inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 13

COMPARISON OF NOISE CALCULATION MODELS

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1. INTRODUCTION

In the summer of 1995 a form with 5 standard road traffic noise situations was send to about 20 national institutions in the noise pollution area. The first results of the round robin test on road-traffic noise calculation schemes showed remarkable differences, which could not easily be explained by the additional information that was supplied. This was the reason to look in more detail at the calculation-methods, and to extend the comparison to more noise sources. The purpose of these comparisons is eventually to pave the way for a European noise calculation model.

2. ROUND ROBIN TEST ON ROAD TRAFFIC CALCULATION

In the first comparison regular situations were chosen. Straight, asphalted roads, no reflections, no ramps, curves or obstacles. The results don't show a clear pattern. The spread is large, from 6 to 10 dB, with a certain tendency for larger differences for the motorway situation and for the night situation. From the information in the forms, is was possible to make corrections for meteorological conditions, facade reflections, ground absorption and vehicle composition. Except for the facade reflection (taken to be 3 dB), the other corrections are small. The results are reflected in figure 1; since the 'true' result is not available this figure shows the differences with respect to the mean of all the values.
These results don't lend themselves to easy interpretation, but the magnitude of the differences is worrying. Consequently it was decided to look in more detail to the calculation methods in order to pin down

the causes for the differences and to find points in common which could be used as a base for a harmonized method.

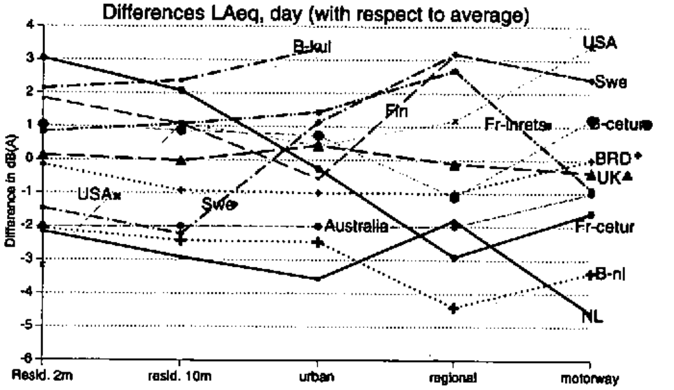

Figure 1 Round robin test for road traffic models; L_{Aeq}-daytime vs average results.

3. DETAILED COMPARISON OF CALCULATION METHODS

For a further comparison the most recent versions of the calculation methods for Road traffic, Rail Traffic, Industrial activities and Air traffic from ISO 9613-2, the Netherlands, Germany, France, Austria and the Scandinavian countries were studied in detail. In order to compare the methods, the source and propagation models were studied separately. The source models for road and rail traffic were recalculated to obtain the sound level per meter for flow traffic with 1 vehicle per hour in the free field (L'_w). For industrial noise only a comparison of propagation models could be made. Propagation differences were calculated with and without screening and either over hard or absorbing ground surface.

Source emission

Figure 2 shows the results for passenger cars.

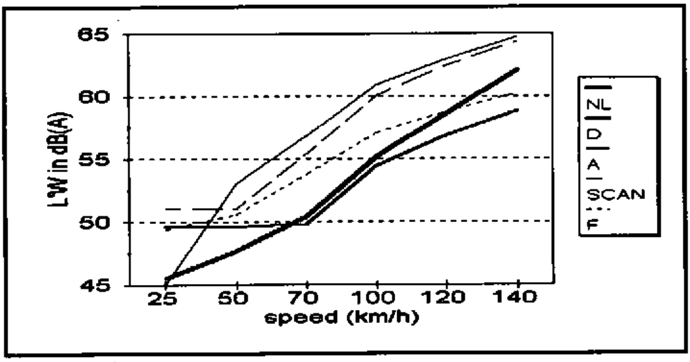

Figure 2 Comparison of emission by passenger cars.

Differences between highest and lowest are around 5 dB, which probably cannot be accounted for by differences in composition of vehicle park. The heavy trucks show a different picture: there seems to be a fundamental difference in velocity dependence for heavy trucks. Even when this is left out, differences are still considerable. The differences for passenger trains are even larger, but there one may expect larger "real" differences because of different types of trains and track constructions.

Summary of emission level In the various countries the emission level for all traffic sources is expressed in different, though more or less related, quantities. Quite often the emission quantity contains a part of the sound propagation. This makes a direct comparison not straight forward.

Sound propagation

Figure 3 compares the excess attenuation according to some of the models for road and rail traffic for the situation without screens. The excess attenuation is relative to the distance attenuation over a perfectly reflecting surface for a long line source (= 10lg(4d) . The differences between the models for absorbing ground are up to about 5 dB(A).

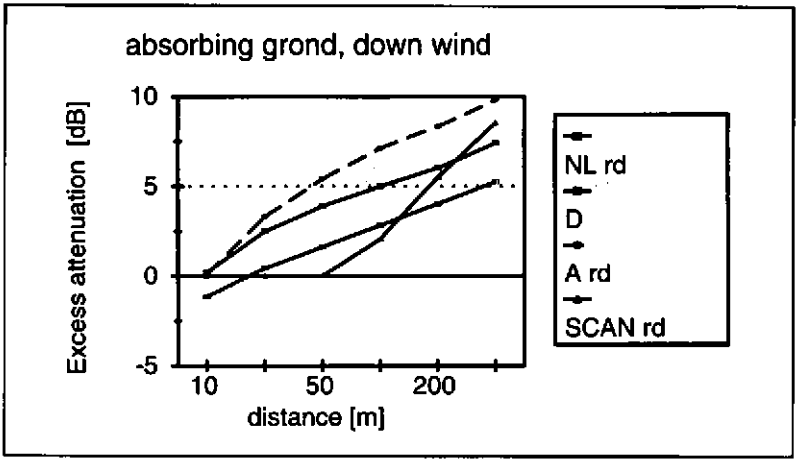

Figure 3 Excess attenuation over a perfectly hard surface for road traffic using formula for absorbing surface.

Figure 4 compares the attenuation due to a screen for road traffic according to some models. The Scandinavian and German models are dB(A) models for the considered source. For others the calculation is done in octaves and the result expressed in dB(A) according to a

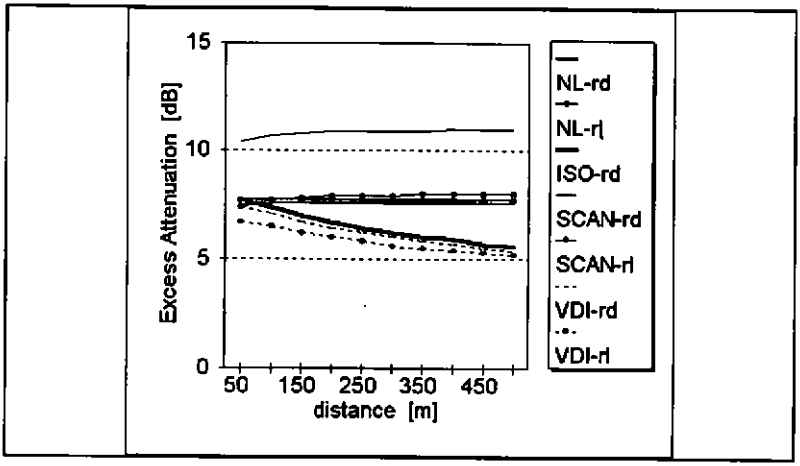

Figure 4 Excess attenuation due to a screen of 2 m at 10 m distance from the line source; receiver height 2 m.

typical road or rail traffic spectrum shape. The interaction between ground effect and screening is not taken into consideration.

The differences between the models for screening is up to about 5 dB(A). The differences between the attenuation models is only partly due to different assumptions about the meteorological conditions.

4. DISCUSSION

The large differences between calculation methods are partly due to differences in source emission and partly due to the propagation model. For road traffic the source differences for passenger cars are around 5 dB. The differences for heavy trucks are so large (reaching 10 dB), that this cannot be attributed to real differences. Differences for rail-traffic are equally large, but probably in that case there are also real differences in source emission. The differences in attenuation are also in the order of 5 dB, like the differences in screening effects. If all these effects would act in the same direction, total differences could add up to 10-15 dB, and the first graph (and other sources) indicate that this may well be the case.
It is a well known fact that the distinction between source and propagation model is not very sharp in most methods. This leaves the possibility that errors in one, the source description, are compensated by errors in the propagation model, so the end outcome is more or less according the "true" values. From the chaotic pattern in figure 1 it seems that on the whole that these attempts have not led to a consistent outcome.
Although this does not look very encouraging to start harmonizing models, things are perhaps better then they look at first sight:

- In almost all cases (Aircraft noise being a notable exception still) the rating method is essentially the same: $L_{Aeq,T}$;
- Differences in approach (downwind conditions or average) need not be harmonized, only specified;
- The propagation- and screen models have already a lot in common;
- Models under revision tend to take over the ISO-9613 approach.

This leaves the question of the source differences: is there for the same amount of traffic more noise in one country then in another?. Now there could be many causes for **real differences** :

- Composition of a mean traffic stream: heavier cars because of different taxation regimes, use of heavier tires (snow!), mean age of car park, preponderance of one type against another (Italy vs Sweden = FIAT vs VOLVO). However, this hypothesis should give consistent differences between countries, which is not the case.

- Driving behavior may account for differences of 3 dB and more; there is interaction with the car park (gear shift vs automatics).
- Somewhat more subtle: the standard street layout favors higher levels (e.g. amount of absorbing surface along the road).
- Circumstances governing ground absorption may be different in different countries; in favor of this hypothesis is the finding that differences increase at larger distance.
- The difference between cars and "heavy traffic" is in most cases based on weight; the distinction varies between 1200 and 3500 kg. The distinction the Dutch method makes in middle and heavy traffic is relatively rare.

5. CONCLUSIONS & RECOMMENDATIONS

Before comparing noise levels and standards between countries, one should be aware that large unexplainable differences result when the same situations are calculated with different methods. The differences vary between 6 and 10 dB(A), **after making corrections on the official outcomes**. This means that when a certain standard is chosen, say L_{Aeq} = 55 dB(A), in Holland 74% (census '93) of the dwellings is under this range when calculated with the Dutch method, but only 15% when calculated with the French Cetur method (without corrections). The need for a combined effort to establish a common calculation method is obvious. From the data it seems quite impossible to come to a simple translation between methods. The differences lack any system. The first step would be to isolate real differences from calculation differences.
As the most used propagation & screening methods already have much in common, harmonizing seems relatively easy.
Harmonizing source models is perhaps not too difficult either, the main difficulty lies in finding the right factors for the emission strength. Research in this field is needed in short term.