



THE NEW GERMAN PREDICTION MODEL FOR RAILWAY NOISE „SCHALL 03 2006“ – SOME PROPOSALS FOR THE HARMONISED CALCULATION METHOD IN THE EU DIRECTIVE ON ENVIRONMENTAL NOISE

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ABSTRACT

The German prediction method for railway noise for new railway lines was revised by an expert team during the last 5 years. The draft issue of a new Schall 03 has been prepared and will be distributed in 2006. The model is based on octave-band sound power levels describing the emission in different heights of different vehicles, noise sources and parts of noise sources, e.g., roughness of wheels and rails, pantograph noise, and engine noise. The description of sound propagation follows the methods of the ISO 9613-2. In “Schall 03 2006” a method is included for introducing new vehicle types or track types. With respect to the harmonised railway computation method to be used for the European Directive on Environmental Noise, recommendations are given for improvement of the harmonised calculation method currently under development.

1 INTRODUCTION

The regulation "Schall 03 1990" [1] to be used in the calculation of railway traffic in Germany was revised and adapted to the state of the art in the past few years. The new directive was worked out by four teams of about 10 experts each. The result of that work is available now for the "railway" part as the draft "Schall 03 2006"; the "tramway" part is currently still under work.

In the following, the essential contents of "Schall 03 2006" shall be presented and evaluated, compared with the techniques of the interim method proposed in the EU Directive on Environmental Noise [2] as well as with the current status of the "Imagine" project.

2 THE CONCEPT OF "SCHALL 03 2006"

2.1 Sound Emission

Sound emission is determined on the basis of the sound power levels in octave bands for individual sound sources of a vehicle unit according to the following relation:

$$L_{W'A,f,h,m,Fz} = a_{A,h,m,Fz} + \Delta a_{f,h,m,Fz} + 10 \lg \frac{n_Q}{n_{Q,0}} \text{ dB} + b_{f,h,m} \lg \left(\frac{v_{Fz}}{v_0} \right) \text{ dB} + \sum c_{f,h,m} + \sum K$$

with

$a_{A,h,m,Fz}$	A-weighted sum sound level of the length-related sound power at the reference speed $v_0 = 100$ km/h on a sleeper track with an average condition of the rail surface, in dB,
$\Delta a_{f,h,m,Fz}$	Level difference in the octave band f in dB,
n_Q	Number of sound sources of the vehicle unit ,
$n_{Q,0}$	Reference number of sound sources of the vehicle unit,
$b_{f,h,m}$	Speed factor,
v_{Fz}	Speed,
v_0	Reference speed, $v_0 = 100$ km/h
$c_{f,h,m}$	Level corrections for type of track and rail surface,
K	Level corrections for bridges and nuisance of noises;

The acoustic parameters were summarized on data sheets for each of the 10 types of vehicles on the basis of noise measurements collected in a database .

Apart from the above-described types of sound sources, different speeds (with minimum speeds for considering e.g. braking noise), types of tracks (sleeper track on gravel ballast, solid tracks with/without absorber), the condition of the rail surface, and the influence of bridges are taken into account.

The parameters to be used are shown in the following diagram:

type of vehicle	type of source	Partial sources
High-Speed traction unit		rail roughness
High-Speed trailer unit		weel roughness
High-Speed train-set	rolling noise	structurborne sound of tank wagons
High-Speed tilting tech.	aerodynamic noise	pantograph
E- and S-train-set	aggregate noise	grills of cooling systems
electric locomotive	engine noise	bogies
Diesel locomotive		ventilators
passenger car		exhaust gas system
freight car		engine

Fig. 1. Example of the determination of sound emission according to Schall 03 2006.

2.2 Sound Propagation

Sound propagation under "Schall 03 2006" is mainly considered according to the ISO 9613-2 [3], a standard already commonly used for industrial noise; the calculation starts from sound power levels at the different reference heights determined in octave bands[4]. In order to obtain clear reproducible calculation results, the specifications of ISO 9613-2 were modified with regard to the following items:

Ground Effect

Since differentiation by different ground factors is not definitely possible in many cases and an almost flat ground is only found in rare cases, the responsible working group came to the conclusion that ground attenuation should not be calculated in octave bands; there is rather used the alternative method of ISO 9613-2 for the calculation of the A-weighted sound pressure level. Reflections on the ground are taken into account by the steradian measure D_{Ω} .

Shielding

Test calculations with the help of commercial software products have shown that different strategies for taking diffraction edges (and reflection surfaces) into consideration are used in complex development situations, which may lead to different results. For the purpose of reducing the resulting spreading in the results, the number of shielding edges is limited to 3 effective shielding edges according to the "rubber-banding method".

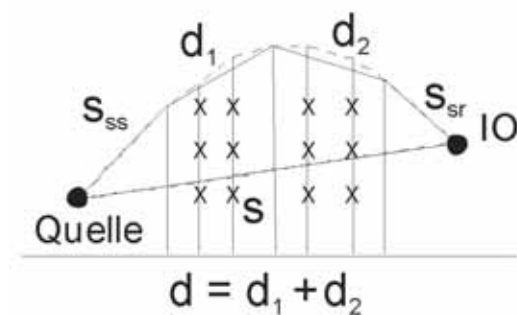


Fig. 2: Shielding edges according to the "rubber-banding method"

The source of sound nearest to the place of immission as well as the highest diffraction edge are taken into account. For calculating the shielding measure D_z , there is used a value of $C_2 = 40$ because comparative calculations made for the source positions assumed with sound measurements [5] with and without shielding wall have shown that this allows to achieve a better approach to the measuring results than the factor $C_2=20$ used in the ISO 9613-2 standard..

Reflections

Reflections maximally of the 3rd order are taken into account. DB Systemtechnik performed measurements with regard to reflections between wagon body and sound-reflecting noise protection walls or retaining walls. These measurements have shown that a sound-reflecting design leads to a reduced shielding effect on the shielded side of the noise protection wall compared to a highly absorbing design of the wall. That reduced shielding effect is taken into account by means of a reduction of up to 3 dB on the shielding measure D_z ..

2.3 Further Specifications

The sound immission levels obtained from the calculations of sound emissions and sound propagation first are determined as average level L_{Aeq} relating to one hour and then, in a second step, are converted into the rating level for the period of time to be considered. Sound emission levels are modified in order to account for particular situations, e.g. additions for the special nuisance of squeal and/or impulse noise and deductions for the lower nuisance of rail traffic compared with road traffic.

Apart from the description of the procedure for determining the sound immission, Schall 03 2006 also includes information on quality assurance of calculations made with the help of software products as well as specifications on the consideration of new railway technology and innovations. That will ensure that the above-mentioned data sheets can be adapted to the state of the art any time.

3 DEDUCTION OF RECOMMENDATIONS FOR THE HARMONISED METHOD OF THE EU DIRECTIVE ON ENVIRONMENTAL NOISE

The Dutch method currently proposed as an interim calculation method shows considerable disadvantages compared with the Schall 03 2006 model. For example the calculations of sound emissions are based on types of trains or on types of tracks that are mainly used in the Netherlands but are only rarely found in the other European countries.

The harmonised calculation method of the "Imagine" project currently in preparation appears to be highly differentiated: Calculation is made in one-third-octave bands, there are considered 5 height ranges, etc. The data collection for that model is extremely expensive so that it must be feared that, as a simplification for economic reasons, rough assumptions must be made for a lot of basic data; a differentiated calculation program may not lead to the objective then. Upon completion of the Schall 03 2006 model, the following simplifications are therefore proposed for a harmonised European calculation model:

- Calculation on the basis of octave bands rather than one-third-octave bands;
- Introduction of a minimum speed instead of considering braking and starting noise;
- Introduction of standard data sheets for selected vehicle units;
- Definition and/or limitation of shielding and reflection to be taken into account;
- Quality assurance of software

REFERENCES

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- [2] EU Directive 2002/49/EG
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- [4] U.J. Kurze et al.: Outdoor sound propagation, Ch. 5 in I.L. Ver, L.L. Beranek (eds.) *Noise and Vibration Control Engineering*, 2nd ed., Wiley, Hoboken, NJ, 2006
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