

## Lower railway noise and railway noise valuation by information system

### - The german Railway noise exposure cadastre -

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### Introduction

Railway noise is created between the rolling wheel and the rail. Freight trains with an influence on environmental noise are most disturbing at nighttime (22:00–06:00 h).

Deutsche Bahn AG intends to reduce railway noise where it is created. Source-related measures could be a smooth rail surface (acoustic grinding) and a smooth wheel surface.

Changing the brake system is one possible solution to reduce the noise level of freight trains passing by. The railways in Europe are endeavouring to develop and introduce quieter technologies for the vehicles and the tracks. For new vehicles, limit values for emissions are being set in the Technical Specifications for Interoperability (TSIs).

In the current noise abatement programme on existing railway lines, the measures for noise reduction are noise barriers, noise-insulation windows and rail grinding. This will make it possible in the coming few years to protect those trackside residents more seriously affected.

Deutsche Bahn AG's Railway Environment Centre has created a noise exposure cadastre. It is based on a geographical information system and includes the whole network of Deutsche Bahn AG (37,000 km). It is very important for strategic statements and the effectiveness of noise reduction measures. Railway traffic noise along railway lines can be computed and visualized. Two- and three-dimensional computation methods are used to visualize isophones or the façade noise level on residential buildings. The number of persons subjected to noise pollution can be determined. This tool also makes it possible to show the effect of quiet technologies and to derive strategies for DB AG.

The system gives Deutsche Bahn AG the basic tool to fulfil the EU directive regarding the assessment and management of environmental noise. Strategic noise maps and action plans require only slight modifications.

### Noise control at the railway traffic

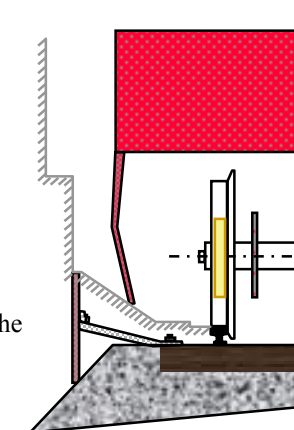
Smooth wheels on smooth rails must be the objective of noise control at the railway. Source-related measures such as rail grinding or replacing cast-iron brake blocks with composite brake blocks are being advanced at DB AG. The composite brake blocks (K-blocks) have the positive property that the wheel tread is roughened only to a slight degree compared with the cast-iron brake block. It just happens to be the 150,000 or so freight wagons that run through Germany mainly at night that are equipped with these cast-iron brake blocks. Throughout Europe, there are some 650,000 freight wagons with this kind of equipment.

Passenger trains and multiple units run on specific lines but freight wagons are employed in cross-border traffic over the entire European railway network (with a track gauge of 1435 mm). The proportion of wagons from other countries running in Germany is about 15%.

The noise level of a vehicle passing by can be reduced by about 7-9 dB(A) by using composite brake blocks instead of cast-iron brake blocks. For the computation of the emissions of the railway line, this measure can lead to a reduction of 3 to 7 dB(A) in the emission level. This depends heavily on the traffic density of the line and the type of trains.

From today's point of view, no other measures on the track or the vehicle - such as damping the wheels or the rails, acoustically optimised running gear, decoupling the transmission of structure-borne sound from the wheel to the running gear (bogie) and to the vehicle body - have such a high reduction potential as the creation of a smooth wheel tread from composite brake blocks or the disc brake. Also the technological introduction of the other measures mentioned is only possible to a limited degree. Screening the wheels with shrouds is technically feasible but cannot be implemented at the time being for reasons of operational safety. The costs of the other measures are very high compared with emission reduction.

**Figure 1:** freight wagon with "Low Noise Technologie"  
Measures on vehicle and track type of brake (K-Block, Discbrake or LL-Block)  
Isolation of running gear from vehicle body  
Damping and acoustic optimisation of the running gear and the vehicle superstructures  
Acoustic rail grinding  
(Wheel (bogie) skirts with very low noise barrier)



**Figure 2:**  
composite brake block



## Noise abatement programme on existing railway lines in Germany

Acoustic treatment along Federation-owned railway tracks in Germany started in 1999. The acoustic treatment programme costs € 51 million per year. The essential noise abatement measures are setting up noise barriers and the installation of noise-protection windows in residential buildings. Rail grinding and the sound-deadening of steel bridges are complementary measures.

The indicative values for the assessment noise level at residential buildings are 70 dB(A) during the day and 60 dB(A) at night.

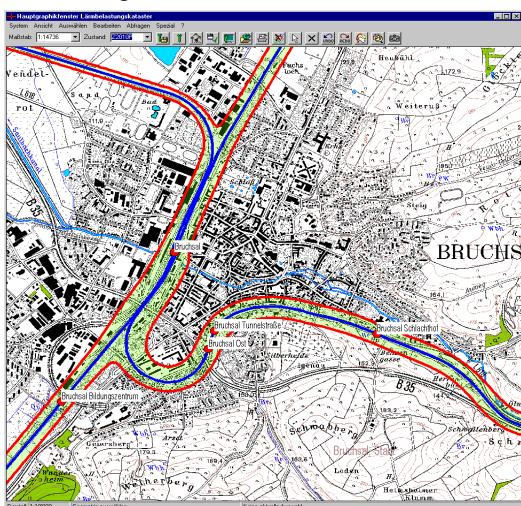
An overall concept, which was drawn up with the aid of the noise exposure cadastre, shows that there are some 3,500 km of railway line with residential buildings. Since the funds are very limited and the total volume amounts to approx. € 2.3 billion, it would take 40 years to complete the programme. DB AG is however endeavouring to push ahead with the measures mentioned above for freight wagons and thus to reduce the emission level on railway lines, particularly in the night period (22:00-06:00 h). The acoustic treatment programme can be implemented significantly faster and at lower costs with source-related measures on the vehicles.

## Employment of the “noise exposure cadastre” as a strategy instrument for German Railway

### Structure of the noise exposure cadastre

The noise exposure cadastre (NEC) is based on a geographical information system (smallworld – GIS) and a computation core for computing the sound propagation (Soundplan). The entire DB AG line network (37,000 line km) has been incorporated true to its natural location. The first background map we use is a map on the scale of 1:25,000. On acoustic treatment lines or on line sections on which noise-measuring work has been carried out, there are track layout plans and cadastre maps on the scale of 1:1,000 and general maps on the scale of 1:5,000.

Figure 3: 2D Isophones



All railway lines are depicted with both the valid timetable and a forecast timetable. It is possible to create 3-D objects (buildings, noise barriers, etc.) and to set up a topographical model of individual sections. It is also possible to use laser-scanning data. Further NEC data components to be entered are acoustically relevant factors such as level-crossings, bridges, noise barriers and line-speeds.

The emission value can be computed from the number of acoustically assessed trains (according to the computation directive "Schall 03") and the line properties. In 2-D visualizations, isophones can be computed with the propagation computation. The façade noise levels of the residential buildings on the individual storeys and the exceedence of a limit value can be computed and visualized in 3-D propagation computations.

## The noise exposure cadastre to support the DB AG noise strategy and to comply with the EU Environmental Noise Directive

Having the entire railway line network, the complete timetable and the proper geographical location of the lines in the towns and municipalities, views and assessments of the noise situation can be provided for the whole of Germany or the regions. It was possible to compute and visualize a general map with the line emissions (in 5 dB(A) stages) for "day" or "night" for the development of an overall DB AG noise strategy. This means that focal points on line sections, on which acoustic treatment for example should be initiated, can be identified very quickly and clearly. Conversion of the brake equipment on freight wagons (replacement of the cast-iron brake block with the composite brake block) was given as an example for the effect of employing quieter vehicles. Computation showed that a significant part of the lines could be dropped from the acoustic treatment programme.

The area of the municipalities with residential buildings and the number of inhabitants in it can be shown in the noise exposure cadastre. The number of persons affected by railway noise above a prescribed value can be determined from the intersection of the area of the residential buildings with isophone lines for various sound levels. For full compliance with the EU directive, a façade noise level on the residential buildings has to be determined. This means that a three-dimensional (3-D) computation has to be carried out, and a 3-D model of the terrain is required. We can perform these computations in the DB AG NEC at selected positions and indicate the required  $L_{DEN}$  und  $L_{NIGHT}$  on the buildings. In the present computation model, the noise levels demanded for Germany (day, night) are indicated with exceedence. In order to show the effects of noise barriers, 3-D models of the terrain have to be made. Once the model has been set up, variants and new computations can be performed very quickly.

The disadvantage of precise 3-D computation is the very high costs for making the topographical model for Germany. This gives rise to the proposal for complying with the EU directive for the railway traffic sector that the "strategic noise maps" be drawn up in a 2-D model and 3-D computations be used in the special cases of preparing "action plans".