back will be lower than that of dark coloured cars. Here, too, it can be added that during the after period, any difference will be in direct contrast to the result for the before period. This is assumed on the basis that rear lights will enhance the contrast of dark coloured cars to a greater extent than that of light coloured cars.
- With head-on collisions, the proportion of light coloured cars will be smaller than that of dark coloured cars, but in the after period, that difference will have disappeared.

- Light coloured cars will be less involved in accidents with slow traffic than dark coloured cars, both during the before period and during the after period.

In the limited analysis, it can be assessed, for example, whether the proportion of light coloured cars in the random sample is smaller than the proportion of dark coloured cars, if neither were using DRL. In the event that only the dark coloured car was using DRL, the difference between the proportion of light coloured cars and dark coloured cars will be the same.

Of course, the hypotheses formulated should not only relate to the category of fast traffic, but should also relate to accidents between fast traffic and slow traffic.
Further elaboration of other possibilities that offer a linkup between registration numbers for the accident records and the registration database of the RDW, insofar these are relevant to the evaluation study, will be looked at in further detail during the study.

2.2. Project B: Measuring the use of DRL in the Benelux

1. Principle

The accident study has pointed out the importance of collecting user data for different circumstances and under various conditions several times before, as the chance of demonstrating a (statistically significant) effect depends on a good insight into the development of the use of DRL over time. Therefore, it is not only necessary to define stringent requirements for a measurement programme, but every country in the Benelux must also be able to carry out such a programme in its entirety.
After November 1, 1989, the Netherlands will be carrying out the measurement programme described below on a monthly basis. Denmark, too, performed measurements on the basis of this measurement programme in the months prior to the introduction of the DRL measure (October 1, 1990).
In order to enure uniformity in the collection of data on the use of DRL in the Benelux countries, and to enable the linking up of data from these three countries, it is at this point assumed that Belgium and Luxembourg will also be able to conform to the set-up and execution of the Dutch measurement programme.

2. Aims

Data on the use of DRL serve the following purpose:

- To be able to assess to what extent compliance in the use of DRL is satisfactory and remains so, in order to carry out an accident study successfully. This also means that analysis of the user data must be carried out fairly frequently, in order to provide information for the enforcement policy and information campaigns on the development of compliance (relationship with Project C, para. 2.3).
- To be able to evaluate the influence of information campaigns and police campaigns. In order to carry out the most comprehensive cost-benefit analysis possible, the efforts of information campaigns and the police must be evaluated. In addition, establishing differences in the use of DRL can serve to conduct any interim, locally oriented information campaigns. The development of the actual use, in association with the development of safety awareness are of importance in this context (relationship with Project C).

• To be able to draw scientifically sound conclusions from the results of the accident analysis, relevant to the assumed correlation (relationship with Project A, see para. 2.1).

3. Conditions

Based on the aims, four requirements which the measurement programme must meet are outlined:

1. The measurements must show user percentages at a nationwide level. This means that the measurement locations in Belgium and Luxembourg must be chosen such that they are well distributed over the country, so that location-dependent factors that influence the use of DRL are sufficiently represented.
2. The measurements must show the user percentage as a function of the light intensity and weather conditions. This means that the measurements should be able to register seasonal influences and that the times where measurements are taken per measurement location are chosen such that they are well distributed over the day.
3. The processing of data (on tape) must take place as soon as possible after monthly measurement have been carried out, in order to enable an adequate periodical analysis.
4. The development of the wear to car lamps must be established. It was previously noted that one of the side effects that critics expressed with respect to the DRL Benelux test is that an increase in night time accidents can be anticipated, because car lamps will wear out sooner. This criticism assumes than there is a relationship between defective lighting and involvement in accidents. The measurement programme must also carry out measurements at night time, therefore.

4. Factors of influence on the use of DRL

In order to ensure a reliably composed user percentage on a nationwide basis, it is necessary to take measurements at a great number of locations, under all conditions. This is not feasible, both for practical and economic reasons. It was therefore decided to organise a nationwide measurement programme that satisfies the possibility of offering average approximate percentages, and where the major factors of influence have been discounted. The analysis results of the user figures for the Netherlands demonstrate the following factors of influence:

- amount of light and weather conditions;
- regional differences and degree of urbanisation (large, medium to large and small towns);
- inside versus outside the built up area, and differences between types of road;
- month, type of day (working versus weekend day) and hour of the day;
- presence of public lighting.

Based on the composition of the population and the distribution according to traffic composition and intensity, the Netherlands is divided into four regions. For Belgium and Luxembourg, differences between low-lying areas, hills and mountainous areas will also be of importance.

Diagrammatically, this shows the classification according to location types:

Outside the built up area			Inside the built up area		
motorways	trunk roads	80 km/hr roads	< 30,000 inhabitants through rd/ local st.	30-100,000 inhabitants through rd/ local st.	> 100,000 inhabitants through rd/ local st.

In other words, at least <u>nine</u> location types must be selected per region. Aside from these location types, which are the same for all regions, the following 'types' have also been added to the measurement programme in the Netherlands:

- Amsterdam (capital of the Netherlands with its 'own style').
- Two 80 km/hr roads in polder areas (this is a specifically Dutch problem).
- Texel (one of the islands to the north of the Netherlands).

Next, measurement locations must be found in the chosen areas and towns. The following requirements are set for the measurement sites:

- Measurement sites should not be close to tunnels, where the use of lighting is compulsory.
- Measurement sites on motorways should not be close to exits or approach roads.

- Measurement sites should be chosen in the 'open' field when possible; there should be no question of shadowy measurement sites, for example.
- Measurement sites must be chosen such that observers can carry out the measurements with safety.

5. Reliability of the collected data

Comparability of the use of DRL

The use of DRL which is measured for each of the location types described in the above is considered by the accident analysis to be the best estimator of DRL use at all locations in that region corresponding with that type. In order to establish whether this is a reasonable assumption of the actual situation, at least one 'shadow' location must be chosen for each location type.
At these shadow locations, at least once in the summer and once in the winter on a working day, a full measurement over a day must be carried out, at the same time as the measurements at the set locations.

Reliability of the data

In order to establish the reliability of the collected data by observers, simultaneous measurements are conducted. These are measurements that are carried out by a control observer at the same measurement site, at the same time as the actual measurement is taken, without the 'permanent' observer being aware of the fact. In other words, exactly the same traffic is counted 'twice' by two independently acting observers. In the Netherlands, a simultaneous measurement is carried out at least two times per year at every measurement site. In addition, random checks are carried out to check that the observers are present at the site.

Reliability of the lux/light meters

The amount of light is an important intermediate variable used to explain the variation in the measured use of DRL. Therefore, the lux meters and/or light meters must be regularly calibrated. In the Netherlands, a calibration is carried out once a year. All lux meters (the Dutch study used eleven during 1990/1991), are adjusted on the basis of one of the lux meters. This 'test meter' is used to carry out simultaneous measurements. If light meters are used in Belgium and Luxembourg, those light meters must be calibrated in relation to the Dutch test meter. The calibration is carried out by measuring light values and lux values at the same time. Based on this data, a regression formula can be used to convert the light values to lux values. The establishment and monitoring of the reliability of the lux meters is important, because the accident analysis can only work with lux values.

6. Organisation of the measurement days

In 1990, the use of DRL in the Netherlands was measured throughout the year, from sunrise to sunset. This was necessary to establish when (in practice) there was question of 'darkness' (= everyone was driving with their lights on). In order to establish this, for example, the measurements during the summer months were taken from 5 a.m. to 10 p.m.. Due to financial considerations, and because it was acceptable from a study methodology standpoint, the measurement times in the summer months of 1991 have been reduced.
In 1991, monthly measurements are carried out in the Netherlands at every measurement site, on a working day during one morning or one afternoon.
- In the winter months, the morning measurements commence at 8 a.m. and end at 12.30 p.m. In the spring, summer and autumn months, the measurements commence one hour earlier (at 7 a.m.). During the winter months, measurements are carried out over four hours, while in the summer months a five hour period applies.
- In December 1991, one measurement must be carried out between 5 p.m. and 6 p.m. This measurement is regarded as a measurement during night time conditions.
- The afternoon measurement commences at 12.30 p.m. and continues until 6 p.m. (in the winter months until 5 p.m.).
- On a weekend day, measurements are taken over four hours between 10 a.m. and 3 p.m. As the measurements on weekend days represent an added financial burden, it was decided to carry out a Sunday or Saturday measurement at every measurement site, once every two months.
- The days of the week must rotate in the measurement programme.
- In order to meet the requirement of carrying out shadow measurements within the scope of the budget, measurements have only been carried out in residential streets with a reasonable traffic flow in the Netherlands since 1991. With regard to the number of location types per region indicated here, this means that, in the Netherlands, measurements in residential

areas are only conducted in seven of the twelve original towns (four regions and three towns per region).

7. <u>Measurement apparatus</u>

The light intensity can be measured most accurately if use is made of lux meters which can measure light intensities to 200,000 lux. If this is not possible for Belgium and Luxembourg and the light level is measured with a light meter, the comparability of the data and for the purposes of accident analysis, calibration between the light meters and the 'test' lux meter used in the Netherlands (this has been previously discussed under point 5 "Reliability" will be necessary.

8. <u>What will be measured</u>?

The use of DRL will be measured separately for:
- passenger cars
- lorries/vans (a 'van' is regarded as a lorry if it has double rear wheels);
- motor cycles
- mopeds (in 1989, it was not yet clear whether moped riders would also be obliged to use DRL. In addition, it was anticipated that moped riders would participate under the influence of such a measure, which would affect their involvement in accidents);
- the light level (with lux meters, the light entering at right angles to the meter is measured at five minute intervals);
- weather conditions, subdivided according to:
- clear sunny;
- lightly overcast;
- dry, but heavily overcast;
- drizzle;
- light rainfall;
- heavy rainfall;
- snow or hail.
- the condition of the road surface (dry or wet);
- the visibility, subdivided according to:
- good visibility;
- mist;

- fog;
- heavy fog (< 50 m);
- public lighting (not present, on or not on).

The weather and visibility conditions, as well as the condition of the road surface are subjective data. The observer assesses and notes down these three variables at five minute intervals.

In order to avoid registration errors during the observation as much as possible, observers in the Netherlands use four manual counters each. These are used to count passenger cars and lorries, subdivided according to whether their lights are on or off.

Each five minutes, the position of the counters is noted on a tally form specially designed for the purpose (cumulative; when the measurement hour has passed, the manual counter are reset to 0).
The number of motor cyclists and moped riders is low enough to be counted at five minute intervals, i.e. <u>not</u> cumulative.

9. Processing the user data

In the Netherlands, the counting records of the observers are coded every month and entered into the computer. Using a specially designed computer programme, the cumulative figures for passenger cars and lorries are then calculated back to the actual figures per five minutes. The presence of false codes (which cannot occur) is checked, and corrected where necessary. Using a second programme, the log-lux values and a number of new variables are created.
Based on the geographic location (latitude and longitude) of the measurement sites, the position of the sun is measured at five minute intervals using a formula for sun altitude, and then added.
The database is then ready for the application of analyses.

10. Analysis

As stated previously, the purpose of the analysis is as follows:
- to distinguish between night time, twilight and daytime situations;
- to establish differences between variables;

- based on the distribution in use, to estimate the lowest use of DRL (in the Netherlands, the analysis method of the PROBIT model is used for this purpose);
- to describe the development of the use of DRL over time;
- to extrapolate DRL distributions.

It is important for the purposes of analysis that a method is developed to enable corrections subject to the influence of weather conditions in a simple manner. The development of such a correction factor is being worked on in the Netherlands.

2.3. Project C: Influence of information campaigns

1. General problem definition

Measures are complied with all the better as road users become better informed about the aim of the measure and realise the importance of the measure for themselves and others. If the road user is convinced that a measure contributes to his or her feeling of safety, the compliance percentage can be very high. In such cases, the road user will be more readily prepared to make an investment so that the measure can be more easily complied with (Lindeijer, 1988).

An Austrian study demonstrated motivation prior to the use of DRL with people between 25 and 45 years of age. The number of years that people have been driving also seems to be pertinent. Persons that have had a driving licence for at least 7 to maximally 15 years score well on the acceptance level. In addition, women and lorry drivers scored a significantly higher acceptance level (Schützenhöfer, 1988). This study related to an orientation study of a group which was not nationally representative, although it did offer an indication that information campaigns must take into account those target groups that do not have the same attitude towards DRL (Schützenhöfer, 1988).
In a survey held in the Netherlands at petrol stations, the drivers entering were asked: why do you have your lights on or off? This demonstrated that those using lights did so primarily to enhance their feeling of safety (Lindeijer, 1990).

The DRL measure also leads to emotional resistance. These could be of such a nature that arguments related to safety are unlikely to make much difference - they will not lead to the desired behaviour. In such cases, arguments such as the cost-increasing aspect, the environment, blinding etc. will weigh more heavily, even if the government is able to offer solutions to these. Negative feelings must be taken seriously and cannot be dismissed simply by stating that people are obliged to comply with the law.

As yet, there is little known about the background to the negative emotions aroused by DRL. Based on the previously cited study in Austria, emotions

against DRL may also have to do with a deep seated fear. This fear may be due to the association people make between light and speed (Schützenhöfer, 1988).
In recent months, a different type of emotional feeling has been identified. Indications can be found in the written response to publications on a Benelux test currently in progress. For the moment, these types of feelings are explained as follows: DRL would make it more 'evident' that the quality of life is becoming increasingly artificial; everywhere around you, you see artificial light.
But less profound reasons are also supplied, that have more to do with the fact that sunlight and artificial light do not mix; you do not use artificial light if it is not necessary.

These type of negative emotions are not only found amongst road users. If the efforts of the police ar required, it must be investigated to what extent they also harbour objections. It is particularly important that police officers have a positive attitude towards this measure. Convincing them of the usefulness of a measure, where any underlying emotions have been discussed, will contribute to their readiness to enforce the measure in practice.

2. Set-up of the study

DRL appears to be a measurement which is an emotionally sensitive issue. It is therefore important to uncover the foundation of this emotional resistance, so that the information campaigns can respond to this. In addition, arguments proposed by those who are even now using DRL voluntarily, independent of light level and/or weather conditions, could contribute to the process of acceptance.

The aim of this project is to answer the following study questions:
- Which emotions or arguments underlie the motivation to accept or reject DRL? Which target groups can be distinguished in this respect?
- What is the influence of information campaigns on these emotions or arguments? Will they change as a result of these campaigns?
- How great is the willingness of the public to cooperate?
- are people prepared to purchase technical aids (relationship with Project E)?

- How does the outcome of the opinion polls concerning DRL relate to the development in the actual use (relationship with project B).
- Does the sense of safety change as a result of an increased use of DRL (relationship with projects F and G)?

The most common method of measuring acceptance levels and attitudes is through the opinion poll, or survey. Depending on the purpose of the measurement, surveys are either conducted by telephone, in writing or orally.
For a national survey, a list of questions has to be designed. The problem with compiling such a questionnaire is that it is necessary to know what is in fact being measured, particularly when one inquires after subjective issues and wishes to establish whether safety consciousness has changed. For this reason, the first step is to conduct so-called in-depth interviews. Approximately 20 respondents will have to be interviewed (two respondents per target group. See also point 3: Analysis).
The interviews must uncover the principal arguments and feelings, both for and against DRL, and must be held in all the countries of the Benelux. It is expected that the differences between cultures and social dispositions within the Benelux will also lead to differences in the principal feelings for or against DRL.
Based on the knowledge derived from the interview, questionnaires per country can be drawn up. If the interviews are conducted professionally and analysed, the added expense can be recouped when holding the nationwide questionnaire and interpreting the data. A good qualitative analysis of the problem in advance can reduce the number of questions and will in retrospect enable the nationwide data to be better interpreted and validated. Coordinating the content of the various questionnaires is important in this regard.

3. Analysis

In principle, the following target groups are approached:
- known cyclists (male/female);
- known drivers (male/female);
- professional chauffeurs (distinction according to gender seems unnecessary in this case);

It is assumed that this group will sooner respond to DRL based on their experiences in traffic, rather than on the basis of emotional considerations.

For practical reason, four age classifications are distinguished, i.e.:
- below 18 years of age (no driving licence);
- between 18 and 25 years of age (young drivers);
- between 25 and 50 years of age (working population; educators);
- above 50 years of age (decline in physical properties).

The first opinion poll can be held on the basis of the questionnaires compiled in the before period in a Benelux context (= 0 measurement). These assessments must be repeated after the information campaigns (= second assessment) and will be repeated one year following commencement of the Benelux test (= third assessment). In this way, the influence of DRL on the safety consciousness of road users is measured.

In order to establish and follow a shift in safety consciousness within and between the target groups, each target group should include a sufficient number of respondents. For example, approx. 200 persons per registration group. This means that in the nationwide random sample, approx. 3500 respondents will have to be questioned.

The results will have to be analysed as quickly as possible following the organisation of each opinion poll, in order to inform the Working Group for Information and the police. This information relates to:
- the development of the acceptance level (nationally and per registration group; relationship with Project B);
- the expression of negative motivations (e.g. due to experiences with empty batteries or wear of lamps, etc; relationship with Project B and E);
- the effect of information campaigns (relationship with Project G);
- the prevalence of mobility-restricting emotions for groups in the community (relationship with Projects D and F);
- to what extent people are prepared to purchase technical aids (this is an important factor to allow better interpretation of the development of actual use of DRL; relationship with Projects B and E);
- which (technical) problems road users (believe they) will experience as a result of increased use of DRL (relationship with Projects D, E and F).

2.4. Project D: Behavioural adaptations as a consequence of DRL

At present, an adequate explanatory theory for the effect of DRL is still in the process of development. This means that it is not possible to indicate from a theoretical aspect whether behavioural adaptations can be anticipated and, should this be the case, whether that can lead to negative developments in awareness (see Project C) and/or safety (see Project A). The lack of a theoretical foundation is the reason why many criticisms can only be answered on the basis of results from empirical study. Some of the studies described below are an example of this.

2.4.1. Project D.a: DRL and crossing behaviour of pedestrians

1. General problem definition

Sweden, Norway and Finland have reported that accidents between fast traffic and slow traffic have shown the greatest relative drop; these seem to derive the greatest benefit from the use of DRL by fast traffic. This positive result is regarded by some as a consequence of the added threat imposed by fast traffic. They believe that this could even cause DRL to restrict the mobility of pedestrians, for example.
Whether there can indeed be question of side effects in terms of a restriction in the mobility of groups of people was already dealt with in Project C as one of the areas of attention. The study that is proposed here attempts to collect empirical evidence to show that there is indeed question of a change in the crossing behaviour of pedestrians as a consequence of an increase in the use of DRL.
Before a pedestrian decides to cross, he/she is oriented towards the traffic on the road. The moment that he/she decides to cross, a more 'exact' impression of the possibilities is required. This is when information relating to, for example, speeds and relevant traffic participants is selected, in order to decide at what moment it is safe to cross the road. The latter phase can be 'measured' and is described in the above. For the orientation phase, video recordings are required.

2. Set-up of the study

A possible change in the crossing behaviour of pedestrians is translated into the following study questions:
- Is there a change in the behaviour of pedestrians during the approach to the crossing point, in particular the way they look at cars, as a result of an increased use of DRL?
- Is there a shift in the average value of accepted gap times for crossing pedestrians as a result of an increased use of DRL?

For the setup and execution of the study in a Benelux context, the following is proposed. Assuming that the criteria that pedestrians use when deciding that it is 'safe' to cross are the same for all three Benelux countries, it is sufficient for the study to be carried out in just one of the three countries.

The study relates to behavioural observations of the crossing behaviour of pedestrians in traffic and consists of two parts, i.e.:

a. recording visual behaviour by means of registration on video. This part must answer the first study question;

b. measuring the speed of fast traffic, recording whether or not they use DRL and distinguishing between the different times required for the 'crossing process' of the pedestrian. This data serves to answer the second study question.

In order to answer the first question, video pictures are taken as the observer notes an approaching pedestrian; i.e. independently of whether the pedestrian will in fact cross the road.

The material required to answer the second study question is collected as follows:

- A road is chosen which has only one lane for fast traffic. For example, a street with one way traffic or a street with a sufficiently broad central island. The influence of traffic from the other direction will in the latter case have no bearing on the decision of the observed pedestrian to cross the first lane of traffic.
- During the period of observation, the following data on the fast traffic are noted:
  - speeds (using radar equipment);
  - the time, coupled to the measured fast traffic (this is made possible by linking up with a computer);
  - whether or not the measured cars are using DRL.
- The observation of crossing behaviour commences from the moment that a pedestrian arrives at the kerb, with the evident intention to cross. At that moment, the first signal is given to the computer connected to the radar measuring the speed of the passing vehicles with or without DRL. If the pedestrian decides to cross, a subsequent signal is entered. When the pedestrian passes the point at which, if he/she had estimated wrongly, a collision would have occurred, another signal is entered.

The last signal indicates that the pedestrian has reached the other side. This also allows the crossing speed of the pedestrian to be included in the analysis as a variable, and will also represent a measure of changes in crossing behaviour.

If the study is carried out in the Netherlands, it must also be ensured that no moped riders or cyclists can pass between the fast traffic and the pedestrian, in order to prevent a 'disruption' of the crossing behaviour. This is ensured by selecting the crossing point between a separate cycle path and the lane of traffic.
There should not be any traffic lights at the site, not for cyclists nor for pedestrians.
In addition, the study will include the variable of whether or not a pedestrian crossing or (cycle) crossing was present.
During the study, it will be recorded whether there was question of:
- simultaneous crossing of adults with children;
- whether there is question of a 'group' of pedestrians;
- gender;
- estimated age, for example based on four categories (children to 12 years, adults, middle aged persons and the elderly).

3. Analysis

A video film records the 'orientation' phase. In order to analyse that material, however, one needs more theoretical knowledge than is available at present. In terms of 'better' or 'worse', any change in behaviour must be indicated if it can be shown that behavioural choices made by pedestrians have become 'more' or 'less' cautious as a result. These interpretations are only possible with the aid of a theory on the effect of DRL.
As this study is designed to establish whether there is question of changes in the (viewing) behaviour as a result of an increased use of DRL, this material must be collected during the before period.
The analysis will be finalised once there is more known about the effect of DRL. This explanation must be derived from Project F (para. 2.6).

Based on study that took place to examine the crossing behaviour of pedestrians in the Netherlands (study into the influence of 'flashing yellow pedestrian lights'; Janssen et al., 1991), the following definitions for the purposes of data processing have been copied:
- Caution when crossing can be demonstrated by a shift in the so-called critical gap. This is the point in the distribution of acceptable and non-acceptable gaps that is accepted in 50% of cases. An increase in caution also demonstrates a restriction in mobility.

The distribution of gap times consists of two gap times per pedestrian, i.e.

- the acceptable gap (= crossing), which is less than 10 seconds (empirical boundary recommended by the previous study).
- the longest non-acceptable gap (= no crossing), which is less than 10 seconds after the first car has passed the pedestrian once he/she has reached the kerb. It was decided that the first non-acceptable gap should be omitted, because it has been shown that people partially determine their arrival time on the basis of the traffic situation.

A measure of safety is found in the extremely brief acceptable gaps, e.g. less than 3 seconds. It is anticipated that as a result of DRL, these gaps with respect to the number of crossings will decline.

- Discomfort of pedestrians can be expressed in hesitant behaviour and stepping back, but also in increased crossing speeds, in short a greater variation in crossing behaviour.

The study should be carried out during the before period, specifically at those times when the use of DRL is lowest. It is therefore recommended that the study commence in 1991. If the study is carried out in the Netherlands, the measurement times can be selected in accordance with the hours of the day when the use of DRL is at its lowest (see "Analysis for specific effects"; para. 2.1.1, point 7). In the after period, the study must be represented at the same hours of the day and during the same month as in the before period.

2.4.2. Project D.b: DRL and the crossing behaviour of cyclists

1. General problem definition

The problem that is noted in relation to a possible restriction in the mobility of pedestrians, if the use of DRL increases markedly, would also be applicable to the category of cyclists (see para. 2.4.1). Therefore, the study questions could be the same, i.e.:

• Is there a change in the observing behaviour of cyclists as a result of an increase in the use of DRL?
• Is there a shift in the average value of acceptable gap times for crossing cyclists, as a result of an increase in the use of DRL?

2. Set-up of the study

As the Netherlands is the ideal cycling country and the objections to DRL are primarily voiced in the Netherlands, it is recommended that the study be carried out in the Netherlands.
Cyclists also experience an 'orientation' phase and a phase where it is decided whether they will in fact cross the road. Therefore, the fieldwork as proposed for observing the crossing behaviour of pedestrians, in principle also applies to observation of the crossing behaviour of cyclists. Additional realisation problems are associated with this category, however. While for pedestrians it is still reasonably accurate to define the exact point at which crossing commences, for cyclists this so somewhat more difficult to determine. This can be solved as follows:

- Locations will be selected with and without right of way situations.
- Locations will be chosen with and without separate cycle paths.
- The moment that the cyclist can observe (fast) traffic emerging from a side street, it is assumed that <u>that</u> is the time at which an approaching car may possibly affect the decision made by - and therefore the behavioural consequence for - the cyclist. This point will have to be determined on approach and marked during the observation period.
- When the cyclist reaches the first 'point of contact', the first signal is entered into the computer. If the cyclist leaves the cycle path, the second signal is given. The third signal is entered when the cyclist reaches the point of conflict, while the last signal indicates that the cyclist has reached the cycle path on the other side.

In addition, the requirements and the distinctions made on the basis of different variables are similar to those described in the study into the crossing behaviour of pedestrians (see para. 2.4.1).

3. Analysis

For the analysis of the video recordings, the same applies as was discussed in the previous paragraph.
The execution of the analysis based on the measured crossing behaviour can then be carried out as for the analysis of the crossing behaviour of pedestrians. The question is whether the limit of 10 seconds, as used for pedestrians, should not be set lower for cyclists. This will also have to be determined empirically in a pilot study.

2.4.3. Project D.c: DRL and the searching behaviour of fast traffic with respect to slow traffic and motor cyclists

1. General problem definition

From the point of view of motor cyclists, the objection is voiced that if all fast traffic uses DRL, this will influence the specific position that motor cyclists presently occupy in traffic (with regard to DRL). The fact that motor cyclists are obliged to use DRL in almost all European countries resulted from a need to increase the conspicuity and perceptibility of this group amongst al the other fast traffic. Due to the small number of motor cyclists in traffic, behavioural observations cannot be carried out. The problems noted will receive attention in Project C, which will investigate how motor cyclists' sense of security will develop as a result of DRL.

Those that protect the interests of slow traffic claim that drivers using DRL will expect slow traffic to see them 'more quickly' or 'better'. This would lead to drivers devoting less attention to slow traffic; in other words, this would result in a shift in the searching behaviour of drivers with respect to the presence of slow traffic.

Drivers must note the presence and movements of other road users in traffic at the 'right' moment. The road users that are of importance at any given moment differ for each situation. Therefore, drivers must 'search' for the road users per situation. Search patterns for relevant information can be distinguished in controlled or automatic search patterns.

Controlled search pattern

It is assumed that experienced car drivers have a more or less fixed search pattern. This searching is sometimes made easier and sometimes made more difficult by the outward appearance of other road users and their background. DRL can affect that searching behaviour, because approaching vehicles will be seen more quickly. This would leave more searching time to locate road users without DRL. Insofar motorists search for cyclists or pedestrians, it is questionable whether, with increasing use of DRL, this searching will become more difficult. To date, based on the study results, there is no foundation for this fear (Theeuwes & Riemersma, 1990).

Automatic search pattern

Other road users, due to their appearance and background, can also become more or less noticeable without anyone actually searching for them. The consequence of DRL in this case could be that motor vehicles will become more noticeable than cyclists and pedestrians, even if they are not specifically searched for. Also in this situation DRL will save time. On the other hand detecting cyclists and pedestrians will take more time in the automatic search process.

The results of an observation study on possible negative effects could be:
- search times become longer to detect cyclists and pedestrians (= controlled search process);
- or that cyclist and pedestrians more easily remain undetected, particularly if they are not searched for (= automatic search pattern).

It is therefore of particular importance to know whether motorists looked for cyclists and pedestrians in the before period or not. The consequences of DRL could be different with one scenario than with the other.

The problem that is really at issue here is:
- What degree of attention do motorists presently devote to slow traffic (at a low level of DRL use)?
- Will that attention become 'more' or 'less' in the after period, as a consequence of an increasing use of DRL?

2. Options for study

There are various ways of studying the searching behaviour of car drivers: In previous studies with video recording outside, the principal movements were recorded at the approach to intersections. The pattern of head movements appeared to correlate with the presence of a car or cycle on the intersecting road and/or priority road. Using the same type of study, the influence of DRL can be examined. One restriction of this type of study is that the traffic situation needs to be relatively simple, in order to allow analysis of the measurement results. Furthermore, movements of the head are no more than a rough indication of searching behaviour (Janssen et al., 1988).

A second possibility is to measure conflicts between motorists and cyclists or pedestrians crossing the road. Previous studies have shown that in some situations, the probability of conflict was great, because drivers apparently paid too little attention for cyclists. With this type of study, therefore, the consequences of the searching behaviour are established in order to enable statements about the searching behaviour as such. This is only possible in situations where a driver must give right of way to a cyclist or pedestrian in accordance with the traffic code, and therefore has to see them in time (Tenkink, 1985).

The third possibility for study is to determine the eye and head movements of drivers in consecutive situations while driving. With this type of study, some experience has already been gained in the Netherlands. Nevertheless, it is still difficult to process the collected material in order to know which road users are searched for or found.
Here too, the fact that there is no conclusive theoretical foundation available hampers analysis.

In consideration of the study into the crossing behaviour of pedestrians and cyclists (para. 2.4.1 and 2.4.2), the second option as described in the above has been selected as a basis for study, for the following reasons:

- the searching behaviour as such can be 'measured' in a fairly simple way;
- the measured behaviour allows statements about the actual searching behaviour;
- the results will relate well to the two preceding studies (see para. 2.4.1 and 2.4.2).

2.4.4. Project D.d: DRL and the driving behaviour of motorists

1. General problem definition

In relation to DRL and driving behaviour, three separate objections have been voiced which can be distinguished as follows, i.e.:

- DRL lessens the attention level of drivers, because others will now be able to see them more quickly or better (see preceding paragraphs).
- Those that are now using DRL demand that others move out of their way.
- Based on the theory of risk compensation, the average speed after a certain period will increase, after people have come to feel safer with DRL.

All three of these objections will be examined in depth, and indications given on how these objections can be supported or repudiated by the study results.

The first objection relates to the supposition that cyclists and pedestrians - as well as drivers - expect that a reduction in the attention level of drivers will occur as a result of DRL. Their reasoning is based on the following: the use of DRL makes drivers feel that others see them 'better' or 'more quickly'. They expect this because others more often respond by moving out of their way and/or giving right of way. This is thought to lead to a reduction in the attention level of drivers. Whether this objection is founded in fact will have to be answered through experimental study results and behavioural observations in practice (see Projects D.c. and F).

The second objection has to do with the use of DRL by a single driver in a traffic situation where the majority of people do not use DRL, and the speeding behaviour demonstrated by the former. The reasoning here is probably: people using DRL expect others in traffic to move out of their way sooner, because they are visible from a greater distance. This reasoning can have different consequences, e.g:

- This 'type' of driver is regarded as belonging to the group of 'fast drivers'. People do not wish to belong to that group, so they refuse to use DRL themselves. Whether this behavioural consequence is in fact seen will be investigated in Project C.
- People regard DRL as threatening; it enhances their feeling of

insecurity in traffic. Drivers do not want to cooperate with this negative image (Project C. will also devote attention to this matter).

For moped riders, cyclists and pedestrians, this could lead to a restriction of their mobility. Such consequences will receive attention in Projects D.a., D.b., D.c. and C.
One could claim that these problems would no longer be an issue if everyone used DRL. Furthermore, if this reasoning is founded in truth, the 'means' will be taken from the fast driver if everyone uses DRL. However, for the purposes of information, it is important to have the 'hard facts', in order to approach this problem effectively. Therefore, the before period must measure speeds in order to assess whether the basis of this negative feeling towards DRL is also founded in truth.
In October and November of 1990, speed measurements were conducted on 80 km/hr roads outside the built up area at various locations in the Netherlands. In many cases, it was possible to link the use or non-use of DRL to the speed measurements recorded. The results of the analysis show that the speed distributions of drivers with and without DRL are identical (Lindeijer & Bijleveld, 1991).
Whether this is also true for other road types in the before period, such as motorways and/or roads inside the built up area, must still be investigated. A study dealing with this subject is discussed in this chapter.

The third objection can be derived from the theory on risk compensation. The reasoning issuing from this theory is as follows: if everyone uses DRL and feels safer as a result, in the course of time the average speed of fast traffic will increase, because drivers tend to compensate for a feeling of greater security.
Whether this is the case will have to be demonstrated from speed measurements in the before period, compared with subsequent speed measurements, once a sufficiently long period has passed following introduction of the Benelux test with DRL.

2. Set-up of the study

In the Netherlands, the measurement of speeds in the before period within the built up area and on roads outside the built up area will in principle be the same as the measurements conducted on 80 km/hr roads (Lindeijer & Bijleveld, 1991).

Speed measurements on motorways

In the Netherlands, regional differences have been recorded on 80 km/hr roads from region to region (Oei & Van de Pol, 1991). It is assumed that this will also be true for motorways and for differences in the degree of urbanisation.

It is known that the social behaviour in large cities differs from that in small towns. Behaviour in traffic is social behaviour. Therefore, speed measurements will have to be carried out at least on one motorway per region in the Netherlands. It would be ideal if the measurements were recorded on motorways where the use of DRL is already being monitored (see Project B). The measurements are performed with radar to which a computer is connected, which notes the time simultaneously. With every passing vehicle, a signal is transmitted to the computer if the car is using DRL. In this way, it is also possible to distinguish between lorries and passenger cars, and perhaps motor cyclists.

The measured speeds and times will be supplied on tape.

Inside the built up area

Although the principle of measurement is identical to that for motorways, an extra problem presents itself here. The speed to be measured within the built up area can easily be influenced by mopeds. This can be solved by conducting measurements on through roads inside the built up area where there are special cycle paths, so that slow and fast traffic are kept segregated.

On the other hand, it is recommended that the speed of mopeds with and without lights is also measured. This advocates measurements on roads where both types of traffic occur. With mopeds, too, an increase in the average speed is anticipated in the course of time, based on the same theory.

In order to minimise the number of measurements required, it is proposed to carry out the total number of measurements within the built up area in two cities with more than 100,000 inhabitants, and two towns with less than 30,000 inhabitants. Here, too, it is best to conduct speed measurements in towns where the use of DRL is already being measured on a monthly basis.

It may be assumed that the speeding behaviour in the Benelux differs from country to country, as previously noted. Therefore, speed measurements must be carried out in all countries of the Benelux.

The speed measurement must be repeated twice during the after period: the first after measurement one year subsequent to the start of the Benelux test, and the second measurement two years subsequent to the commencement of the test, in order to determine the development over time.

For after measurements in the Netherlands, speed measurements must also be carried out on 80 km/hr roads.
In Belgium and Luxembourg, speed measurements on 80 km/hr roads (or similar roads) should also be carried out in the before period, aside from measurements on motorways and inside the built up area.
- In the before period, measurements must take place during periods when the use of DRL is at its lowest.
- The measurements in the after period must be taken from the same measurement sites, day, hour and month as for the before period.

3. Analysis

After the field work is completed, the data must be supplied on tape. The analysis will compare the speed distributions between fast traffic with and without DRL. Subsequently, the distributions in the before period will be compared with those from the after period, if necessary corrected for development in traffic performance. Aside from speed, the times were also noted, in order to allow an analysis of the 'tailing' times (the distance between two vehicles, expressed as a time unit). It is assumed that such tailing times, aside from speed measurements, are also an indication of whether people using DRL are in a 'hurry', i.e. they would show shorter tailing times than non-DRL users.

2.5. Project E: Environmental, technical and cost-related aspects resulting from the use of DRL

1. General problem definition

One major objection to DRL is the increased consumption of fuel. In addition, the fear is often voiced that people will experience inconvenience as a result of empty batteries and more rapid wear of lamps. It was reported previously that some also fear that there is a relationship between defective lighting and night-time accidents. On this subject, questions are asked in Project C, counts are performed at night-time in project B and a special analysis is devoted to this subject in Project A. It may also be assumed that these objections will affect the willingness of people to use DRL, which means that information campaigns will have to offer an alternative (relationship with Project C).

2. Increase in fuel consumption

For the moment, based on the literature, it is assumed that the increase in fuel consumption will be approx 1%.
The questions that must be answered, given the knowledge on the use of DRL, include:
- Is the percentage quoted at present realistic?
- Are there any technical developments that could effect a reduction in this figure?

The first question can already be answered in the before period (1991), by applying data on the use of DRL in the Netherlands. In this way, a correction can be made for the use of DRL in the before period. The analysis over the year of user data in the Netherlands in fact demonstrates that:
- As soon as there is question of rainy weather conditions, an average of one in two passenger cars will use DRL, regardless of the time of day. However, location-related factors must be taken into account, such as:
  - regional differences;
  - inside or outside the built up area;
  - motorways or 80 km/hr roads.
- It is a legal requirement that people switch on their lights from one half hour after sunset to one half hour after sunrise. In practice, it

seems that, on average, people keep their lights on for longer than the legally required time, again dependent on location-related factors and weather conditions. The proposed calculation gives a (theoretical) user percentage. It must then be calculated to what degree the result of this calculation can be influenced if the majority of people want to make use of ways to use lights in the daytime at a reduced voltage. For example, it may be possible to use special daytime running lamps. Guidelines for these have been drawn up at a European level.

The results of the abovementioned activities can be used in the information campaigns (See Project C). Therefore, this activity must be carried out before the campaigns commence. During the after period, it must be established what the actual increase is, based on the actual user data coupled to the exposure figures. This information is necessary to carry out a sound cost/benefit and cost-effectiveness analysis (Project G).

3. Wear of lamps

Through the use of DRL, the probability is high that lamps will wear out more quickly through more frequent use. Until recently, it was assumed that with current use, the average life of headlights is five years. Whether this is still realistic considering the current use of DRL must be investigated. This investigation can be carried out at the same time as the study set-up for fuel consumption. In the Netherlands, it has been shown that, at present, approx. 1% of passenger cars using DRL are driving with defective lighting.
There are indications that the use of a reduced voltage will extend the life of the lamps. It must be examined to what extent this is true.

4. Empty batteries

If it is not ensured that lights are automatically switched on or off in tandem with the ignition, the fear that the battery will run out is a realistic one. This can be prevented by fitting an automatic switch in the car, or a warning signal. With new cars, automatic switches could be supplied as a standard fitting.

The SWOV is currently conducting a study into a number of switches available on the market for the previously cited pilot study (Schoon, 1991). The results are expected halfway through 1991. The pilot study examines a number of different switches in practice, and looks at, amongst other things:

- installation problems in the garage;
- comfort aspect for the driver;
- development of fuel consumption (insofar feasible).

For the evaluation study, it is important that during the after period, a costing can be done for the individual increase in costs resulting from the fitting of switches. This aspect is also included in the questionnaire as discussed in Project C (relationship between Projects C, E and G).

2.6. Project F: Explanation of the effect of DRL

1. General problem definition

For the theory formulation related to the explanation of the effect of DRL, this concerns:

- an explanation of the positive effect of DRL under favourable daylight conditions;
- behavioural adaptations to the effect of DRL;
- an assessment of the possible negative effects of DRL, insofar bright vehicle lights would obstruct the observation of other important matters in the traffic environment.

It has already been stated that a theory concerning the effect of DRL is still in the process of development, and that this will have consequences for supporting the interpretation of the study results that were discussed previously.

The aim of this project is to compile a well founded list of explanations for the effect of DRL. Such a list must also offer an insight into the following questions:

- Does DRL make tasks of observation easier or more difficult at an operational level?
- At an operational level, how do aspects of observation function through DRL at both a tactical and a strategic level?
- Are choices at a tactical and strategic level influenced by DRL?
- How does DRL work in everyday practice?

It is anticipated that this list can be composed on the basis of the results of laboratory, field and observation study. This implies a step-wise approach to the study under experimental conditions in the laboratory and the field, allowing the results to be assessed in practice. With all experiments to be carried out, the emphasis is on the cognitive aspects involved in observation (Theeuwes, 1989; Theeuwes & Riemersma, 1990; Hagenzieker, 1990; Koornstra, 1989). This step-wise approach is described on the basis of two study questions.

2. DRL and the information-processing system of man

The importance of DRL can be explained as making oneself more visible to the surroundings. In principle, vehicles are already well visible during daylight conditions; that is to say, for persons who are adapted (used) to the (day)light level.
The central question is:
- What can DRL add to the visual information that is already reaching us in traffic at present (during the daylight)?

The only difference with the situation as it is without DRL appears to be the factor of 'light intensity', or rather 'contrast'. In the daytime, there is a certain range of normal 'contrasts'. If vehicles were to use daytime lights, unique, artificial elements are added that fall outside this 'normal' contrast range. The direct effect of the use of DRL is therefore, it is assumed, a heightened contrast. If DRL is to have any effect on road safety, this should be derived from the effect of this artificially enhanced contrast. However, it is not easy to link up the postulated effect of DRL, in terms of attracting attention more rapidly or more effectively, with reference to the current literature in the field of attention. With many accuracy tasks, it has been shown that 'attention' can result in mistakes, both with regard to identification and location. With regard to the correct identification of elements for which use is made of 'internal' cues, such as in this case 'luminance', little is known as yet (Theeuwes, 1989; Hagenzieker, 1990).

In order to illustrate this problem area, we will look at two questions in further detail (formulated by Hagenzieker in 1989 an unpublished note).
1. The first question is of a fundamental nature and reads as follows: is artificially enhanced contrast indeed such an important factor in observation-controlled behaviour, specifically with regard to 'recognition'? Based on this formulation, one of the working hypotheses can state: One characteristic of the object itself (in this case an enhanced contrast) is a better cue for selection and better information processing (identification) than other cues.
2. The second question is of an applied nature and states: if artificially enhanced contrast is indeed an important factor, what does this factor contribute to (safe) behaviour in traffic?

3. Fundamentally oriented research

In order to assess whether contrast is indeed the crucial variable with recognition, a laboratory study should suffice.
Laboratory experiments should be able to answer the general question of whether light intensity in general, and a high degree of contrast in particular, have a positive effect on 'recognition', both in static and dynamic situations.

Assuming a static situation, it must be determined whether:
- the factor of contrast contributes to the conversion of information in behavioural parameters;
- if so, whether a more enhanced contrast causes relevant information to be converted more rapidly and more effectively to behaviour for a particular task (i.e. in this case, 'recognition').

For the set-up of a test, it is possible to expand on previous study (Hagenzieker et al., 1990), where the variable of 'light intensity' plays an important role. This study demonstrated that the factor of 'light intensity' indeed is of importance for the task described in the above. However, at different levels of processing, other factors are involved: with the correct localisation of elements, other effects of the light intensity factor are found than with the correct identification of these elements. During the cited study, the contrast was deliberately kept the same at all times. An adaptation of the conditions is therefore required, because - as previously explained - the contrast factor is probably the most relevant.

In other words, in a fundamentally oriented study, it can be carefully established to what extent the contrast factor contributes to the successful execution of a 'recognition task'. It was already noted that light colours enhance contrast (Roszbach, 1972). Therefore, this variable will also be included in the study of contrast.
It is again pointed out in this context that the recognition task is only one of the mechanisms of effect that will have to be investigated.

4. Applied experimental research

The step from fundamental research to observation of behaviour in practice is often too great. The laboratory results cannot be directly translated into practice, although they supply the necessary hypotheses for commencing a well-based study into other cognitive aspects.

Therefore, the next step - continuing on from experiments with regard to contrast - is to carry out experiments with stimuli consisting of more complex figures (such as traffic signs, cars etc.). The available computer equipment allows such experiments with complex figures.

Using video recordings, the following principal experiments can also be carried out:
- selective attention (testing hypotheses from laboratory situations);
- identification (testing hypotheses from laboratory situations);
- distance estimation (new activity);
- speed estimation (new activity);
- direction anticipation (new activity);
- risk estimation (new activity);

A disadvantage is the problem of translating the result to the actual situation. The advantage is that simulated traffic situations are already being used. This makes it possible to translate to the actual situation, allowing hypotheses to be formulated for field work. The field work will be directed at behavioural aspects and, with regard to points of attention (depending of the feasibility of the laboratory experiment within the time available), will be set up entirely to test the hypotheses. See also the various project areas of Project D.

5. Behavioural observations

In order to examine what the factor of contrast contributes to (safety) behaviour in traffic, it will ultimately be necessary to look more closely at behaviour in traffic itself; the results found must be compared to the actual situation. For example, the range of luminance intensities that can actually be observed (outside the laboratory) cannot be realised in a laboratory set-up; this is one of the reasons why the results must be tested in practice. This type of assessment is carried out with the aid of observations in the field.

Put in a general sense: behavioural observations are examined in practice with respect to whether and how the effects found in the laboratory for behaviour in laboratory tasks are reflected for behaviour in traffic, for example:

- What type of mistakes can be translated to the traffic situation or behaviour in traffic from the laboratory study (relationship with Projects C and D)?
- Based on the results of fundamental research, which types of accidents could be reduced as a result of DRL, and which could not? (relationship with Project A).

6. DRL and the optimum illumination

There are two objections voiced against DRL that relate to the increase in fuel consumption and 'blinding'.
Fuel consumption can probably be reduced with the aid of technical appliances, but also by examining at what light intensity the increased contrast still has the desired effect in terms of a reduction in the number of accidents (relationship with Projects A, E and F).
Blinding (disability glare), in the physiological sense of the word, does not occur under daylight conditions (Hagenzieker, 1990). Therefore, the objection against blinding is here regarded as a form of discomfort or irritation (discomfort glare). For example, if the light intensity of dipped headlights could be reduced so that this will, on the one hand, benefit the comfort of observation during the daytime, and on the other, contribute to a reduction in fuel consumption (Polak, 1986).

A study designed to find an 'optimum' level of DRL can be derived from the fundamental and experimental study into 'contrast', as described here in the example.

2.7. Project G: Cost/benefit and cost-effectiveness analysis

2.7.1. Project G.a: Evaluation ex post of the Benelux test with DRL

1. General

In the last phase of the evaluation into the effect of DRL, it will be possible to compare the invested costs of the test with the effects achieved.
For this calculation, all costs and effects should be described in as much detail as possible. These consist of:
Costs
- Individual costs:
- extra lamp hours;
- extra fuel consumption;
- extra batteries, alternator or similar wear and tear.
- Government investments
- extra police efforts;
- study costs (insofar made to realise the test);
- costs of information campaigns;
- costs of the development of technical aids, and the like.

Effects
- A decrease or increase in the number of accidents, categorised according to the various items.
- Possible (positive or negative) side effects.

This analysis will include two calculation methods:

2. Cost-effectiveness analysis

This calculates the costs associated with the DRL test (= economic cost calculation), expressed as the difference in the number of accident and any side effects resulting from the Benelux test. If possible, the result of this analysis will be compared with the cost-effectiveness data of, for example, costs for the improvement of the infrastructure and the effect this would have on road safety.

3. Cost/benefit analysis

This analysis associates the benefits (= the difference in the number of accidents saved and any side effects) with the DRL test in financial terms. It is clear that this analysis encounters ethical problems, such as the following:

- what does an injured person cost the community?
- what is the saving of human life worth to society?

Problems are also anticipated in expressing these side effects in monetary terms.

- For example, how can a likely restriction in mobility be expressed in financial terms?

If there is no acceptable alternative to express benefits in terms of a measurable unit, this form of analysis can still be globally applied; i.e. benefits are expressed in monetary units. Here, too, it is true to say that if data is available on the cost/benefit relationships of other road safety measures, these would offer a means of comparison.

2.7.2. Project G.b: Evaluation ex ante for the benefit of other countries

In an international context, and for the benefit of the European harmonisation concept, it is particularly important to determine whether equipment requirements can be laid down for motor vehicles, on the basis of this study.

Therefore, with the aid of data from this study, supplemented with other material, an estimation will be made of the costs and effects that can be anticipated from a DRL measure in a number of the countries involved.

2.8. Project H: International cooperation

A Benelux Committee for DRL has been set up (BC-DRL). This Committee will include participation by the following working groups (in alphabetical order):

- Benelux Working Group for Research (BWR-DRL)
- Benelux Working Group for Technology (BWT-DRL).
- Benelux Working Group for Information (BWI-DRL).

The secretary of the Sub-Committee for Road Safety of the Transport Committee of the EC will act as Benelux coordinator. The evaluation study of the Benelux test is based on the following aims:

- To conduct scientifically sound research into the effect of DRL on road safety, both from a methodological and analytical viewpoint.
- To provide material based on which the scope of an effect can be calculated for other countries.
- To offer recommendations for adapting vehicle requirements as part of the European harmonisation principle.

This master plan is only concerned with the activities of the BWR-DRL, and where necessary towards the relationship with other working groups.

2.8.1. Project H.a: Benelux Working Group for Research (BWR-DRL)

1. General problem definition

Prior to a predetermined date, the analysis results of a limited before and after study must be submitted in order to allow decision-making with respect to the subsequent procedure to be followed (Lindeijer, 1991). Therefore, each project, insofar this can be reviewed, describes the activities that must be carried out prior to and during the test period. From an organisational standpoint, this chapter offers an instrument to arrive at good working agreements, which are necessary to supply the required information within the set times.

2. Accident analysis (Project A)

The accident analysis can best be carried out by one of the countries on a central basis. For a limited analysis, the tapes with accident data from 1987 to May, 1993, and prior to August 1, 1993, should be forwarded for the purposes of central processing (both the accident tapes and the DRL user data, up to and including May, 1993). If this requirement is met, the first (interim) result can be reported to the IC-DRL and the decision-makers prior to September 1, 1993. This time planning takes into account the possibilities offered by the Netherlands.

It is anticipated that, during the test, other road safety campaigns could take place and other measures could be introduced. Such a development disrupts the opportunity of studying the effect of DRL. This can be compensated for to a large degree by including control countries in the study. It must be investigated which of the countries named below have shown a comparable road safety development to countries in the Benelux. The countries which are thought suitable are (in alphabetical order):

- Denmark (long-term study)
- Finland
- France
- Germany
- Norway
- Sweden
- United Kingdom.

If these countries wish to cooperate, it must be investigated whether the entire country is suitable or only parts of the country. The deciding criteria in that regard include:

- geographic correlations (e.g. flat country, hilly country, etc.);
- traffic composition and developments.

A close comparison will be necessary, therefore it is recommended that representatives from the control countries be invited to sit on the BWR-DRL.

Project A.a.: Limited and extensive before and after studies, time series analyses, analyses for specific effects, analyses into risk.
The data required in this context include:

- Injury accidents on tape subsequent to 1987, but preferably from 1980 onward. The tape must also be supplied with:
  - a clear description of how the data is stored technically;
  - a code book giving the translation of the codes used;
  - a list giving the positions corresponding with the different variables.
  - definition of what is understood under 'injured' and under 'fatal outcome'.
- Accidents with material damage only. The same applies as for the tape with injury accidents.

For the limited analysis, the DRL user data are also required. These should be supplied prior to August 1993 on tape, or prior to July 1, 1993 as raw data.

Project A.b.: Probability of an accident for non-DRL users.
For the Netherlands, it is investigated to what extent police registration of DRL with accidents is reliable and useful. This study will involve a number of police forces. Belgium and Luxembourg (possibly control countries) must investigate whether this data can be collected. If possible, the usefulness and reliability of this data must also be established. The basic material must be supplied on tape to the analysis centre, under the same conditions as stipulated for Project A.a.

Project A.c.: Involvement of light and/or dark coloured cars with accidents.
With the discussion of this field of study, it was already indicated that this study could be held in the Netherlands, provided a number of condi-

tions are met. Belgium and Luxembourg have as yet to indicate whether this study is also feasible in their country. If so, the supply of data must meet the same conditions as already described. For this report, too, an assessment on the feasibility and/or added value will be submitted to the International Committee.

3. Project B: Measurement programme and collection of user data on DRL

The Netherlands has been carrying out monthly measurements into the use of DRL on a monthly basis for almost two years. Belgium and Luxembourg must still commence their measurement programme. If the information campaign starts on August 1, 1992, the measurement programme in both countries must start on August 1, 1991 in both countries at the outside, in order to ensure that the before measurements have not already risen, as was the case in Denmark.
High requirements must be set for the reliability and distribution of the user data to be collected, because this will determine the likelihood of a valid accident analysis!

It is proposed to process the raw data (tally records) at a central location and store it on tape. The Netherlands has already carried out an analysis for a year and has gained experience with processing and analysis. It would therefore be most obvious that the Netherlands also process and analyse the data from Belgium and Luxembourg. If this is agreed, the counting forms must be submitted centrally on a monthly basis.
With regard to the analysis, there is a clear relationship with Projects A and C.
A monthly report will be issued to the Information Working Group and the police on the analysis results.

4. Project C: Information campaign

Before the information campaign can commence, the following data must be known:
- To what extent is the public prepared to cooperate?
- Are people prepared to invest in technical aids?
- To what extent are police prepared to act in an 'educational' context?

This project must ensure that information, and police compaigns and the analysis of user data are well coordinated. The following activities may be distinguished:

- Taking in-depth interviews and analysing these. Prior to January 1, 1992 at the latest.
- Prior to February 1, 1992, the questionnaire must be drawn up. The expectation is that the questionnaire may differ from country to country. Therefore, coordination of the contents must be carried out prior to March 1, 1992.
- Prior to June 1, 1992, the <u>first</u> opinion poll will be held and analysed.
- Prior to July 1, 1992, the analysis results must have been reported to the Information Working Group.
- On August 1, 1992, the information campaigns should commence.
- The <u>second</u> poll survey be held in November 1992 and analysed. The results must be compared with the analysis results for the DRL user data over the months of August 1992 to October 1992, inclusive.
- Reporting of the second opinion poll and analyses prior to January, 1993, to the Information Working Group and the police.
- Prior to July 1, the <u>third</u> opinion poll with be held.
- Here, too, the same procedure will be used as for the second poll.
- Reporting prior to September 1, 1993, to the IC-DRL.

Again, it is noted here that every country bears its own responsibility for taking in-depth interviews, drawing up the questionnaire, carrying out a national opinion poll and analysing the results. However, the results must be passed on in time to those carrying out the analysis of DRL user data.

5. <u>Changes in behaviour as a consequence of DRL (Project D)</u>

For <u>Projects D.a and D.b</u> (Crossing behaviour of pedestrians and cyclists), the Netherlands is a suitable country in which to conduct the study.

For <u>Project D.c</u> (Searching behaviour of drivers with respect to slow traffic and motor cycles) it is recommended that the study be carried out in all three countries, as it is anticipated that there will be differences in driving attitudes, etc. between the countries.

Project D.e, for reasons as are already assumed with Project D.c, will have to be carried out in all three countries.

- The before speed measurements must take place at times that use is at its lowest. This implies that these measurements must be carried out in the summer or autumn months of 1991. If that is not possible, the measurements can still be carried out in the spring of 1992.
- The first after measurements must be presented one year after commencement, during the same hours, day and month as in the before period.
- The last measurement is carried out two years subsequent to commencement, under the same conditions.

6. Environmental, technical and cost aspects as a consequence of DRL (Project E)

The development of technical aids would sooner seem to be a task of the Benelux Working Group for Technology. The Netherlands could perform a calculation to arrive at a more realistic estimated percentage for an increase in fuel consumption, based on the current use of DRL. The results of this calculation will be reported to the Benelux Working Groups for Technology and Information prior to July 1, 1992.

It is likely that industry would be prepared to offer its services in the field of possible applications to reduce voltage, but that also is an activity that is the responsibility of the Working Group for Technology.

7. Explanation of the effect of DRL (Project F)

There are sill many gaps noted in the explanation for the effect of DRL and how it works. Nevertheless, reasonable progress has already been made in some areas by the Dutch TNO Institute for Perception (IZF-TNO) and the Traffic Research Centre (VSC) of Groningen State University. Particularly in the field of fundamental research into the mechanisms of effect with the information system of man in relation to traffic tasks, the IZF has been active for several years. At the time of writing this master plan, it was not yet known to what degree this type of study is also being carried out in Belgium and/or Luxembourg.

From an organisational perspective, it is recommended that the institutes working on this project be invited as members of the BWR-DRL. Theoretical support is required with the interpretation of the results for Projects A (Accident study), D (Behavioural adaptations) and E (Lighting aspect).

8. Cost-benefit study (Project G)

The activities that must be carried out here only play a role at the end of the study. For the sake of comprehensiveness and organisation, this is described in brief.
For each country, both the data on costs and benefits as well as on (positive/negative) effects must be collected. Each country will have to carry out its own cost-benefit analysis and effectiveness analysis. If that is not possible, all data will have to be forwarded to a central location, where the overall analysis for the Benelux will be carried out.

2.8.2. Project H.b: International Committee for DRL (IC-DRL)

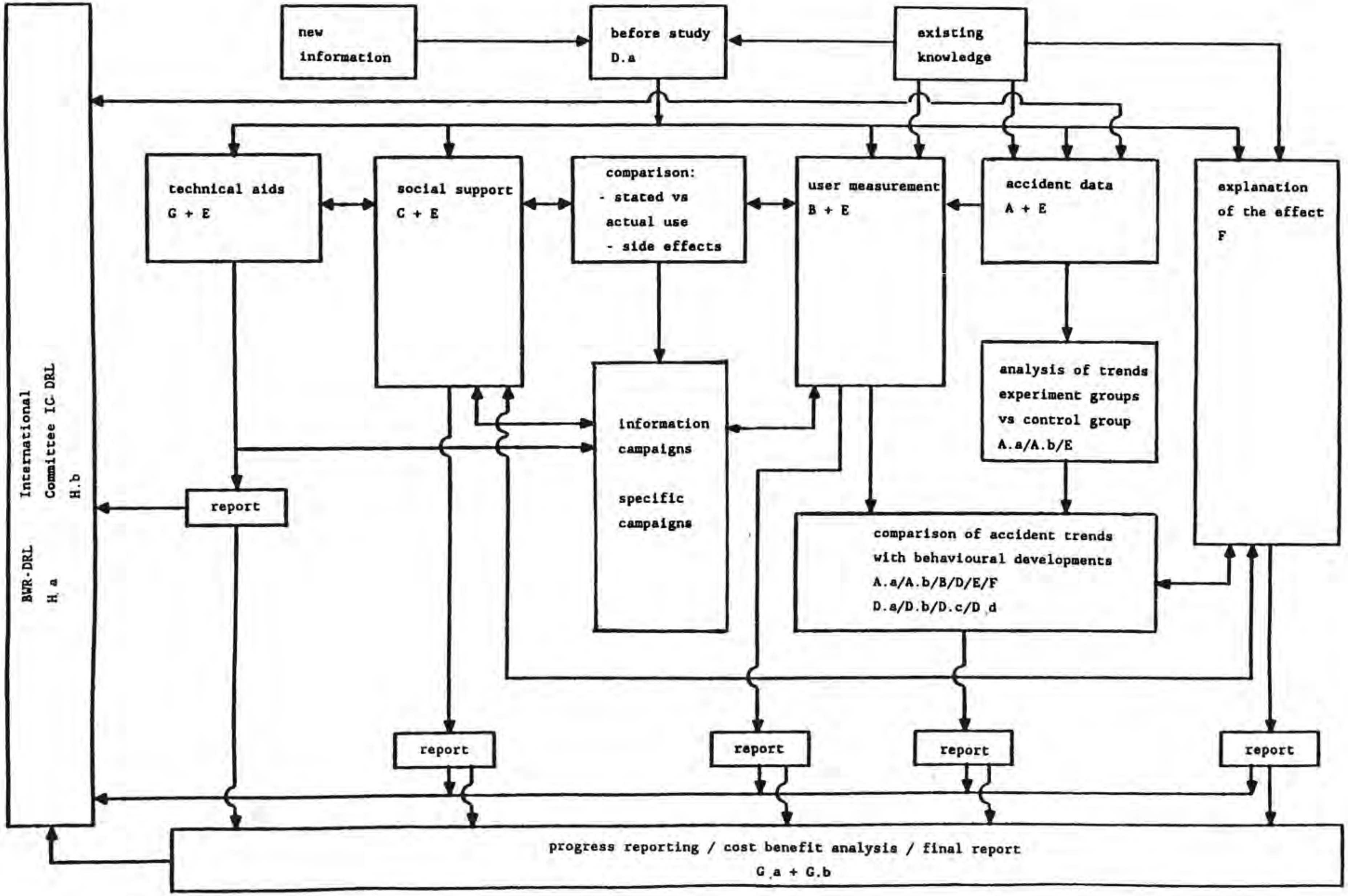
The IC-DRL was officially founded on October 10, 1990, and consists primarily of research experts from various European countries. One representative from the European Cyclists' Federation acts as observer in this Committee. The United States, Canada and Australia are corresponding members. In April, 1991, the IC-DRL compiled a report in which recommendations are given for study, if a new experiment with DRL is under preparation. These recommendations are issued to ensure that a new experiment replies to the problems that must be solved before the IC-DRL is ready to report the results to the EC.
This relates to the following matters:
- The evaluation study must be able to meet scientific criticisms on methodology and analysis.
- Based on the study result, the scope of an effect of DRL in other European countries must be estimated. This is only possible if there is a sufficiently well-founded theoretical basis for the effect of DRL.
- The study must offer information on long-term effects.
- The study must offer sufficient insight into the socio-psychological and socio-cultural resistances to DRL.
- The study must be aimed at intended and non-intended effects of compulsory use of DRL and explanations for these.
- The position of moped riders, pedestrians, motor cyclists and non-DRL users must be studied in detail.
- An analysis must be carried out of the costs and benefits of DRL; energy consumption, technical developments, optimum for the required light intensity, development in feelings of safety and the like.

Given the requirements described in the above, the tasks of the IC-DRL are as follows:
- To assess the master plan for an evaluation study into the effect of DRL in the Benelux.
- To safeguard the scientific quality of the study to be carried out.
- To supervise and help find alternatives if problems present themselves in the field of research.

In order to carry out these tasks properly, the IC members will be kept regularly informed about the state of affairs. The IC-DRL will meet at

least once a year. In these meetings, the (interim) report will be assessed, and the progress of the study will be reported. Reporting will be in the English language.
The secretariat of the IC-DRL will be carried out by the SWOV from 1990 onward.

3. SCHEMATIC OVERVIEW OF THE RELATIONSHIP BETWEEN THE PROJECTS



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