

FOG LAMP REGULATION AS A SAFETY MEASURE TO REDUCE RISK IN FOG CONDITIONS

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1. INTRODUCTION

1.1. In the autumn of 1990, during the informal GRE-meeting in the Netherlands from 5 to 8 November, a very serious accident in fog took place at the motorway system in the Netherlands; 67 vehicles were involved, 10 occupants were killed and 25 injured.

Although these accidents are relatively rare, the consequences are so serious that at each occasion there is a strong need for measures to reduce the risk of accidents in fog conditions.

A similar disaster happened in 1984.

The Dutch Road Safety Council organized a special hearing in order to detect the causes and to collect possible safety measures. The findings are formulated in an advice of the Road Safety Council to the Minister of Transport and Public Works [1].

The SWOV Institute for Road Safety Research took part in that hearing and reported also about the safety problems during fog [2]. Several measures were suggested, one regarding the use of fog lamps.

The last catastrophe has intensified the need for the implementation of this measure and its regulation. Therefore, the Department of Road Transport RDW of the Ministry asked SWOV for advice. This short notation summarizes the aspects that are relevant for a decision concerning the regulation with regard to fog lamps.

1.2. For most road users fog is a surprising event. Sometimes it is completely unexpected and happens at certain parts of the road, sometimes one is relatively unprepared when confronted with fog at the departure of a trip.

The average yearly number of days with fog in the Netherlands is 76. In 25% of these cases the meteorological sight is less than 200 meters. However, the actual distance at which a car is detected is considerably smaller than 200 meters.

Fog occurs more frequently from September to March (51 days) and also more in the early morning hours.

There are two types of fog:

- Radiation fog is caused by a sudden decrease in temperature of the lower layers of air. It is local and can be very dense. It is difficult to predict and therefore the most surprising event for road users. It occurs relatively often in the morning hours at the end of the summer.
- Advection fog occurs when large quantities of damp air from sea are blown over the relatively cold land. It covers large areas, occurs mostly in the autumn, winter and spring, remains often for several days, but much of the time it is not extremely dense.

1.3. A relatively small number of all accidents with injuries occur in fog conditions. However, the proportion of the accidents with many cars and injuries involved that take place during fog is very high.

In the Netherlands the average number of fog accidents is less than 500 per year, about 1% of all reported injury accidents.

During the morning peak hours this percentage is 3%. For the rest of the day time it is less than 0.5%.

At roads with high speed limits these percentages are higher than at roads with lower speed limits.

The percentages increase from 0.5% at roads with a speed limit ≤ 50 km/hr, to 1.6%, 2.2% and 3.1% at roads with limits of 60-70 km/hr, 80-90 km/hr and 100 km/hr respectively.

For built-up areas this percentage is 0.7% and for rural areas 2.9%.

Although these percentages differ significantly, the range of variation is small. This is not the case for similar classifications with regard to the number of cars or the number of injuries involved. In these cases the percentage of fog accidents increases considerably.

A study carried out in the USA reports that 50% of the accidents at free-ways in California with more than 9 vehicles involved, took place during fog, while this was only 3% for the accidents with less than 5 vehicles involved [3].

For the total of all injury accidents in the Netherlands these percentages were 30% and 2% respectively.

Furthermore, the major part of the catastrophes on motorways in the Netherlands took place in fog conditions in the early morning hours. The combination of all these findings shows, that fog causes a serious safety problem with a high potential of disaster, especially at motorways during the peak hours.

1.4. The most important factors that explain the increase of risk at motorways during fog conditions are the following:

- In normal conditions, the sight distance is large. During fog this sight distance becomes suddenly very short. With unrestrained sight, the changes in speed are gradually, e.g. when congestion occurs.

Speeds and changes in speed of cars ahead are easily perceived and well predicted. Therefore, relatively high speeds are not problematic. Car following times of 0.5 sec. or less, although obviously dangerous, are frequently measured.

During fog cars appear ahead suddenly with low speeds, while there are no visual signs nor signals from the traffic stream about such events.

- In normal conditions drivers have learned to cope with short following times on the basis of information from several cars ahead. This results in driving routines that are relatively safe under these conditions, because there are almost no abrupt speed changes and the preview is sufficient.

During fog, the situation is completely different. Particularly in case of local fog, sudden changes in speed patterns occur, while there is almost no preview. But also in constant fog conditions drivers do not know what speeds he should expect from cars in front or from behind.

- In fog conditions the driving routine built up day by day is not adequate anymore. There are no strong signals about this inadequacy. Fog covers the danger and does not make it evident.

Drivers do adapt in order to cope with this new situation, but have little experience with the necessary adaptation of their behaviour.

There are no unambiguous rules that advise the driver how to detect the sight distance and with what particular speed he should drive. They suddenly change from experienced into unexperienced drivers. They cannot depend on the behaviour of the other road users anymore either.

Some will immediately switch their fog lamp on and/or brake sharply, others will keep their speed. Even direct signals from the police do not change their behaviour adequately.

Drivers who behave responsibly in normal conditions seem to be suddenly suicidal. Only strong, clear and unambiguous signals may have an effect on their behaviour under these circumstances.

2. SAFETY MEASURES

In general, the safety measures to be taken are all aimed at a desired change in behaviour of the road users. These changes can be broadly categorized in:

- Measures that inform the driver about the situation and advise him to change his behaviour. Facilities concerning the vehicle, such as radio information or information from beacons along the road, given to the driver about the fog condition ahead, belong to this category and can be implemented on short term.
- Measures that force the driver to change his behaviour or even limit the range of options. For cars this could imply measures such as variable speed limits, controlled by beacons along the road side, in combination with 'intelligent' accelerators that guarantee maximum driving speeds. Given the ambiguity of behaviour described in the introduction, we must realize that the effect of safety measures related to the first category is limited.

Only measures from the second category can guarantee a sufficient solution to the safety problem.

Controlled speed measures on motorways may not seem applicable at the moment, but if the planning of such measures starts now, implementation in the near future is possible. Such systems can start as simple, static devices and be developed gradually into more complicated, situation or traffic dependent systems.

Completely automated systems for motorways will certainly not be operational in the near future.

Direct measures to be taken now, such as fog lamp regulation, will belong to the first category and be meant to inform drivers in the first place.

We will not discuss here all possible measures to reduce risk during fog, but restrict ourselves to the particular measure of fog lamps.

3. FOG LAMPS AS A SAFETY MEASURE

3.1. Fog lamps belong to the first category of measures. They inform drivers of following cars about the position and speed of the car ahead. This information will help the driver who follows to adjust his behaviour.

Fog lamps are allowed in the Netherlands, but they are not obligatory. There also are no strict rules for the number of fog lamps. Some cars use one lamp some cars two, some none at all.

Sometimes the fog lamp is installed low, sometimes as part of the configuration of lights at the rear and placed at one or two sides. In these cases the fog lamps are easily confused with the braking lights.

The moment that the driver decides to switch them on is variable, as is the light intensity which is sometimes irritating.

3.2. Given the need for strong and clear signals that will prevent confusion, regulations are necessary to reduce the negative aspects of this safety device. These regulations concern the necessity, number, location, colour and intensity of the fog lamps.

The following points are important for a decision on these aspects:

- In order to detect a vehicle in front, one red fog lamp of high intensity is sufficient.

- However, the advantage of two lamps is, that more information is given about the distance and the approach speed with regard to the car ahead than with one lamp. The human eye is highly receptive for changes in the angle of vision between the two lights. A disadvantage is the fact that two fog lamps are more easily confused with braking lights than one lamp is.

4. CONFIGURATION

4.1. In order to minimize the probability of confusion between fog lamps and braking lights, it is recommended in any case to locate the fog lamp or lamps at a significantly higher or lower level than the braking lights. In general one can say that, given the lighting configuration at the rear end of cars as used today, one fog lamp is better than none if adequately placed and two lamps are better than one also if adequately placed.

Practical arguments may limit the decision. If for practical reasons a less effective location should be selected, e.g. a location on the same level as the braking lights, then one lamp in the centre should be preferred over lamps at one or both sides. Two lamps is not to be recommended in this case.

If two lamps are used, these should be located at a fixed distance from each other as far as possible from the braking lights.

The optimal intensity of the lamp should be selected such that its detection is as good as possible in dense fog conditions without causing too much glare.

A lamp that is mounted low causes less glare than a lamp at a high position.

4.2. Less complicated solutions are possible if the total set of signalling functions at the rear end of cars is reconsidered. E.g. if braking lights were flashing (possibly with a frequency dependent on the amount of deceleration), the same high intensity lights could be used in a constant mode during fog.

Such a solution supports an increase in the level of attention for braking and in the detection distance for driving during fog. Decisions for such a change in configuration may look even more difficult to take, but will have a positive effect on all rear end collisions.

Flashing frequencies should then be selected that are comfortable in case of moderate braking.

If such an option is not applicable, one or two highly mounted additional lamps can be used in a constant mode during fog.

Eventually, the same lamp or lamps can be used in a flashing mode in case of severe braking. This option combines the concurrent needs for one or two highly mounted fog lamps and braking lights.

Finally, we will stress the point mentioned in the beginning, that the safety problem in fog conditions is a serious problem of adequate behaviour.

Regulations should not be restricted to the installation of fog lamps, but must be combined with rules for their use and the speed and following behaviour during their use. Such rules should also be part of the driver training. This, in order to get a uniform and adequate behaviour of road users.

It is questionable, whether or not the fog problem can be solved completely by giving information to the driver.

Furthermore, it is difficult to give suitable guidelines to drivers and to enforce such rules under sometimes rapidly changing conditions. Therefore, the improvement of the installation of lamps at the rear end of cars is just a moderate step towards a safer traffic system during fog. Only drastic measures, that guarantee gradually, uniform and satisfactory speed reductions will help us solve the problem more definitely.

REFERENCES

- [1] Raad voor de Verkeersveiligheid (Road Safety Council). Advies "Mist-ongeval" (Advice "Fog accident"). Den Haag, 1985.
- [2] Oppe, S. (1988). Verkeersonveiligheid bij mist (Traffic safety in fog). R-88-49, SWOV, Leidschendam. IRRD. 826485.
- [3] Theobald, J. (1969). Fog, drivers' reaction and accident in California. In: Proceedings 2nd Symposium on Visibility, Berkeley, California, 1969.