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# SWOV Fact sheet

## Daytime running lights (DRL)

### Summary

Europe has decided that as from 7 February 2011 new types of passenger cars and delivery vans shall only be approved when fitted with lights that automatically switch on when the car is started. As from 7 August 2012 this also applies to new types of lorries and buses in order to receive a registration number. Using daytime running lights (DRL) increases the visibility and recognizability of road users and thus reduces the risk of a crash. Research has shown that road users who do not use headlights during the daytime, pedestrians and cyclists, can also benefit from DRL. If nearly every driver had their headlights on during the daytime, close to 30 road deaths and 500 serious road injuries per year could be saved in the Netherlands.

DRL's negative consequences, which are a higher fuel consumption and - consequently - larger CO<sub>2</sub> emissions, are limited considerably by using energy-efficient lamps.

### Background and content

By using lights at the front of the vehicle, approaching motor vehicles become more conspicuous in traffic during the daytime. This results in fewer road casualties. Using lights at the back of the vehicle during the daytime does not have any added value and causes a higher fuel consumption than needed. In daylight conditions either dipped headlights can be used or daytime running lamps especially designed for this purpose. The latter are more conspicuous than dipped headlights, which are intended for use in the dark and are directed downwards in order to illuminate the road while avoiding other road users to be blinded. In addition, dedicated DRL does not activate the rear lights and number plate lighting. The technical requirements of daytime running lamps are included in ECE regulation 87 and the installation requirements in ECE regulation 48.

DRL have already been mandatory in a number of European countries for quite some time. As yet, this has not been the case in the Netherlands. However, many drivers are seen to voluntarily switch their headlights on during daylight hours, especially on rural roads and when visibility is poor. The last time that the use of DRL was measured in the Netherlands was in 1993; 30% of the drivers then used DRL (Lindeijer & Bijleveld, 1994).

The European Commission (EC) aims at harmonization of the DRL regulations and determining the necessary vehicle requirements. In doing so it is important to emphasize the positive effects (saving road casualties) and to limit the negative effects (especially the higher fuel consumption) as much as possible. Another point of interest for the EC is whether the road users who do not use lights (cyclists and pedestrians) will still be noticed in time, and whether the visibility of motorcyclists (who already use DRL) is not negatively affected when cars also use DRL. The EC has decided that as from 7 February 2011 new types of passenger cars and delivery vans must be equipped with special headlamps which automatically switch on when the car is started, and switch off when the dipped headlights (in combination with the rear lights) are switched on. As from 7 August 2012 the same goes for new types of lorries and buses. In 2003, the EC commissioned a study on the effects of DRL and the implementation strategies, in preparation of European legislation. Research institutes in the Netherlands (Netherlands Organization for Applied Scientific Research TNO and SWOV) and in Norway (Institute of Transport Economics TØI) carried out this study. This fact sheet not only presents the results of this study, but also those of studies carried out in the 1990s. The safety effects of DRL, the visibility of other road users, the expected decrease in road crash casualties in the Netherlands, possible disadvantages of DRL and the current state of affairs in Europe will be discussed in this order.

### What is the effect of DRL?

In-depth crash studies have shown that not having seen the other road user or having seen the other road user too late plays a role in 50% of the daytime crashes, and for intersection crashes this is even 80%. Theoretical insight and observations mainly attribute the DRL effect to the greater contrast

between vehicles and their surroundings; DRL increases the visibility of vehicles and makes them better identifiable (recognizable as an oncoming motor vehicle). An additional effect is that vehicles with DRL are estimated to be closer than they really are. This reduces risk taking by drivers of oncoming vehicles preparing to overtake another vehicle and by road users crossing the street or entering an intersection.

DRL is a tool to assist road users in their visual observation task. DRL studies in the 1990s indicated reductions of 10-15% (Elvik, 1996) and 8-22% (Koonstra, 1993) in the numbers of daytime crashes in which two or more road users were involved.

The 2003 study commissioned by the EC involved a meta-analysis of 41 studies of the effect for cars and 16 studies of the effect for motorcycles (Elvik et al., 2003). This showed that for cars DRL reduces the number of daytime injury crashes by 3-12%. The effect on fatal crashes can be estimated as somewhat greater (-15%). For motorcycles DRL reduces the number of injury crashes by 5-10%. For these categories we should mention that the results found per individual study differ widely. The reduction refers to daytime crashes in which more than one road user was involved. A greater effect may be estimated for fatal crashes. Some of the studies found that the effect of DRL decreased after some time, but others found that it did not decline. No proof was found that the effect of DRL depends on the season. In agreement with the previous study of Koonstra et al. (1997), it was found that the effect depends on latitude, but the relation is now shown to be less strong (Elvik et al., 2003: section 5.5).

The fact that rear lights that are on during the daytime can obscure the brake lights is no longer a problem since the introduction of the third brake light, which has been mandatory for new cars in the Netherlands since 1994. Moreover, with modern automatic DRL the rear lights are not switched on.

#### **How visible are the other road users?**

It is sometimes suggested that vehicles that do not have their lights on during the daytime are visually 'pushed aside' by DRL vehicles, due to the masking effect. The EC has had this investigated as well. TNO carried out a laboratory experiment (Brouwer et al., 2004) in which subjects were shown slides with pictures of traffic situations in daylight circumstances. The slides contained a car with or without DRL and another road user: a pedestrian, a cyclist or a motorcyclist with or without lights. The subjects were instructed to determine as quickly as possible whether there was another road user present.

The results showed that subjects were able to identify the traffic situation of cars with DRL more accurately and faster than that of cars without DRL. No indications were found of a lesser conspicuousness of vulnerable road users when near a car with DRL. On the contrary, results pointed in the opposite direction: road users without lighting in fact profited from DRL. It is also an advantage that vulnerable road users can see cars with DRL sooner than cars without DRL.

The meta-analysis of Elvik et al. (2003) concludes - be it with some reservation - that DRL probably reduces the number of car crashes involving cyclists and pedestrians. A study carried out by the Austrian Epigus Institut (Pfleger, 2007) concludes that, based on a study of road users' looking behaviour, DRL have no benefits in good weather, but are an advantage in bad weather. In rare cases DRL could be responsible for obscuring persons and vehicles, according to this study. Motorcyclists in the Netherlands, who nearly all have their headlights on during the daytime, sometimes express the fear that their conspicuousness will diminish if cars also have their lights on during the daytime. The TNO laboratory experiment (Brouwer et al., 2004) showed that the subjects saw both motorcycles with their lights off and motorcycles with their lights on earlier if cars also used DRL. However, motorcycles with their lights on were spotted faster. Wildervanck (1994) had already explained this phenomenon earlier. By having his headlight on a motorcyclist as it were detaches himself from the static surroundings and is therefore noticeable as a moving vehicle. And that situation does not change if the surrounding vehicles also have their lights on.

#### **How many casualties could be saved in the Netherlands through DRL?**

If nearly every driver had their headlights on during the daytime, close to 30 road deaths and 500 serious road injuries could be saved in the Netherlands on a yearly basis. This calculation is based on the casualty numbers of 2009 and compared to a current DRL use of 20% in urban areas and 50% in rural areas. The decrease in the number of casualties is based on the meta analysis of DRL studies by Elvik et al. (2003):

- fatal crashes: a reduction of 15%;
- serious injury crashes: a reduction of 10%.

In Europe, as from 7 February 2011 all new types of passenger cars must be equipped with automatic energy-efficient daytime running lamps. This means that the full benefits of DRL will not be visible until 2025, when nearly all cars will be equipped with it. In order to benefit from DRL before this time, drivers without this equipment have to switch on their dipped headlights manually during the daytime. Early 2008 the then minister of Transport announced to make DRL mandatory as a behavioural measure in answer to question of Parliament.<sup>1</sup> However, the minister abandoned this idea when the Dutch Bureau for Traffic Enforcement of the Public Prosecution Service (BVOM) indicated that it did not want to enforce this, because of the expected extra police workload.

### **Does DRL have any disadvantages?**

The use of DRL increases fuel consumption. Obviously, when the lights are switched on, a bigger load is placed on the dynamo. However, there is a large difference between using the customary dipped headlights and using low-energy LED lights, not switching on the parking lights, rear lights and registration plate lights. We will first take a look at the customary dipped headlights. Although the extra power consumption due to switching on the dipped headlights is nominally the same per car (2x55W), the relative differences are large. A fuel-efficient car using 6.7 litres per 100 km (1:15) with DRL using dipped headlights has an extra fuel consumption of 3%. A 10 litres per 100 km (1:10) car, for example, uses 2% more, and a lorry using 33 litres per 100 km uses 1% more (ETSC, 2003). At the same time, increased fuel consumption causes an increased emission of CO<sub>2</sub>, which is bad for the environment. The CO<sub>2</sub> emissions of car traffic would increase by 0.6-1.4% (Elvik et al., 2003). Saving fuel and reducing CO<sub>2</sub> emissions can be achieved for more than 50% by using special DRL lamps (21W per lamp) and for 90% by using LED (about 5W per lamp). Another disadvantage of using conventional dipped headlights for DRL is that headlamps burn out faster, because they are switched on longer. This problem is only small if LED lamps are used.

There is also the matter of to what extent glare occurs when DRL is used. Glare has been researched extensively (Koorstra et al., 1997; Hagenzieker, 1990). There are different degrees of glare, varying from nuisance to complete blinding. It has been established that DRL can cause glare (mainly in the form of nuisance) when the light intensity of the dipped light is too high and the surrounding lighting is at a relatively low level (for example at sunset). The too high intensity of dipped headlights is due to incorrect adjustment. In fact this is not a DRL problem; the glare is more serious at night. Nowadays, dipped headlights are quite well adjusted because of the MOT (Ministry of Transport test: an annual test of automobile safety, roadworthiness aspects and exhaust emissions required for most vehicles over three years old) and built-in systems that take care of automatic adjustment of headlights. Glare does not occur with lamps that have been specially developed for DRL purposes.

### **What is the current state of affairs in Europe?**

At present, 15 EU countries have mandatory DRL for cars. Bulgaria, Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Poland, Slovenia, Slovakia, the Czech Republic and Sweden have mandatory DRL throughout the year for all roads. In Hungary, Italy and Romania DRL is mandatory on rural roads throughout the year. A number of other countries recommend the use of DRL. In Austria mandatory DRL has been abolished as of 1 January 2008. However, Austria is in favour of mandatory low-energy DRL lighting. In all countries where DRL is mandatory for cars, it is also mandatory for motorcycles (on all roads). DLR is mandatory for motorcycles but not for cars in Belgium, Cyprus, Germany, France, Greece, Austria, Portugal and Spain. In nearly all countries in which DLR is mandatory for motorcycles, it is also mandatory for mopeds and light mopeds. European countries outside of the EU in which operating lights by day is mandatory for cars as well as for motorcycles, are Bosnia-Herzegovina, Iceland, Croatia (cars only in winter), Macedonia, Moldavia (cars only in winter) Montenegro, Norway, Russia, Serbia, and Switzerland.

In countries that have mandatory DRL, the driver must switch on the dipped headlights manually, so this is a behavioural measure. Then there is the vehicle requirement, which is an automatic DRL device in cars. Swedish car producers began to equip their cars with this device years ago already. This means that in Scandinavian countries where DRL has already been mandatory for a long time, there are many cars with automatic DRL devices.

<sup>1</sup> <https://zoek.officielebekendmakingen.nl/ah-tk-20072008-1108.pdf>

The incentive for the European implementation of DRL was a study done by the Netherlands (TNO and SWOV) and Norway (research institute TØI), commissioned by the European Commission (EC); (Commandeur et al., 2003). This research led to quite some discussion between the member states, after which the EC eventually decided, as mentioned earlier, to implement DRL as a vehicle requirement. This decision in fact comes down to a gradual introduction of DRL. Considering the differences of opinion within Europe it has been decided not to introduce the mandatory behavioural measure to switch on DRL manually. A supplementary vehicle requirement is already being drafted, namely that the dipped headlights and rear lights are automatically switched on based on light sensor techniques in situations with little surrounding light, for example at twilight or in tunnels.

## Conclusion

Use of DRL contributes to further road safety improvement. There is no scientific support for the often assumed negative effects for pedestrians, cyclists or motorcyclists. As from 2011, in Europe all new types of passenger cars must be equipped with dedicated daytime running lamps. This means that nearly all passenger cars will be equipped with DRL around 2025. If we would wish to benefit more from the road safety effects of DRL before that time, all drivers that do not have this device should manually switch on their dipped headlights during the daytime. In 2011, this would have saved nearly 30 road deaths and 500 serious road injuries in the Netherlands.

## Publications and sources (SWOV reports in Dutch have an English summary)

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Pfleger, E. (2007). [Untersuchung von blicktechnischen Interaktionen im realen Straßenverkehr in Ortsgebieten und Freiland.](#) Epigus, Institut für ganzheitliche Unfall- und Sicherheitsforschung, Wien.

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