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Overview of Railway Noise Control in Europe

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European and national legislation, increasing freight traffic, political pressure and many more factors contribute to make noise an issue of increasing importance for the railways. This paper provides an overview of railway noise abatement efforts throughout Europe. Different countries in Europe have adopted varying noise abatement strategies, ranging from an emphasis on infrastructure based measures to a combination of rolling stock measures with noise barriers. Important in the current European discussion is the development and retrofitting of freight wagons with K- and LL-brake blocks. To support this retrofitting a wide variety of incentives, such as differential track access charges, operational restrictions or direct subsidies are being discussed. The current efforts by the European Commission, the International Union of Railways (UIC), the Community of European Railways (CER) and other international organisation to promote silent railways are presented.

1 Introduction

This report summarizes the state of the art in railway noise control. The report is based on a series of European Union (EU) and International Union of Railways (UIC) workshops held in Brussels, Paris, Pisa and Utrecht from 2005 – 2007, on recent information from the UIC Network Noise as well as on direct contacts with the EU Commission, the railways and national ministries. The report intends to inform a wider public on the issues involved.

2 European Framework

The European Commission is concerned about the impact of transportation on the environment. It realises that railways are the most environmentally friendly and sustainable means of transportation, both for freight and passenger traffic. In 2001 a White Paper of the European Commission therefore proposed to increase the market share of the railways to the levels of 1998 by the year 2010, a position reaffirmed in the 2006 Mid-term Review. If rail noise results in restriction in freight traffic, this would endanger the aims of the White Paper.

European Commission considers noise one of the main local environmental problems and therefore gives noise abatement a high priority. An EU working group on railway noise analysed different noise abatement scenarios and produced a position paper proposing to retrofit the existing rolling stock with braking systems that reduced rolling noise and to introduce noise creation limits for new rolling stock as the first priority.

In the Technical Specifications for Interoperability (TSI) the EU enacts noise creation limits for railway vehicles, both for new rolling stock and for renewed or upgraded rolling stock. Different values are defined for the various types of rolling stock (i.e. freight wagons, locomotives, multiple units, coaches) as well as for different operating situations (i.e. pass by, stationary, starting and interior noise). For conventional railways the limit values for pass-by noise came into force in June 2006. This TSI includes noise emission limits for wagons with retrofitted braking systems. Already in 2002, a TSI for high speed trains came into force, which also includes noise regulations TSI regulations must be revised every three years.

All EU member states as well as Norway and Switzerland have enacted noise reception thresholds for new lines. Most countries have also enacted limits for upgraded lines, while a few, such as Switzerland and Italy, have also enacted reception thresholds for existing lines.

The directive 2002/49/EC relating to the assessment and management of environmental noise has the intention to give the European Commission an overview of the extent of noise problems, to determine if the population is sufficiently protected and, if necessary, to reconsider the legislation. The END requires strategic noise maps and action plans for major railway lines ($\geq 60'000$ trains per year) and for large agglomerations ($\geq 250'000$ inhabitants) by 2007 (maps) and 2008 (action plans). Five years later strategic noise maps and action plans will have to be drawn up for railway lines with more than 30'000 trains per year and agglomerations with more than 100'000 inhabitants per year. The END also applies to road and airplane traffic as well as for industrial noise. The action planning is the responsibility of the individual member states, who usually delegate the actual planning to regional or local authorities. The EU intends to organize meetings with member states to prepare the review of the legislation due in 2009.

3 Railway Framework

Noise abatement of increasing importance for railway operation: On existing railway networks, freight traffic is the main source of noise. In order to maintain a sustainable transport system, the railways must reduce noise because it is their main environmental problem. Otherwise political and public support of the railways may decline. In addition noise issues may prevent a traffic increase and therefore hinder the implementation of the European transport policy and its focus on increasing the railways' traffic share. The situation is high on the political agenda in certain areas: In Germany, for example, there is tremendous public pressure along the Rhine corridor to reduce noise and operational restrictions have been threatened on the political level. In The Netherlands operational restrictions and lawsuits have already been issued by the government.

EU railway package divides infrastructure and operations: The first railway package separates essential functions, such as rail capacity allocation, infrastructure charging and licensing from transport operations to enable new rail operators identical access conditions to the rail market. This package also foresees that railway undertakings set up different accounts for passenger transport services and freight transport services. The package requires that environmental charging can only occur if the same charges are applied to competing transport modes. A further constraint is that infrastructure may not profit from money earned from environmental charging. Many different stakeholders with different agendas are therefore involved in all railway noise issues.

Railways operate in a tight competitive economic environment: Two types of competition are relevant: The

railway sector competes with other transport modes and there is competition between railways. For achieving the goals of the EU White Paper, the competition between sectors is more relevant. Since it is the stated policy of the EU to promote railway traffic, it must be avoided that noise abatement becomes an additional cost factor and thus causing the railways to lose market shares.

Railway operations are a long term endeavour: Normally railway rolling stock is only replaced after a very long life span. A satisfactory noise reduction within reasonable time therefore cannot be achieved merely through the commercially motivated replacement of noisy existing wagons with new silent wagons. Time tables are generally adapted once every year and allow little short term flexibility. Also infrastructure improvements are usually planned many decades in advance before being implemented during several years of construction.

4 Composite brake blocks

Smooth wheels on smooth tracks result in less noise: Railway rolling noise is the result of roughness on both the wheel and the track in the contact area between the two. Both the wheel and the track vibrate, when the train is in motion, thus creating noise. A significant portion of the noise can be eliminated, if the both wheels and the track are smooth. The use of cast-iron brakes causes rough wheels. On the other hand, wheels remain smooth using composite brake blocks. Therefore, the choice of brake blocks has a large effect on rolling noise levels.

Smooth wheels can be achieved using composite brake blocks: Currently two types of composite brake blocks are being developed and implemented: The K- and the LL-blocks. K-blocks have a higher coefficient of friction than cast iron blocks; because of this they require an adaptation of the braking system. LL-blocks simulate the braking performance of cast-iron brake blocks and therefore only minor adaptations of the braking system are necessary. The reason for the difference in braking performance lies in the variation in the coefficient of friction at different speeds for different brake blocks. Figure 3.2.2 shows the higher coefficient of friction for K-blocks and the similar level of LL- and cast iron brake blocks over a range of speeds.

Brake block homologation: Braking is crucial for the safety of operations. Therefore there is a need for a well defined approval process. In addition to braking performance, homologation procedures require considering safety and operating issues, such as performance under severe winter conditions and studying possible effects on track circuits. The brake blocks are developed by industry and the UIC defines the homologation process including the required tests. The UIC Leaflet 541-4 describes the requirements for composite brake blocks and is available on the UIC website. Currently two K-blocks have been homologated and two LL-blocks have passed all safety tests, the latter however show very high wheel and block wear.

Summary of K- and LL-blocks: The main characteristics of the two composite brake blocks under consideration are summarized in Table 1.

	K-blocks	LL-blocks
Rolling noise reduction	8 – 10 dB	8 – 10 dB
Retrofitting requirements	requires adapting braking system	minor adaptation required
Braking characteristics	independent of train speed, higher braking coefficient than cast iron brake blocks	train speed dependent (similar to cast iron brake blocks), braking coefficient similar to that of cast iron brake blocks
Homologation	system approval since 2003,	Provisional certification since 2005

Table 1: Comparison of K-and LL-brake blocks.

Railway sector supports development of K- and LL-blocks: UIC has supported development of K- and LL-blocks for many years. Its current strategy is the following:

- 1) Until 2009 UIC continues support of developing more types of K-blocks and the observations of those wagons already retrofitted.
- 2) The ongoing programmes to finalise homologation of LL-blocks will be continued until mid 2009. The aim is to have either homologated types of LL-blocks or a defined state of the art.
- 3) Simultaneously UIC will prepare technical specification for test procedures so that LL-development could continue even without a specific UIC test programme. For this purpose the UIC will provide the technical expertise and test facilities on a commercial basis.

5 The economics

Retrofitting has the best cost-benefit ratio: Anticipating the need to optimize noise control strategies on a European level, both the railways and the EU have undertaken cost-effectiveness analyses. The most comprehensive study was the STAIRRS project, co-financed by the EU fifth framework programme and by the UIC. In this project the acoustically relevant geographic, traffic and track data were collected for 11'000 km of lines in seven European countries. Standard cost-benefit methodologies were adapted to fit the requirements of the project. An extrapolation mechanism allows studies on Europe as a whole and, in an approximate manner, also on each individual country or region of interest.

Major conclusions were:

- Retrofitting freight rolling stock has the highest cost-effectiveness both on its own and in combination with other measures.
- Noise barriers, in particular high ones, have a low cost-effectiveness.
- Combining noise barriers with retrofitting improves overall cost-effectiveness

- The conclusions for Europe as a whole are also true for individual countries.

In summary, STAIRRS shows that solutions using composite brake blocks save considerable amounts of money (billions of Euros in Europe) in comparison to noise abatement with only noise barriers. These conclusions were supported by studies undertaken in Switzerland, The Netherlands, France, and Germany. In Switzerland, for example, using the combination of retrofitting with noise barriers costs only 30 % of a solution consisting of noise barriers only, reducing original costs of € 2.2 billion to € 0.7 billion. Also in The Netherlands € 750 Million could be saved by 2020, if retrofitting is implemented.

Noise barriers are most commonly used noise abatement strategy: Despite the fact that retrofitting has very good cost effectiveness, the most commonly used noise abatement strategy are noise barriers. A study undertaken by the UIC (compare uic.asso.fr) shows that at the end of 2005 some 1000 km of noise barriers had been built and insulated windows installed in 60'000 buildings. This results in a noise protection of about 1'250'000 persons.

Significant savings possible with retrofitting instead of noise barriers: Just based on the planned expenditures for noise barriers, it is estimated that several billion € can be saved throughout Europe, if the freight fleet is retrofitted instead of only constructing noise barriers.

Reasons why noise barriers are being favoured: Analyzing the reasons why noise barriers are being built may help to promote retrofitting.

- Organisational obstacles: The separation of infrastructure and operations gives no incentives to look at the whole system.
- Legal obstacles: It is currently unclear, if state aid rules apply to retrofitting. Additionally, certain countries, i.e. Italy have a national legislation preventing the funding of retrofitting.
- Political obstacles: Locally elected politicians favour local solutions.
- Philosophical obstacles: Fighting symptoms with noise barriers is usually preferred over fighting causes with retrofitting. There is also concern that others profit from money spent on retrofitting.
- Incentives mainly for noise barriers: The price for noise barriers is usually included in new projects.
- Lobbying support for noise barriers: The construction lobby promotes noise barriers and the road lobby is against direct subsidies of railway operators.

New wagons cost neutral; retrofitting requires investment: Purchasing new wagons with K- or LL-blocks instead of cast iron blocks does not increase the overall costs of a vehicle. As shown in table 2 the cost for retrofitting wagons are significantly lower using LL-blocks than using K-blocks. Even when a block is homologated, each wagon type must undergo testing to prove the braking performance before retrofitting is possible. This results in considerable costs (several hundred thousand Euros) for each wagon type. Wagon classes consisting of only few vehicles are therefore not the primary focus for retrofitting. Because the life span of K- and LL-blocks is expected to be longer once a wagon has been retrofitted, the life-cycle costs for K-

blocks and LL-blocks may be in the same range as for cast-iron brake blocks.

	K-blocks	LL-blocks
Retrofitting costs	€ 4'000 – 10'000	€ 500 – 2'000
Costs for brake blocks	€ 23 – 28	€ 23 – 28 (organic) € 40 – 60 (sintered)
Life cycle costs in comparison to cast iron brake blocks, once a wagon has been retrofitted	probably similar due to expected longer life span	not quantified yet

Table 2: Costs for K- and LL-blocks

Maintenance costs: First studies indicate that maintenance costs are probably not affected when cast-iron blocks are replaced with composite brake blocks. Some studies indicate a small increase while others show a small decrease. The main cost drivers are wheel and brake block wear. These effects are in the process of being evaluated, in particular the cost effects of the wheel-sets. There is potential for optimization in maintenance cycles, so that an overall decrease in costs is expected.

Extent of retrofitting: Retrofitting is most cost-effective if carried out during compulsory freight wagon inspection, which must be undertaken at least every 6 years. In total about 400'000 – 500'000 wagons must be retrofitted throughout Europe. This number has been reduced from previous estimates because the freight fleet has been optimised and an increasing number of new wagons with K-blocks have been purchased.

6 Current Activities

European Commission addresses retrofitting issue: In 2007 the European Commission held a public consultation as well as a workshop on noise abatement measures addressing the existing European freight fleet. The commission's discussion focuses on planning and decision issues as well as incentives. An impact report has been published which analyses two scenarios in detail: A combination of subsidies, operating restrictions and voluntary agreements as well as differential track access charges, emission ceilings and voluntary agreements. A communication on the subject is planned for 2008.

UIC supports retrofitting: For more than a decade, the UIC has actively supported retrofitting by providing the framework for brake block homologation, by considering funding and financing issues as well as communicating the issues involved.

National retrofitting projects: Switzerland is in the process of retrofitting its entire national rolling stock. All of the passenger wagons and half of the freight wagons have been retrofitted. The programme will be completed by 2010 and is financed by direct subsidies. Germany has started a retrofitting pilot project. Several countries, such as The

Netherlands, have extensive pilot projects and testing programmes.

National incentives: The Netherlands and Switzerland have adopted noise related differential track access charges. The subject is being studied in other countries as well, although not all countries are convinced that this is an appropriate incentive. Switzerland also provides direct subsidies for retrofitting as mentioned above.

Railway support of testing: Several railways and wagons owners are active in the testing of K- and LL-shoes. Examples include DB, Green Cargo, SBB, Hupac, and AAE.

7 Conclusions

Railway noise abatement crucial for a sustainable transport system: Railways are a sustainable means of transport, however noise issues must be addressed, if restrictions on rail freight traffic are to be avoided.

Retrofitting saves money: Noise abatement solutions using freight wagons with composite brake blocks are cost-effective and save considerable amounts of money (billions of Euros in Europe) in comparison to solutions including only noise barriers.

Outside financial support necessary for railway operators: Due to the harsh competitive transportation market, the railways are currently not in a position to finance retrofitting.

The railway sector suggests direct subsidies: The railway sector proposes that the retrofitting be subsidised directly in a first step and that differential track access charges be used in a second step to achieve a self propelling retrofitting process of the freight fleet.

Implementation of the Environmental Noise Directive (END): The possibility of retrofitting freight vehicles with composite brake blocks should be considered in the action plans of the END including funding modalities.

Continue technical development: The UIC continues its support of the development of more K-blocks until 2009. At the same time the efforts to finalise homologation of LL-blocks will be continued until 2009 as well. If no feasible LL-block is available by that time, the UIC will stop its direct support; however it will continue to offer technical expertise and to provide testing guidelines.