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Noise limits and noise levels along motorways in Europe

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ABSTRACT

Environmental noise caused by traffic is one of the main local environmental problems in Europe. The National Road Authorities, which are combined in the Conference of European Directors of Roads (CEDR), are aware of the environmental noise problems along their motorways. The CEDR noise group has done a comprehensive questionnaire on how the CEDR member states handle noise abatement. The paper focuses on the part of noise limits and noise levels along motorways in Europe. It also deals with noise indicators and noise calculation models in Europe.
On a European level, the comparison of noise levels and noise limits along motorways is complicated, due to the use of different noise indicators and noise calculation models. In the context of the European noise directive on noise mapping and action plans (2002/49/EC), more or less the same goes for the number of people living in dwellings that are exposed to certain noise levels. The best way to solve these problems is to use the same noise calculation model for road traffic noise throughout Europe: the outcome of the HARMONOISE/IMAGINE projects. On the level of individual CEDR member states however, there are pros and cons in using such a new calculation model.

1. INTRODUCTION

Environmental noise, caused by traffic, industrial and recreational activities is one of the main local environmental problems in Europe. It has been estimated that around 20 percent of the European population suffer from noise levels that scientists and health experts consider being unacceptable. Thanks to European legislation and technological progress significant reductions of noise from individual sources have been achieved. According to the Green Paper on future noise policy from the Commission of the European Communities[1], the noise from individual cars has been reduced by 85% since 1970 and the noise from lorries by 90%. However, despite thirty years of source reduction policy by means of a type approval, the emission of traffic noise has not decreased[2]. According to Hooghwerff[3] the decrease of noise emission due to the vehicle fleet using Dutch motorways during the period 1981 - 2000 is 1,9 dB(A). The growth of traffic has surpassed these rather small technological improvements regarding noise emission from traffic on motorways. No wonder that data covering the past thirty years do not show significant improvements in exposure to road traffic noise along motorways.

The National Road Authorities (NRA's), combined in the Conference of European Directors of Roads (CEDR), are aware of the environmental noise problem along their motorways. The CEDR strategic plan[4] shows the priority items the member states want CEDR to concentrate on in the coming years. Noise is one of those items. To get things going, all the member countries of CEDR have been invited to appoint a member to the new CEDR noise group. One of the

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main objectives of the CEDR noise group is to facilitate knowledge sharing on noise abatement issues among the European NRA's. In order to do so a comprehensive questionnaire survey has been performed on how the European NRA's handle noise issues. This paper focuses on the topic of noise limits and noise levels throughout Europe, based on the answers given by 21 of the 27 CEDR member states.

2. LEGISLATION, POLICY AND GUIDELINES

The CEDR member states have legislation, policy and guidelines setting immission limits for noise exposure in sensitive areas. The status can vary between legislation, policy and guidelines. From a legal point of view, there is quite a difference between these possibilities. Legislation means there is a law and people can go to court in order to ask the NRA to fulfil the limits. Guidelines are more or less an intention of the NRA to fulfil limits. The NRA will do its best to fulfil them, but in court the fulfilment of guidelines cannot be extorted. As for policy, the fulfilment is a responsibility to try that cannot be extorted in court also. Legislation however is a responsibility to achieve a certain result.

The survey done by the CEDR noise group shows that in most CEDR member states the noise limits have a legal status. In most Scandinavian countries the noise limits do not have a legal status, but the status of their guidelines is more or less the same as legislation.

A NRA not only has to deal with the building of new motorways, but also with the modification and maintenance of existing ones. The status of noise limits for (the modification of) existing motorways are more or less the same as for new motorways. But there may be conditions of circumstances where the NRA do not have fulfil the noise limits. Half the CEDR member states have conditions where they do not have to fulfil the noise limits along new and existing motorways. In most cases these conditions have to do with the cost-effectiveness of noise measures or, in case of an existing motorway, the increase of the noise levels due to the road project, especially in urban or alpine areas.

3. NOISE LIMITS

A. Noise indicators and day periods

There are several indicators used for defining noise limits and to calculate and measure noise levels. Most noise indicators use specific periods of a full day to calculate or measure noise. In the European Noise Directive (END) from June 2002 for instance the periods are:
- the day period (Lday): from 07:00 till 19:00;
- the evening period (Levening): from 19:00 till 23:00;
- the night period (Lnight): from 23:00 till 07:00.

All three periods, combined with an extra 5 dB for the evening period and an extra 10 dB for the night period, results in the formula for Lden in dB given by the END. Normally, the indicator LAeq does not take these 'dB-corrections' for the evening period or the night period into account.

The noise indicator most used in the CEDR member states is the LAeq, but several CEDR-countries use the noise indicator Lden according to the END (see figure 1). In some member states the change from LAeq to Lden is scheduled.

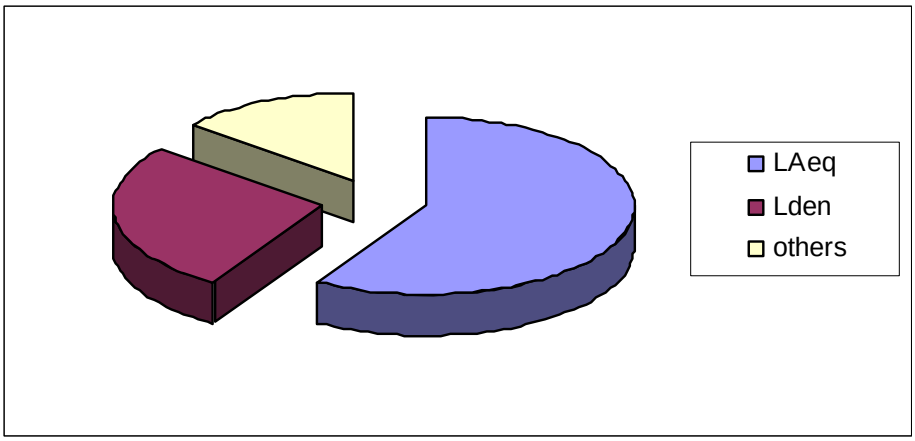

Figure 1: The noise indicators in CEDR member states.

One must be aware that there is a considerable difference in the specifications of the periods used to calculate or measure noise using the LAeq-indicator (see figure 2). In brief there are four possibilities. The simplest one is a LAeq based on the average of the 24 hours of a full day: the LAeq,24h. The most complicated one is a LAeq based on a full day divided into three periods: the day, evening and night period. To make things even more complicated, there are slight differences in the beginning and ending of the day, evening and night period. The third possibility only has two periods, one for the daytime and one for the nighttime. In the last possibility, some CEDR member states use a specific period of a full day, for instance the period between 08:00 and 20:00.

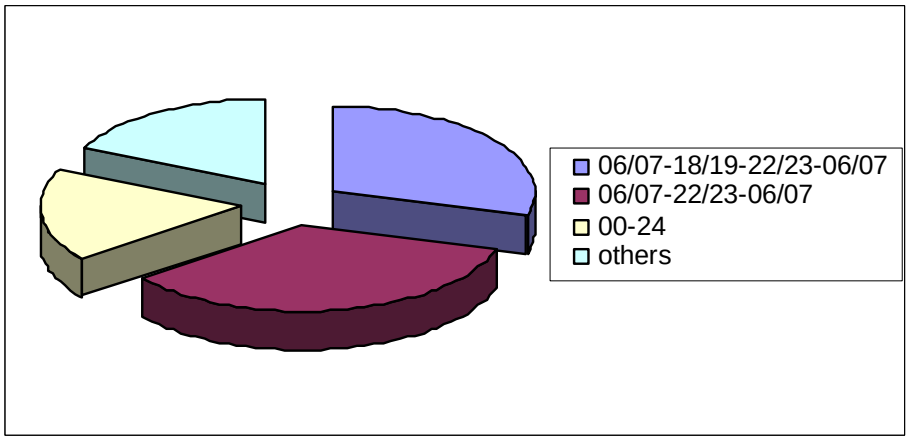

Figure 2: The day periods in the indicator LAeq in CEDR member states.

Due to the different definitions of the LAeq indicator throughout Europe, the same amount of noise can result in different LAeq noise levels. As a consequence, one can never be sure that noise with a level of for instance 55 dB(A) LAeq in one country will give the same result in dB(A) in another country. The use of different day periods in the definition of LAeq also complicates the relation between LAeq and Lden. In fact, there is no European standard for the relation between LAeq and Lden noise levels. In Denmark and France[5] for instance, they use the formula Lden = LAeq + 3. In the Netherlands however, they use the formula Lden = LAeq – 2. This means that 50 dB Lden is 52 dB(A) LAeq in one European country, but 47 dB(A) LAeq in other ones.

B. Noise models

To calculate noise levels prediction methods have been developed. In the CEDR member states different computer models are in use (see figure 3).

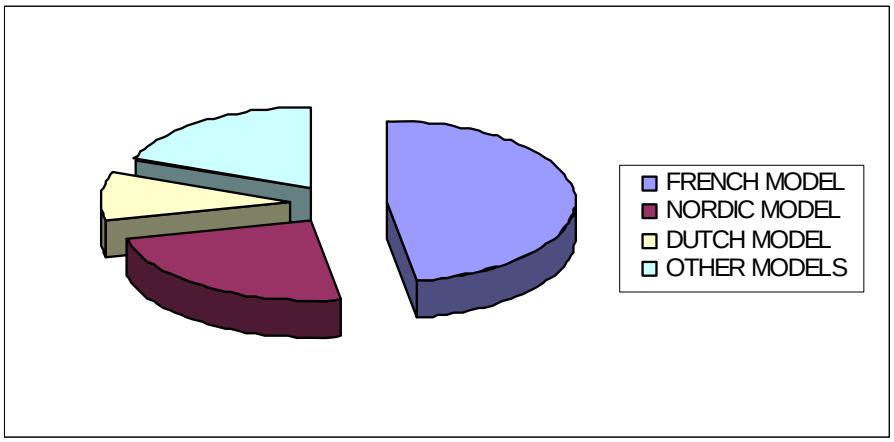

Figure 3: The noise calculation models in use in CEDR member states.

The French model (NMPB-Routes-96/XPS 31-133) is used in ten CEDR member states. Five member states use the Nordic model (Nord2000) and two use the Dutch model (SRMII).

C. Outdoor noise limits

To see whether or not there is a noise problem along a motorway, calculated or measured noise levels have to be compared with the noise limits from legislation, policy or guidelines. For noise sensitive buildings, mostly houses, these noise limits vary considerable (see figure 4). There is a wide variety in the application of outdoor noise limits. In most cases they are valid for all facades of the noise sensitive building with a (bed- or living) room behind the facade. Others countries apply their outdoor limits to all facades or the most exposed facade.

Almost all CEDR member states have LAeq outdoor noise limits for the day and night period. For new motorways the LAeq outdoor noise limit for the day period varies between 50 and 67 dB(A). The most common outdoor limit is 55 dB(A) LAeq in the period 06:00/07:00 - 18:00/22:00. For the modification of existing motorways, the LAeq outdoor noise limits for the day period are the same as for new motorways.

For existing motorways not all CEDR member states have legal LAeq outdoor noise limits. In case they have, outdoor noise limits for existing motorways are often the same as for the new motorways or the modification of existing motorways. In case they do not have legal outdoor noise limits, some countries have policy goals. Most CEDR member states also have LAeq outdoor noise limits for the night period. Often these night limits are 10 dB(A) lower than the limits for the day period. The noise limits for the night period varies between 45 and 55 dB(A) LAeq, the most common outdoor night limit is 45 dB(A) LAeq in the period 22:00 - 06:00. Some countries use Lden as the indicator for their noise limits. For new motorways outdoor noise limits based on Lden range from 48 to 60 dB. The most common Lden outdoor limit for new motorways is 55 dB.

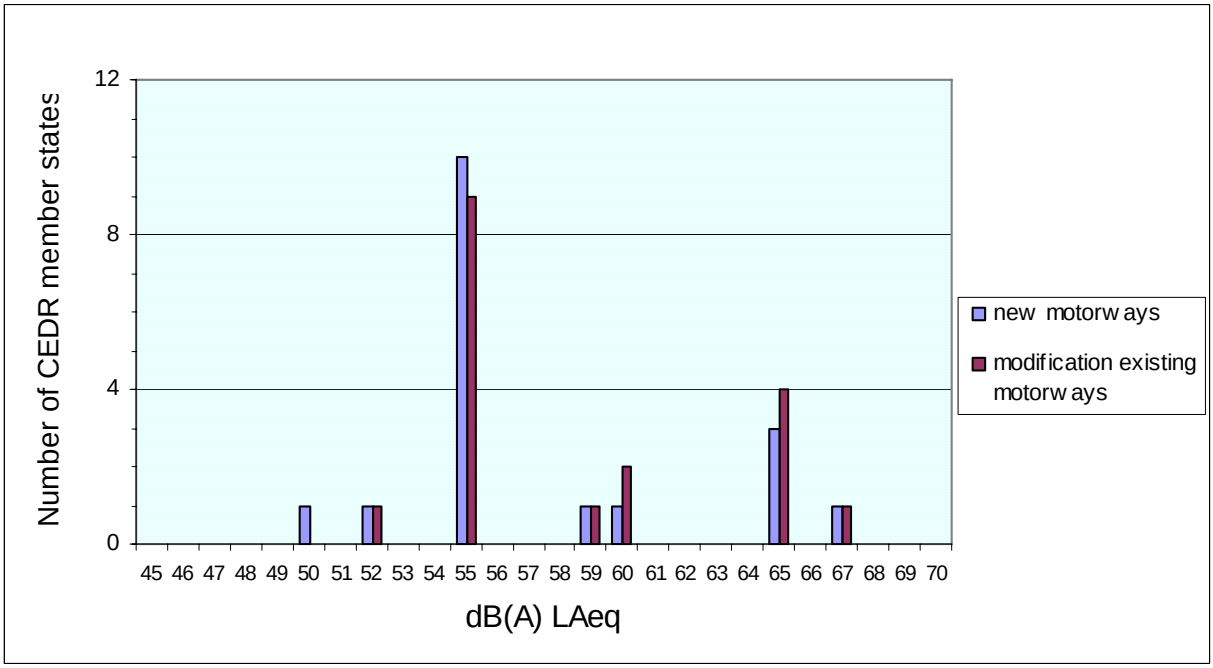

Figure 4: The outdoor limits in dB(A) LAeq in the day period for motorways in CEDR member states[6].

In several member states there are circumstances in which the standard noise limits are exchanged for other ones. In town centres for instance noise limits can be higher than the standard limits. In new housing areas noise limits can be lower.

D. Indoor noise limits

Besides their outdoor noise limits, half the CEDR member states also have indoor noise limits. In most cases they are valid for all rooms inside a house. In some countries the application of indoor limits is restricted to bedrooms.

The LAeq indoor limits for the day period vary between 27 and 45 dB(A) for new motorways[6]. The LAeq indoor limits for the night period are 5 to 10 dB(A) lower than for the day period. In case of modifying existing motorways, sometimes indoor noise limits are higher than for new motorways, but in most cases they are the same. The same applies to existing motorways.

In several countries there are circumstances in which the standard noise limits are exchanged for other, higher ones. In case of building new houses along motorways for instance indoor noise limits can be lower than the standard.

4. COMPARING NOISE LEVELS AND NOISE LIMITS ON A EUROPEAN LEVEL

According to Nijland & Dassen[7] and Vinçotte Environment[8] the national calculation models used in the European countries can show differences of up to 10 dB(A) in calculating the same situation. This is caused by unintended differences between the various calculation models. All these models have a noise emission and a noise transmission part. The main differences seem to occur in the noise emission part, for instance in the definition of the different traffic categories, the relation between speed and noise emission and the correction due to different pavements. The differences in the noise transmission part, like the meteorological conditions, the noise reduction by barriers and the number of reflections, are smaller. As long as different noise

models with different indicators are used in Europe, this means that comparing noise levels on a European level is complicated to say the least. And because a noise limit is a noise level with a legal status, the same goes for noise limits. As a consequence, the European comparison of figures based on using different noise models will be problematic. It is not surprising that European Commission representatives like Kephalopoulos et al[9] concluded that "at the moment, it is not possible having a comparable assessment at EU level of the exposure of population at harmful Lden and Lnight levels …". According to Kephalopoulos et al[9], comparability of information is essential for the future development of EC measures to reduce noise emitted by major sources, in particular road vehicles and infrastructure[10]. Large differences among the different methods used in Europe, would be a strong argument in favour of future harmonisation of the methods. The best way to solve the problem of results incomparable on a EU level, is to have a common European noise model and to use it in the EU member states[11].

In all probability, a common European noise calculation method might be established by the European Commission, based on the outcome of the HARMONOISE and IMAGINE projects. The HARMONOISE project has produced methods for the prediction of noise levels caused by road and railway traffic. The HARMONOISE project is closely linked to the IMAGINE project. The IMAGINE project focused on the implementation of the harmonized noise calculation methods in Europe. These methods were intended to become the harmonized methods for noise mapping in Europe. Although these projects were finished some years ago, according to Wetzel & Krapf[12], there is still some additional effort necessary to turn the existing model into an accepted, trusted and freely accessible common European calculation method. Also matters like documentation, intellectual property rights and the (presumed) complexity of the new EU model have to be solved.

Until a common European noise model is adopted, for END noise mapping the European member states may use the methods laid down in their own national legislation. But the member states must demonstrate that those methods give equivalent results to the results obtained with the recommended interim method (for road traffic noise: the French method NMPB-Routes-96/XPS 31-133). In the Netherlands for instance, Gerretsen[13] gives the results of the comparison between the French and Dutch model. Since the average difference in noise immission from traffic on motorways varies up to 8 dB(A), the results of Gerretsen[11] are in line with the figures given by Nijland & Dassen[7] and Vinçotte Environment[8].

But on the level of an individual CEDR NRA, there are pros and cons in using a new EU calculation model instead of their own national model. From an acoustical point of view, the EU model is the state of the art. Using it will give accurate output comparable at a EU level. But from the NRA point of view, there are disadvantages as well. It is not obvious the NRA's can handle the EU model. Some NRA's simply do not have all the necessary input data. Getting missing data or improving the accuracy of existing data will be costly. Furthermore, in case of motorway projects and noise measures, the NRA's use their own national noise model. The EU model has not been tested on a large scale in motorway projects to see if it meets the specific needs of the NRA's. The change from the national model to the EU model is another major disadvantage. It means a long-term, laborious and expensive process of adjusting the existing national noise legislation, noise policy and noise limits. Overlooking these pros and cons, one might conclude that for the NRA's the advantages of a new EU model do not outweigh the disadvantages. This raises the question of the objective, why should we do all this?

In the first round of END noise mapping, the NRA's used different national noise models The END maps show there are noise problems along motorways throughout Europe. In their action plans the NRA's described measures to do something about it. They also informed the public about their maps and plans. So the NRA's have fulfilled the first END objective of noise

mapping, informing the public and action planning. Now it is up to the European Community to fulfil the second END objective of developing Community measures. The NRA's provided the European Commission with the necessary END data. Although the NRA's used different assessment methods and mapping results are not comparable, still the END results provide a solid basis for the European Commission to develop Community measures to reduce noise emitted by the major sources. A new common noise assessment methods shall give better and comparable results, but will not enhanced the basis for developing Community measures. To update of the European Tyre Directive for instance, one does not need comparable END results.

5. CONCLUSION

In most CEDR member states, there is noise legislation. Others have noise policy or noise guidelines. Although the legal status of these documents may differ, they all use noise limits to control noise along European motorways. Two noise indicators - LAeq and Lden - are used to calculate and measure noise levels and to define noise limits. Due to different definitions of the indicator LAeq, the same amount of noise can give different LAeq noise levels in Europe. Also noise levels and noise limits expressed in LAeq differ from noise levels and noise limits expressed in Lden. In some European countries a Lden noise level is 3 dB(A) lower than the LAeq noise level, but in another one it is 2 dB(A) lower.

Almost all CEDR member states have LAeq outdoor noise limits. For new and existing motorways these limits vary between 50 and 67 dB(A). The most common outdoor limit is 55 dB(A) LAeq. Some member states use - or are going to use - Lden as noise indicator, for those member states the most common noise limit is 55 dB Lden. Half the CEDR member states also have indoor noise limits. The LAeq indoor limits for the day period vary between 35 and 45 dB(A), for the night period they are 5 to 10 dB(A) lower.

In the CEDR member states, there are at least seven different computer models in use to calculate noise levels. The French and Nordic model are the favourite ones. But using different noise models affects comparing noise levels throughout Europe. First, one must always keep in mind the different definitions of the LAeq indicator and the difference between the noise indicators LAeq and Lden. There can be differences of up to 10 dB(A) in the noise levels calculated by the different European noise models. Because they are formalized noise levels, these differences also go for noise limits. In practice, this means that at the moment comparing noise levels and noise limits on a European level is complicated to say the least. The best way to solve this problem is to have and to use the same European noise calculation method for road traffic. But on the level of individual NRA's, there are pros and cons in using such a new EU calculation model. For the NRA's the advantages do not outweigh the disadvantages. Although the NRA's used different noise methods for END, they have fulfilled the first END objective of noise mapping, informing the public and action planning. Now it is up to the European Community to fulfil the other END objective of developing Community measures. They do not need comparable END results to do so.

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5. F. Besnard, N. Fürst, “How can strategic noise mapping achieve the best cost/benefit ratio?”, in *Proceedings Euronoise 2003*, Naples, Italy, 2003, paper n° 187.

6. Outdoor and indoor noise limits in dB Lden are converted into dB(A) LAeq according to different equations, like Lden=LAeq+3 dB for the member states using the French and Nordic model, Lden=LAeq-2 for the member states using the Dutch model and Lden=LAeq+5 for the member states using the British model.

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8. Vinçotte Environment, “MOB/ArcNoise 2004: eindrapport”, *Report 60100194-001(MOB-ArcNoise2004)fin-r.doc*. Vinçotte Environment, Brussel, België, 2006.

9. S. Kephalopoulos, M. Paviotti & B. Gergely, “Differences among European noise mapping methods”, in *Proceedings Euronoise 2008*, Paris, France, 2008, paper n° 3190.

10. Developing Community measures is one of the two objectives of the END (see Article 1(2)), the other is noise mapping, informing the public and action plans (see Article 1(1)).

11. During the recent workshop on “Target quality and input values requirements” DG ENV and DG JRC presented the roadmap to a common noise assessment method in the EU.

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