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Journal of Sound and Vibration 293 (2006) 1051–1057
JOURNAL OF SOUND AND VIBRATION
www.elsevier.com/locate/jsvi

Implementing the retrofitting plan for the European rail freight fleet

P.H. de Vos[a,*], M. Bergendorff[b], M. Brennan[c], F. van der Zijpp[a]

[a]AEA Technology Rail bv, P.O. Box 8125, NL 3503 RC, Utrecht, The Netherlands
[b]UIC, 16 rue Jean Rey, F 75015 Paris, France
[c]AEA Technology Rail, Central House, Upper Woburn Place, London WC1H 0JN, UK

Accepted 26 August 2005
Available online 9 March 2006

Abstract

In 1998, the International Union of Railways (UIC) agreed on an Action Plan, proposing the retrofitting of the complete European rail freight fleet. Early 2003 the European Commission, Directorate General for Transport and Energy, commissioned the study reported here. The scope of the study was to supply an independent assessment of the conclusions of the UIC Action Plan and elaborate on implementation scenarios and funding options. The retrofitting of existing wagons, by an exchange of cast iron brake blocks with composition blocks, is the preferred option to achieve a substantial noise reduction. K-blocks have been homologated by UIC in 2003, but they require an expensive modification of the wagon. The opportunities for LL-blocks, an economically attractive alternative, are still being investigated to date. The retrofitting reflects some 600,000 wagons and, with an expected reduction of 10 dB(A), probably represents the largest single operation for traffic noise reduction ever. The process could best be combined with the maintenance cycle of freight wagons. In that case the process would require up to 10 years. Through a combination of funding options, the financial burden for wagons owners and freight operators could be softened.

1. Introduction

The growing societal opposition to excessive noise from transport in general is putting pressure on railway operations. Rail freight transport is generally considered the dominant source of annoyance in railway noise. Freight trains run mainly at night and freight vehicles produce a rolling noise that has remained unchanged. However, recent developments clearly demonstrate the intention of different parties to address the problem and come up with solutions. Noise creation limits have been proposed by the European Association for Railway Interoperability (AEIF) in the Technical Specification for the Interoperability of the Trans-European Conventional Rail System, which was largely agreed in April 2004 but has been re-discussed since. Also in 2004, the International Union of Railways (UIC) has approved the homologation for two different makes of composite brake blocks of the type K for new freight wagons, which was followed up by a preliminary

*Corresponding author. Present address: DHV Environment and Transportation, P.O. Box 1076, 3800 BB Amersfoort, Netherlands. Tel.: +31 33 4682927; fax: +31 33 4682801.
E-mail address: phdevos@worldonline.nl (P.H. de Vos).

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doi:10.1016/j.jsv.2005.08.054

homologation for LL-blocks in 2005. However, this process would not solve the rail freight noise problem in the short term. Railway vehicles have a life span of 40 years, and due to economic circumstances the renewal rate is very low. Therefore a specific approach is required for existing vehicles.

In June 1998, the UIC Board of Management approved the "UIC Action Plan for freight wagon noise reduction". The key element of this plan is to create the conditions so that new wagons are fitted with composite brake blocks and existing wagons are retrofitted with composite brake blocks replacing the cast iron brake blocks. The retrofitting is aimed to reduce noise levels by about 10 dB(A). Three working groups were installed, focusing on Technical Aspects (chaired by French Railways, SNCF), Retrofitting Aspects (chaired by Trenitalia) and EU work (chaired by Swiss Railways, SBB), respectively. The working groups report to the Noise Reduction Steering Group chaired by German Railway, DB. Since 1998, collaboration has been found with all major associations, viz. Community of European Railways (CER), the Union of European Railway Industries (UNIFE), and the International Union of Private Wagon Owners (UIP), who fully support the Action Plan.

Presently, the three working groups have reached a phase where results have been reported. This fitted well with the agenda of the European Commission (EC), who intended to evaluate the efficiency of their noise source policy by January 2004 (in conformity with the intentions set out in the Environmental Noise Directive 2002/49/EC).

In January 2003, the EC, Directorate-General for Energy and Transport, commissioned a so-called "Implementation Study", referring to the Action Plan [1]. The study was commissioned to a consortium consisting of the railway associations UIC, CER, UNIFE, UIP and International Union of Combined Road–Rail transport companies (UIRR). AEA Technology Rail joined the consortium as a subcontractor and independent assessor.

The objectives of this study were to investigate and analyse implementation scenarios and funding mechanisms for the Action Plan. Also, a third party assessment was made to the results acquired by the three working groups. AEA Technology Rail was responsible for this third party assessment, which was to look into the following basic questions:

- is the solution proposed in the Action Plan and worked out by the technical working group the preferred solution (compared to available and conceivable alternatives)?
- are the consequences of implementation (size and development of the fleet), as assessed by the Retrofitting working group, complete and correct?

2. Need for the study

2.1. Political aspects for transport

The European economy envisages growing demand for mobility in the European Community. This growth would bring growing congestion on the roads and environmental and scarcity problems in air transport. Evidently, the railways have not been able to match the demand. Rail freight transport has been in decline for several decades. The market share of railways in the freight sector within the EC has decreased from 11% in 1990 to 8% in 1998. It is the EC's policy and a joint challenge of the next decade, for the enterprises involved and for the authorities and legislators on a European and national level, to create conditions and to reshape the system such that the market share of the rail freight transport can and will grow from 8% in 1998 to 15% in 2020 [2]. This involves a trebling of the amount of goods transported by rail.

2.2. Political aspects for transport noise

According to the Directive on the Assessment and Management of environmental noise, adopted in June 2002 (2002/49/EC), the EC is responsible for setting noise creation limits for various sources such as railway systems.

There is a mixed strategy behind the setting of noise creation limits: firstly, it is intended to avoid commercial barriers between member states and to defend the single European market. Noise sources, when complying with the limits set by the EC, will have free access to all member states. Secondly, but at a lower priority, the EC intends to improve the environmental situation for its citizens. In Europe, approximately 36 million citizens are annoyed in some degree by railway noise [3].

Thirdly, and probably most important, the societal objections against increased railway traffic are often expressed in terms of concern about excessive noise. Therefore, noise reduction is an essential condition to the intended growth of rail traffic and is a key element in Europe's strategy towards sustainable surface transport. The latter view is largely shared by the railway operators, as expressed in the Strategic Rail Research Agenda adopted by the European Rail Research Advisory Council (ERRAC) [4].

3. Scope and approach of the study

The scope of the study has been the current Member States and accession countries of the European Union as well as Norway and Switzerland, a total of 27 countries covering the vast majority of rail freight transport in Europe. The study was carried out between January and November 2003. It consisted of desk research and interviews with national contacts in railway operating companies, wagon owners, suppliers and legislators. Interviews were carried out with

- *Operators*: Trenitalia (Italy), SNCF (France), SBB (Switzerland), DB Cargo (Germany), PKP Cargo (Poland), CP Cargo (Portugal), Railion Benelux (Netherlands), EW&S (United Kingdom), and UIRR members and the Freight Transport Association UK.
- Wagon owners.
- Manufacturers.
- Technical Experts.
- *Policy Makers*: EC working group rail [5], DG Transport and Energy.

In addition to the interviews, there were several contacts with the steering group of the "UIC/UIP/CER Action Program noise reduction in freight traffic" and with the members of the consortium carrying out the study.

4. Results: the preferred option for noise reduction

Numerous studies indicate that there is a clear economic gain if one were to change from noise barriers as the standard solution for transport noise to noise control at source. A substantial reduction of rolling noise from freight vehicles can only be achieved if cast iron brake blocks are avoided. Nevertheless, it should be emphasized that railway noise is a product of wheel and track quality. Any cost-effective mitigation measure should reflect this balance between both sources. A mitigation measure applied to the wheel can only have full effect if the track is maintained in good quality.

Three basic options exist as an alternative to cast iron brake blocks: K-blocks, LL-blocks and disc brakes. Disc brakes are not suited for retrofitting, but they may represent the preferred option for certain new vehicles under specific operating conditions. Particularly, in situations with high annual mileage (around 100,000 km), high axle loads and high maximum speeds disc brakes would represent the best solution. From the interviews it was quite clear that the sector does not recognize the need for large-scale introduction of disc brakes at present. LL-blocks are composite brake blocks with a particularly low friction coefficient, such that they can simply replace existing cast iron blocks without any further modification of the brake system. Vehicles equipped with LL-blocks could be operated in mixed traffic without problems for vehicle safety. There are indications that the use of LL-blocks leads to smooth wheel surfaces as for K-blocks, and a noise reduction probably at the same level as that for K-blocks (10 dB(A) compared to cast iron [5]). Although LL-blocks are offered from several manufacturers, only a preliminary homologation for international use has been achieved. This occurred only since the present study was concluded. The testing procedures have been going on for several years, mainly focusing on wear effects, winter conditions and electric conductivity effects

(for signalling), and at present indications are positive, however it is not possible to predict when a final homologation for unlimited European circulation can be concluded. It is for this reason that LL-blocks did not represent the preferred option in the present study.

K-blocks are standard composite brake blocks with a substantially higher friction coefficient than cast iron. Existing wagons can be equipped with K-blocks instead of cast iron, but this requires a significant modification of the brake system (cylinder, rigging) and in some cases also replacement of the wheels. Retrofitting is therefore an expensive and time-consuming operation. K-blocks will, however, be the future standard for new freight vehicles, and this underlines the conclusion that K-blocks represent the preferred option for retrofitting. Results of field experiments with K-blocks with respect to their noise performance show large spreads, which can only partly be explained by differences in reference (cast iron block braked) vehicle, track quality and run-in procedures. The most reliable experiments report reductions of the order of 10 dB(A) [5].

5. Results: the costs

5.1. Incremental life cycle cost assessment

For comparison of the various options, the cost of the retrofitting operation should be assessed. The quantity selected to express these costs was chosen to be the difference in total life cycle costs (LCCs) for the whole of Europe compared with cast iron brake blocks. The process, which was used to derive this quantity, is illustrated in Fig. 1.

The investment cost per wagon is composed of cost elements for labour, workshop overhead, material, waste disposal, wagon withdrawal and possibly homologation testing. These costs depend on the wagon type. Crucial elements are whether or not the wheels need to be replaced and whether or not the wagon needs a homologation test after the modification. The maintenance costs per wagon depend on wear of wheel and brake blocks, which in turn depend on the mileage, the operating conditions and the block type. The LCCs then depend on the total life span of the wagon and the age of the wagon at the time of the retrofit. Finally, the figure for the whole of Europe can be assessed taking into account the total size and composition of the fleet to be retrofitted.

The retrofit working group in the Action Plan had assessed all of the above elements. The approach of the third party assessment has been to re-assess all the assumptions, to build an alternative LCC-model to that existing from the UIC Action Plan and to derive the total LCCs based on the new assumptions. Where different assumptions were available, a sensitivity analysis was made. Some of the assumptions and the main results are reported in the following sections.

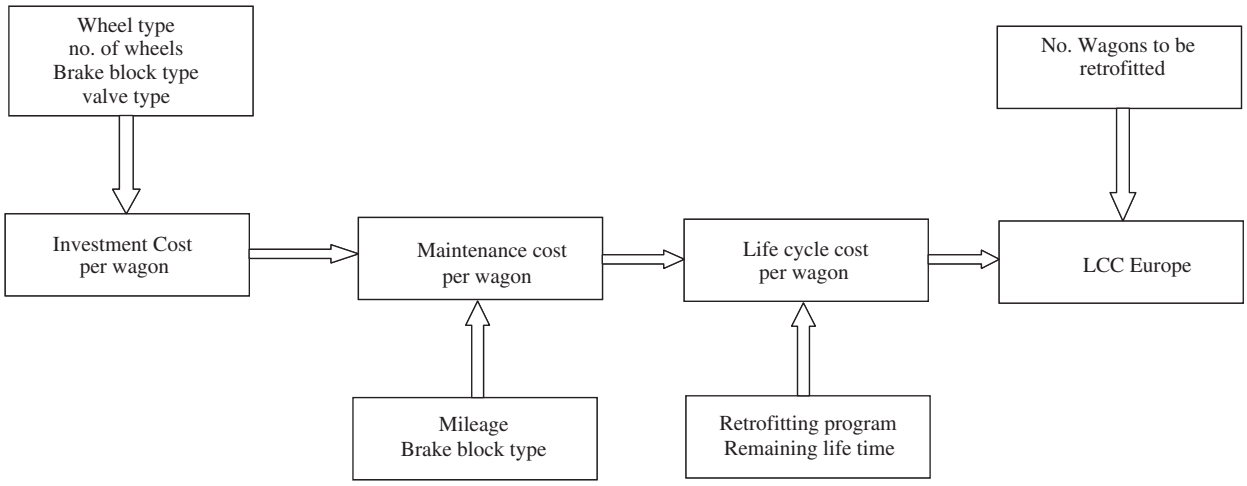

Fig. 1. Illustration of the process of incremental life cycle cost assessment for retrofitting.

5.2. Size and composition of the European freight fleet

There is evidence that the size of the European freight fleet is around 825,000 wagons, of which approximately 600,000 would require retrofitting. This is based on the following assumptions:

- With respect to fleet renewal and refurbishment it was assumed that the present rates will continue (it must be stressed here that since the liberalisation of the railway market and the political change in Eastern Europe, a large part of the fleet has disappeared).
- With respect to age distribution of the present and future fleet it is assumed that never more than 1% of the fleet will be older than 40 years.
- With respect to the retrofitting scenario, it is assumed that it will start in 2005 and will last 10 years and that no wagon will have cast iron brake blocks after 2015.
- With respect to the newly purchased and refurbished wagons it is assumed that they will all be equipped with other than cast iron brake blocks from 2004.

The historic development of the size of the European wagon fleet is presented in Fig. 2.

5.3. Retrofitting investment cost per wagon

The retrofitting costs for the exchange of cast iron blocks to K-blocks would amount to 4500 to 13,000 Euros per wagon. The lower limit is somewhat lower than what was assessed in the UIC Noise Action Plan, whereas the higher limit is identical. The large difference is due to the fact that, in some situations the wheels will have to be replaced, whereas in other situations the existing wheels can be retained. The cost assessment was based on real purchase costs from one experimental retrofitting of a series of 30 wagons, one pro forma quotation from a manufacturer, several practical values on purchase costs of brake blocks and several practical values for workshop and labour costs.

5.4. Life cycle costs per wagon

The LCCs per wagon depend mainly on the life span of wheel and brake block. Different researchers and experts within the sector have suggested that composite brake blocks would lead to higher wheel wear than cast iron blocks, but would show lower block wear in similar operating conditions. The practical information available on this is not sufficient to base firm conclusions upon. A sensitivity analysis was made, depending on two annual mileage scenarios. A crucial element in the assessment is whether or not the wheels have to be replaced. For the entire European retrofit exercise the study shows additional LCCs of 3.4 billion Euro for K-blocks and 0.9 billion Euro for LL-blocks. This result is based on the assumption that, for K-blocks, most wagons in the Eastern European countries would require the wheels to be replaced.

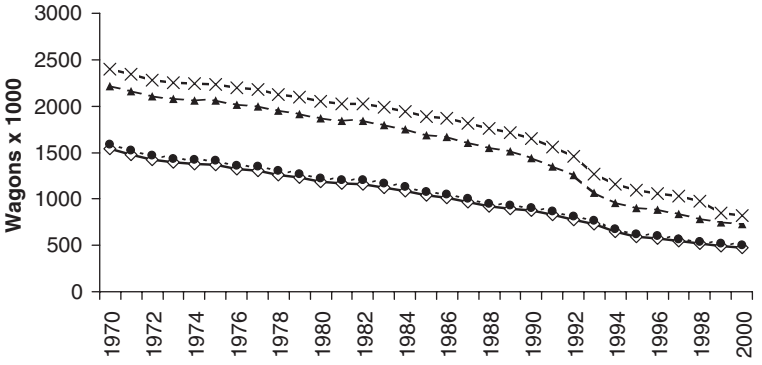

Fig. 2. Fleet size development in Europe in wagons × 1000 for the years 1970–2000 (-◇- EU 15, -●- EU 15 + Norway + Switzerland, -▲- EU Rail 25, -×- EU Rail 27).

6. Implementation scenarios

Different implementation scenarios emerge from different priorities. For instance, priority could be given to annoyance reduction, treating the wagons first that do a high mileage or that run in sensitive areas. The conditions were defined such that a reasonable time frame shall be applied (maximum 10 years) to the retrofitting and that the process should start with a reasonably small delay (i.e. in 2005). The *basic* (*and preferred*) scenario is to combine the retrofit with the regular overhaul of the freight wagon, which takes place typically every 6–8 years (this maintenance cycle is increasing, mainly on the basis of corrective maintenance steered by the actual status of the wagon). The main advantage of the basic scenario is that the costs for transfer of the wagon to a workshop can be avoided. As these costs are relatively large, the basic scenario is to be preferred from a cost point of view. In all other scenarios, there are logistics problems that are quite difficult and expensive to solve.

For the management of the retrofitting process, it is recommended that an overall strategic management and an internal operational management shall be put in place, in order to guarantee and monitor progress and reporting.

7. Funding options

Without a clear incentive the retrofitting will not take place in the desired scale. Incentives may be of legislative or economic nature, the latter one being preferred by the sector. The most promising instruments are direct subsidies (from EU and Member States), specific favourable loans (e.g. from European Investment Bank), in combination with early scrapping and tax exceptions, and differential track access charges.

The expected noise reduction is sufficient to avoid the use of noise barriers in many cases. This could lead to large savings for society in countries, which have noise legislation in place [6]. State aid to infrastructure managers is allowed under European directives, which could lead to the application of differential track access charges as a feasible, but not first priority, instrument [7]. State aid could compensate for the loss of income of the infrastructure manager, due to the lower access charges received when more trains become quieter. Alternatively, the state aid could take the form of early scrapping subvention. A harmonised approach is required to achieve the full effect on a European scale.

8. Outlook

The homologation of two different K-blocks by UIC in October 2003, as well as the adoption of the Technical Specification for the Interoperability for the Conventional Rail System foreseen in due course, pave the way for the gradual introduction of K-blocks as the low noise solution for new freight vehicles. K-blocks will become the standard, but the introduction through renewal only will take a long time. For the existing fleet, LL-blocks would become available within a realistic timescale if the technical questions have been sufficiently answered in order to allow UIC to turn the 2-year preliminary homologation into a definitive one.

Under the European Noise Directive, noise action plans will have to be produced, and that together with political pressure urges the rail sector to take firm decisions on the retrofitting of the existing wagon fleet. Recent examples in the Netherlands show that, even on a local basis it could be advantageous not to choose the standard solution of noise barriers, but to use the budget available for their construction to implement cost-effective ways of noise control in the form of incentives for quiet vehicles.

Acknowledgements

The authors wish to express their gratitude to all those who contributed to the study. In particular the members of the consortium and the parties who provided information in writing or in the interviews have contributed significantly to the work.

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