Developing Noise Control Strategies for Entire Railway Networks

Jakob Oertli[1]

[1] *Rail Environmental Center, Swiss Federal Railways, Hochschulstrasse 6, 3000 Bern, 65, Switzerland, Email: jakob.oertli@sbb.ch*

Introduction

The EU Environmental Noise Directive requires member states to deliver noise maps to the commission by 2007 and action plans by 2008 both for agglomerations as well as for major roads, railways and airports. Noise mitigation projects resulting from action plans are usually very expensive and therefore my threaten the economic viability of the railways in the current harsh competitive transport market, thus hindering sustainable transport policies. It is therefore necessary to develop strategies which optimally balance noise reduction, European and national legislation as well as costs of the measures. In order to ensure fairness, it is additionally advisable to use the same strategy throughout a given network. Ideally the strategy would be obtained through an iterative process, in which relevant legislative bodies work together with the railways to both develop options and to choose the most optimal ones. Usually such mitigation options consist of different threshold levels, different types of measures and combinations thereof as well as a variety of constraints, e.g. cost-effectiveness limitations for noise barriers. In this paper I will present four case studies, where such strategies have been developed and will derive a suggested procedure from these examples.

Switzerland

The Swiss noise ordinance was enacted in 1986 and requires railways to attain defined threshold values, if this is economically feasible and operationally possible. An extensive noise mapping is additionally required as a basis for this mitigation. As a first step the Swiss Federal Railways undertook an approximate mapping of the entire network on a scale of 1:25'000. These maps indicated the location of noise problems necessitating a more extensive three dimensional mapping. With the help of these detailed maps (1:2000) the costs and the amount of noise reduction of different combinations of measures were calculated. In co-operation with the authorities a strategy was found in which

- all Swiss rolling stock is improved
- noise barriers are built in all cases where a predefined cost-effectiveness index is attained
- insulated windows are installed in all cases in which the thresholds are not attained with the first two measures

With the first two elements of this strategy, almost 70 % of the lineside population can be protected at about 30 % of the costs to attain threshold levels for all inhabitants. This strategy was developed in close co-operation with the authorities and subsequently became part of an additional ordinance. The programme is currently being implemented along in the entire system and is scheduled for completion by 2015. To enable efficient noise barrier planing the noise mapping tool was upgraded into a sophisticated planing instrument (called APT Akustikprojektierungstool).

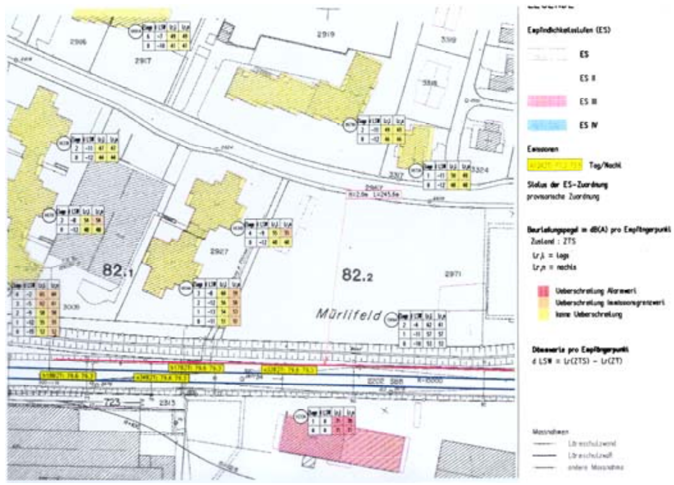

Figure 1: Example of detailed noise mapping in Switzerland

Freight corridors

In the years 1998 to 1999 the UIC (International Union of Railways) commissioned a study to determine the optimal noise control strategy along freight corridors. For this work costs and the effectiveness of different noise control strategies were calculated for a total of 1667 km of line length (Rotterdam-Basel-Milano) and (Bettembourg-Lyon). Without noise control about 250 persons/km had noise values above 60 dB(A). The study showed that to reduce noise levels beneath 60 dB(A) yearly costs of € 20'000 to 100'000/km would be necessary. A maximum benefit was achieved at € 60'000/km/y. Above this value there were no additional benefits in scenarios with higher costs. All solutions containing rolling stock proved to be optimal. Scenarios with high noise barriers were not cost-effective.

STAIRRS (Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems)

In the STAIRRS project (WP1) the freight corridor analysis was enlarged to encompass all of Europe. This project was co-financed by the EU and by the UIC. The acoustically relevant geographic, traffic and track data were collected for 11'000 km of line length in seven European countries. Noise calculations were undertaken with the Eurano 2001 software program. Standard cost-effectiveness methodologies were adapted to fit the requirements of noise control projects. A specifically developed extrapolation mechanism allowed studies on Europe as a whole as well as in individual countries.

The results corresponded to the UIC study. The costs of noise control are expensive, the total extrapolated present costs ranging from € 3.5 billion (k-blocks on freight wagons) to € 76 billion (allowing a maximum of four meter barriers). Again freight rolling stock improvement had the best cost-effectiveness while noise barriers had a low efficiency. Also track measures in combination with rolling stock measures were shown to be highly effective. The conclusions were true both for the 11'000 km for which detailed acoustical data was available as well as for an extrapolation to 21 countries. Exceptions only occured in those countries which have an exceptionally high or low number of freight wagons.

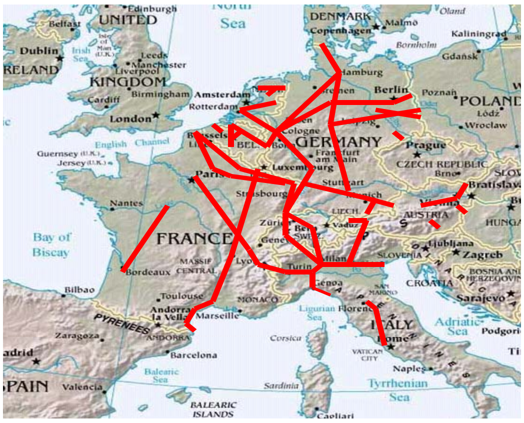

Figure 2: Map showing lines chosen for acoustical data collection in the STAIRRS project.

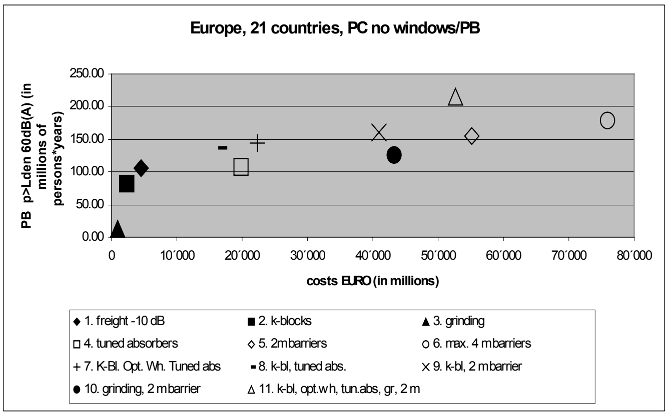

Figure 3: Short term cost-effectiveness of programmes not including windows. Number of wagons from UIC action programme noise reduction freight traffic. PC: present costs, PB: present benefits or effectiveness, PB L_{den} p>60 dB (A): effectiveness as reduction of number of persons above Lden of 60 dB(A), k-Bl: composite brake blocks, Opt. Wh.: optimised wheels, tun. abs.: tuned rail absorbers, gr: grinding, 2 m: 2 m noise barriers.

Luxembourg

In 2002 the Luxembourg Railways CFL commissioned the Swiss Federal Railways to undertake an approximate mapping as a first step in determining an optimal strategy for the network. Using the program Eurano 2001 a two dimensional noise map to the scale of 1:20'000 of the network was undertaken and different strategies and threshold levels were tested in close contact with government ministries. The results for Luxembourg correspond to the STAIRRS results, with rolling stock again demonstrating best cost-effectiveness ratio. These results will form a basis for further studies and decisions on noise control strategies for the CFL.

Developing strategies: Suggested procedure

Our experience in the above examples suggests it is worthwhile to follow the following procedure when developing a strategy for an entire country:

1) Use approximate and inexpensive two dimensional mapping to the scale of 1:25'000 to 1:50'000 to determine the extent of the problem. This mapping should be undertaken in such a way that the parameters necessary for step two have already been collected. These usually consist geographic data (extent of urban areas, individual houses), traffic data (number, composition and speed of trains), track data (acoustically relevant elements) and demographic data (population density of urban areas).

2) Calculate costs and effectiveness of different scenarios using the data obtained in step one. Scenarios include individual measures, combinations thereof or variations in threshold levels. For this purpose it is useful to develop scenarios in close co-operation with the relevant authorities.

3) Based on the results, the optimal balance between legislation, costs and noise protection can be determined and an optimal strategy developed.

4) Based on the strategy and the approximate mapping results, those areas which require further attention can be determined. Here usually a detailed three dimensional mapping is required, which will form the basis for planing the actual noise abatement measures.

Conclusion

This approach to noise control allows adherence to the EU requirements while obtaining a network-wide noise control strategy at the same time. The procedure is in itself cost-effective and results in a strategy that finds a balance between legislation, railway competitiveness and environmental protection.

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