European Commission

Working Group Railway Noise of the European Commission

Position Paper on the European strategies and priorities for railway noise abatement

Version 19403

WG Railway Noise of the European Commission

Position Paper on the European strategies and priorities for railway noise abatement

Europe Direct is a service to help you find answers to your questions about the European Union

New freephone number:

00 800 6 7 8 9 10 11

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu.int).

Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 2003

ISBN 92-894-6055-5

Printed in Belgium

PRINTED ON WHITE CHLORINE-FREE PAPER

Table of Contents

Advisory note from the European Commission Services

This position paper was prepared by a working group of railway noise experts set up by the European Commission in order to provide guidance on possible European strategies and priorities for railway noise abatement. It should not be considered as an official statement of the position of the European Commission.

Executive Summary

Railway noise can be reduced considerably in the near future

The Green Paper Future Noise Policy of November 1996 [11] by the European Commission states that the “public's main criticism of rail transport is the excessive noise level”. This problem will be exacerbated by the modal shift from road and air transport to rail transport as demanded by policy makers (in part due to environmental reasons) and planned by the railways themselves.

Railway **freight** traffic is the main contributor to the noise problems of the European Railways followed by high speed and inner-urban railway lines.

There is a high potential for the reduction of railway noise in Europe. Although the **technical instruments** for a considerable reduction of the freight noise problem are **available**, the main problem is the economically viable implementation of the noise abatement measures. The implementation of the strategies proposed in this document would significantly contribute to the achievement of the environmental policy of the EU to “substantially reducing the number of people regularly affected by long-term average levels of noise, in particular from traffic which, according to scientific studies, causes detrimental effects on human health”[15]. It is more straightforward for a railway to reduce its noise emission and reception levels than for road traffic as it is a more controlled system than road transport. Noise abatement measures could therefore be implemented in an effective and manageable way where the finance is available. Consequently, the implementation of the proposed strategies will increase the environmental advantages of rail transport. All noise abatement measures must fully retain safety standards.

The features of a common European strategy for railway noise abatement

Priority should be given to measures at the **source** (vehicles and tracks) as they generally are more cost-effective (see section 1.8).

Railway noise abatement must be based on a **shared responsibility**: all stakeholders must contribute to a common European reduction strategy.

Due to the international character of rail transport the strategy must include states currently **outside** of the European Union especially the accession countries.

Railway noise consists of various noise types: **rolling noise**, traction and auxiliary noise, aerodynamic noise (see “Existing noise problems for the railways”, section 1.2). Rolling noise is the most predominant.

For the abatement of **rolling noise** the first requirement is to apply measures to achieve smooth running surfaces on the wheels and the tracks (the strategy "smooth wheels on smooth tracks" will lead to considerable synergy effects).

The surface quality of the wheels and rails is subject to strong wear during operation. For durable noise reductions **maintenance** of vehicles and tracks is of utmost importance and should therefore be undertaken regularly.

Beyond managing roughness other measures such as damping and shielding elements can be used to reduce noise radiation.

Due to the long lifetime of rail vehicles it is required to implement measures for new and for **existing** vehicles.

The main responsibilities of the **European Union** are the noise regulations for **new vehicles** and the harmonisation of corresponding procedures, standards and information. Within the Directives for Interoperability the EU is going to implement noise emission levels for "interoperable" vehicles (operating on the trans-European rail network TEN-T). The WG strongly supports the prompt implementation of this instrument and its extension to other types of railbound vehicles.

The most important problem, the noise reduction of the **existing freight wagons**, requires a European wide retrofitting programme which does not jeopardise the competitiveness of the railways. The best practice example of such a programme is the Swiss railway noise abatement programme with a fixed time table for the implementation of the reduction targets and reliable funding of the required financial means without using railways budgets. However, EU public funding rules currently limit this financing route.

The highest priority in railway noise research is the development of affordable retrofitting techniques.

Part of the funding of measures on the vehicles could be made available by **shifting part of the means** from secondary abatement measures such as noise barriers and sound insulating windows to the rolling stock, especially to retrofitting the freight wagon fleet.

Noise emissions from the **tracks** should be dealt with at the **national** level but it is important that there is a common understanding of the options for noise control on the track. Possible options include:

- control of rail roughness by means of track design and maintenance;
- improvement and development of track design to reduce noise emission, including add-on components such as rail dampers, absorption and low track-side barriers, but also novel track structures as they are developed.

Priorities

For **the most important railway noise problem** of **freight transport** the working group has identified two essential instruments:

- noise emission limits for new interoperable vehicles;
- the retrofitting of the existing cast iron block braked freight wagons.

A significant noise reduction in the average daily levels can only be achieved when the major part of the vehicles in operation have been retrofitted. Procedures including financing must be found to accelerate the implementation of noise reduction. The WG recommends an implementation schedule of no longer than 10 years.

For the **railway noise problem in general**, the WG Railway Noise has identified the following most promising **additional** instruments:

- implementation of normal maintenance grinding programmes also taking noise emissions into consideration;
- member state and EU funding for research and development;

- national noise reception limits for new houses along existing lines;
- public funding for noise abatement programmes;
- incentives for the use of low noise vehicles;
- noise emission limits for new **non**-interoperable vehicles;
- improved measurement standards for railway exterior noise;
- specifications for the noise emissions in procuring/ordering new vehicles and tracks;
- noise emission reduction by track upgrading or new design.

Foreword

Tasks of the WG Railway Noise

Within the new noise policy of the European Union a Working Group on railway noise was convened in December 1999 as one of the Working Groups dealing with noise emissions from transport and industry reporting to the Steering Group on Environmental Noise. Members of the WG Railway Noise [1, Annex I] have been nominated by the member states of the European Union, the NGOs and the railway associations UIC[1], UIP[2], CER[3], UNIFE[4] and UITP[5]. For the European Commission the Directorates-General for Transport and Energy (DG TREN), Environment (DG ENV), Research (DG Research) and Enterprise (DG ENTR) are represented. The tasks of the WG Railway Noise are defined in the Terms of Reference (ToR) of December 1999 with a last update in November 2002 [1].

According to the ToR

"the working group shall elaborate the technical and economic aspects of the reduction of noise emission by rail transport systems, taking into account the results of relevant research and standardisation activities. Its output is intended to support the Common Transport Policy, the development of the EU noise policy for rail transport, and the single market for railway supplies."

One of the tasks (No. 3.1) is to

*"investigate and evaluate the impact of noise from different rail transport sources and derive **priorities** for noise abatement. Make a survey of the national approaches to mitigate railway noise in Europe in order to set out proposals for a common **European cost-effective strategy for railway noise abatement**."*

Aim of the Position Paper

This Position Paper of the WG Railway Noise proposes a European strategy for railway noise abatement. It intends to identify the most promising instruments within this strategy which addresses all stakeholders involved. It will support the implementation of the action plans for noise abatement on major railway lines as foreseen by the European Directive on Environmental Noise [2] and the current national railway noise abatement programmes.

Method for the derivation of the Position Paper

The following approaches and background studies have been carried out to inform the development of a European strategy for railway noise abatement:

- the analysis of the national approaches which in effect already show most of the relevant instruments for such a strategy;
- a study commissioned by DG TREN with the aim to assess and propose strategic instruments, carried out by Ødegaard&Danneskiold-Samsøe A/S (ODS), Copenhagen together with Akustik-Data, PSIA-Consult, STUVA, Frama 01 and Politechnico Torino

[1] **U**nion **I**nternationale des **C**hemin de Fer: International Union of Railways

[2] **U**nion **I**nternationale des Wagons **P**rivés: International Union of Private Car Owners

[3] **C**ommunity of **E**uropean **R**ailways

[4] **Un**ion des **I**ndustries **F**erroviaires **E**uropéenne: Union of European Railway Industries

[5] **U**nion **I**nternationale des **T**ransports **P**ublic: International Association of Public Transport

[3], in short "**Study Priorities**". The report contains the following items:

- inventory of existing and planned legislation in the EU member states, Switzerland, Norway, Czech Republic, Poland and Hungary on railway noise;
- evaluation of the railway noise emission situation and the state of art of noise reduction measures (case studies of best practice, not limited to the states mentioned above);
- proposals for a European railway noise abatement strategy;

- a study commissioned by DG ENV on the suitability of the draft standard prEN ISO 3095 [4] for the measurement of noise emissions from railways as a prerequisite for noise emission regulations [5][6], in short "**Study ISO 3095**"[7];
- and the intensive discussion of the WG Railway Noise with the relevant stakeholders and actors in the railway and general noise abatement field.
  There has been an especially close co-operation with
  - the European Noise Policy **Steering Group** (presentation and discussion of the WG Progress Reports [6],[7],[8]);
  - the **STAIRRS**[8] Project especially with respect to its work package 3, the "Consensus Building Workshops" [9], [10];
  - the **AEIF**[9]**.**

Relation to the other Position Papers

The WG is supposed to deliver several Position Papers according to its tasks described in the Terms of Reference. One Position Paper[10] required related to the suitability of international measurement standards for railway noise emissions for the purpose of abatement strategies especially for legislation. This Position Paper on strategies sets out the framework for later Position Papers which will evaluate and establish certain strategic elements such as noise emission limits or voluntary agreements.

Addressees of the Position Paper

The formal addressee of the paper is the Steering Group on Environmental Noise although there are various stakeholders responsible for railway noise abatement in Europe (see "The splitting of responsibilities", section 1.3). A consistent and successful noise policy must be based on this shared responsibility. Therefore the Position Paper addresses all the stakeholders involved and the most important addressees with respect to legislation evidently

---

[6] The report will be part of the Position Paper of the WG on measurement methods for rail traffic noise emissions

[7] It states that the standard ISO 3095 is a sufficient basis for type testing if the track is defined in more detail. In the future more sophisticated methods should be developed in order to better apportion the noise emission contributions from vehicles and tracks. It demonstrates the importance of a strict definition of measurement standards for noise emissions from railbound vehicles which must be taken into account for legislation

[8] **S**trategies and **T**ools to **A**ssess and **I**mplement Noise **R**educing Measures for **R**ailway **S**ystems, project funded by the EC under the Competitive and Sustainable Growth (GROWTH) Programme

[9] Association Européenne pour l'Interopérabilité Ferroviaire – European Association for Railway Interoperability, formed by UIC, UNIFE and UITP. AEIF is mandated by the Commission to develop noise emission limits for railway systemes within the Technical Specifications for Interoperability (TSI)

[10] WG Railway Noise of the European Commission: Position Paper on railway noise measurement standards, in preparation

being the European Union Institutions and the member states. Some of the proposed instruments are also applicable to other modes of transportation. Fair and equal treatment of the various transport modes also requires a co-ordinated time schedule of implementation for road and air traffic.

1 Basic targets, conditions, requirements and assumptions for European strategies and priorities of railway noise abatement

1.1 Targets of the European and member states transport and environmental policy

1.1.1 Targets in the European transport policy

The **European Commission** states in its communique entitled "A sustainable Europe for a better world" that "the Common Transport Policy should tackle rising levels of congestion and pollution and should encourage use of more environmental-friendly modes of transport"[11] [12, p.6]. In its White Paper on a common transport policy [13] the Commission proposes actions by which the market share of the railways will return to their 1998 levels by 2010 making for a shift of balance from 2010 onwards[12].

It is the general political intention to shift short haul air transport to high-speed rail transport and heavy duty road transport to rail freight transport. Generally rail transport is assumed environmentally friendly. In some cases however, new railway lines do not get acceptance from the people living close to these new lines due to concern about unacceptable noise levels. The inability to generate the necessary rail capacity will jeopardise the political objective of a modal shift.

The **railway associations** support the policy of modal shift and aim to double the passenger kilometres and triple the freight tonne kilometres within less than 20 years from now, with no additional environmental impact [14]. A prerequisite for this shift to rail transport as a sustainable means of transport is the revitalisation of the railways. This can be achieved by raising their competitiveness for example by fair prices (internalisation of external costs), by interoperability and by opening up rail transport to regulated competition.

1.1.2 Targets for Noise Abatement

The European Commission **Green Paper** (Com (96) 540) states "more attention needs to be paid to *rail noise* where some Member States are planning national legislation and where there is considerable opposition to the expansion of rail capacity due to excessive noise. In addition to supporting research in this field the Commission will investigate the feasibility of introducing legislation setting emission limit values, negotiated agreements with the rail industry on targets for emission values and economic instruments such as a variable track charge"[13].

---

[11] i.e. rail, inland navigation, short sea shipping

[12] see also Policy guidelines for the White Paper on the Common Transport Policy as adopted by the Commission in July 2001

[13] Today there is no EU-wide legislation on noise creation by rail vehicles. The Environmental Noise Directive requires that the European Commission proposes appropriate legislation for noise sources within four years. For rail vehicles the Directive on Interoperability requires the development of Technical Standards for Interoperability (TSI) including noise emissions. Therefore for rail vehicles there will be legislation on noise emissions in place until 2004.

With the **the Directive 2002/49/EC of the European Parliament and of the Council relating to the assessment and management of environmental noise** [2] the European Union is for the first time introducing noise reception related legislation. The Directive states in Article 1 point 1:

> *„The aim of this Directive shall be to define a **common approach** intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise.“*

and in Article 1 point 2:

> *“This Directive shall also aim at providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular road and **rail vehicles and infrastructure**, aircraft, outdoor and industrial equipment and mobile machinery. To this end, the Commission shall submit to the European Parliament and the Council, no later than 18 July 2006, appropriate legislative proposals. Those proposals should take into account the results of the report referred to in Article 10(1*)”

According to article 3 point (o) :

> *“ **‘major railway’** shall mean a railway, designated by the Member State, which has more than 30 000 train passages per year. “*

And point (s): …

> *„**limit values** may be different for different types of noise (road-, rail-, air-traffic noise, industrial noise, etc.), different surroundings and different noise sensitiveness of the populations; they may also be different for existing situations and for new situations (where there is a change in the situation regarding the noise source or the use of the surrounding);“*

In the same article point (u) :

> *“ "**acoustical planning**" shall mean controlling future noise by planned measures**,** such as land-use planning, systems engineering for traffic, traffic planning, abatement by sound-insulation measures and noise control of sources;”*

Article 8 about action plans :

> *“ 1. Member States shall ensure that no later than 18 July 2008 the competent authorities have drawn up action plans designed to manage, within their territories, noise issues and effects, including noise reduction if necessary for:*
>
> *(a) places near the major roads which have more than six million vehicle passages a year, major railways which have more than 60 000 train passages per year and major airports*;
>
> *(b) agglomerations with more than 250 000 inhabitants. Such plans shall also aim to protect quiet areas against an increase in noise.*
>
> *Measures within the plans are at the discretion of the competent authorities, but should notably address priorities which may be identified by the exceeding of any relevant limit value or by other criteria chosen by the Member States and apply in particular to the most important areas as established by strategic noise mapping.“*

Article 10

> *No later than 18 January 2004, the Commission will submit a report to the European Parliament and the Council containing a review of existing Community measures relating to sources of environmental noise.*[14]

No modal annoyance correction factor is to be used in the mapping of noise however the Directive does allow for their use in developing action plans.

The environmental policy of the **European Union** "aims at a high level of protection"[15]. In its proposals for the 6th Environmental Action Programme [15, Art. 6] the EU states the target of "substantially reducing the number of people regularly affected by long-term average levels of noise, in particular from traffic which, according to scientific studies, causes detrimental effects on human health". According to the **World Health Organisation** (WHO) the outside noise levels (L_{eq}) should be less than 55/45 dB(A) (day time/night time) to avoid serious annoyance or sleep disturbances [16]. Serious health effects have been reported for road traffic noise day time levels (L_{eq}) above 65 dB(A)[16] which correspond to nighttime levels above 55 dB(A) . The WHO targets are more or less reflected in the noise reception limits for new and substantially upgraded railway lines in the member states (see section 2.4.2). Based on the precautionary principle the short term target for existing railway lines should aim at avoiding levels which are detrimental to health.

Priority should be given for measures at the source.

Equal treatment of all modes of transport in noise abatement and environmental policy should be an objective. Equal treatment includes taking into account the different annoyance of the noise levels of different traffic modes: Former WG 2 from EC noise policy concluded, that road traffic noise is by 5 dB less annoying than air traffic noise and that railway noise is another 5 dB less annoying than road traffic noise. These results have to be taken into account in all noise abatement programs. All noise abatement measures must fully retain safety standards.

1.2 Existing noise problems for the railways

1.2.1 Characteristics of railway noise

As with all traffic noise, railway noise can be described in terms of the daily average noise emission of the traffic flow, but also in more detail in terms of the noise characteristics of individual trains, vehicles and tracks. Most current national legislation is limited to reception limits for daily noise levels, which *for railways* is based on *calculations* of noise emission from the traffic flow at a given location.

---

[14] The Commission has declared that "it will evaluate the need to come forward with new legislative proposals, reserving its right to decide as and when itwould be appropiate to present any such proposals", Official Journal of the European Communities, L189/26 of 18th July 2002

[15] see the Consolidated Version of the Treaty Establishing the European Community, Article 174 (ex Article 130r:
–Community policy on the environment shall aim at a **high level of protection,**
–It shall be based on the **precautionary principle**, environmental damage should as a priority be rectified **at source** and the **polluter should pay**)

[16] i.e. increased risk of ischaemic heart disease is consistently found at high noise levels, but the results of the individual studies seldom reach statistical significance. On the basis of the prospective studies the relative risk is estimated to be in the range of 1.1 – 1.5 at noise exposures above (daytime L_{Aeq}) of 65– 70 dB(A), see [17]

Whereas the management of the traffic flow, i.e. train types, composition, timetables and speeds, is important for the daily noise emission, the noise emission characteristics of individual trains and tracks are an important factor in reducing noise at the source, as this works cumulatively. This is illustrated in figure 1 below, which shows an example of the time histories for 24 hours, for a single train passby and for selected wagons in that train.

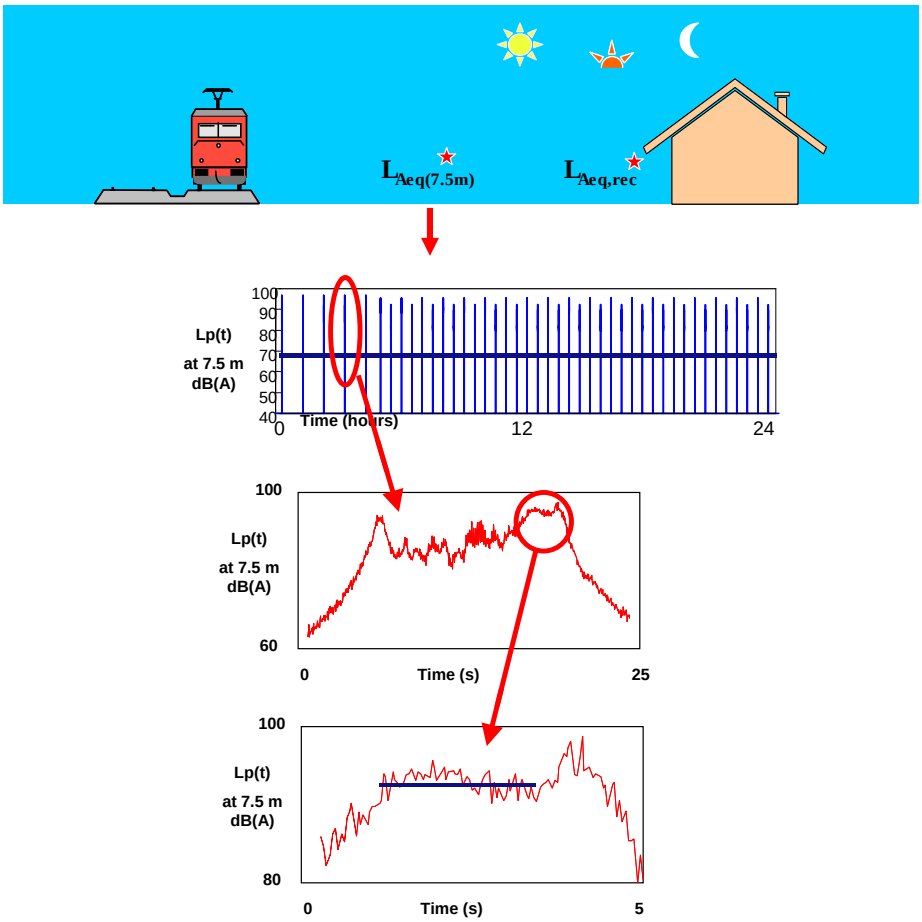


Figure 1: Example of the time histories for 24 hours, for a single train pass-by and for selected wagons in that train

When considering the noise emission characteristics of individual train or vehicle types, there are a number of major noise sources, which are relevant for particular situations, as illustrated in table 1.

These main situations, which are relevant for the management of environmental railway noise, are the pass-by situation, which includes constant speed, acceleration and deceleration; stationary noise (in and around stations), and shunting noise, which includes a variety of noise sources.

Noise situation	Pass-by noise: Constant speed and acceleration/ deceleration	Stationary noise	Shunting and other
Noise sources	Rolling Traction/auxiliary Aerodynamic (Locally: Squeal, Impact, bridges)	Traction/auxiliary	Squeal/Impact Traction/ auxiliary Rolling

Table 1: Major noise sources relevant for particular situations.

The predominant types of noise source can also be given per train category as indicated in table 2.

	Rolling noise	Noise from traction and auxiliary systems	Aerodynamic noise
Freight trains	++	+	
High speed trains	++	+	++
Intercity trains	++	+	
Urban trains	++	+	

+: Relevant

++: Highly relevant

Table 2: Main types of noise source for four train categories

Train speed is a major influence parameter for noise emission. The noise due to traction and auxiliary systems (diesel units, electrically driven powertrains, cooling equipment, compressors), if present, tends to be predominant at low speeds, up to around 60 km/h. Wheel-rail rolling noise is dominant up to speeds around 200-300 km/h, after which aerodynamic noise takes over as dominant factor. The transition speeds from traction noise to rolling noise and from rolling noise to aerodynamics noise depend entirely on the relative strength of these sources. The rolling noise, for example, depends strongly on the surface condition (roughness) of wheels and rails, whereas aerodynamic noise depends on the streamlining of the vehicle.

An example of typical speed dependency is shown in figure 2.

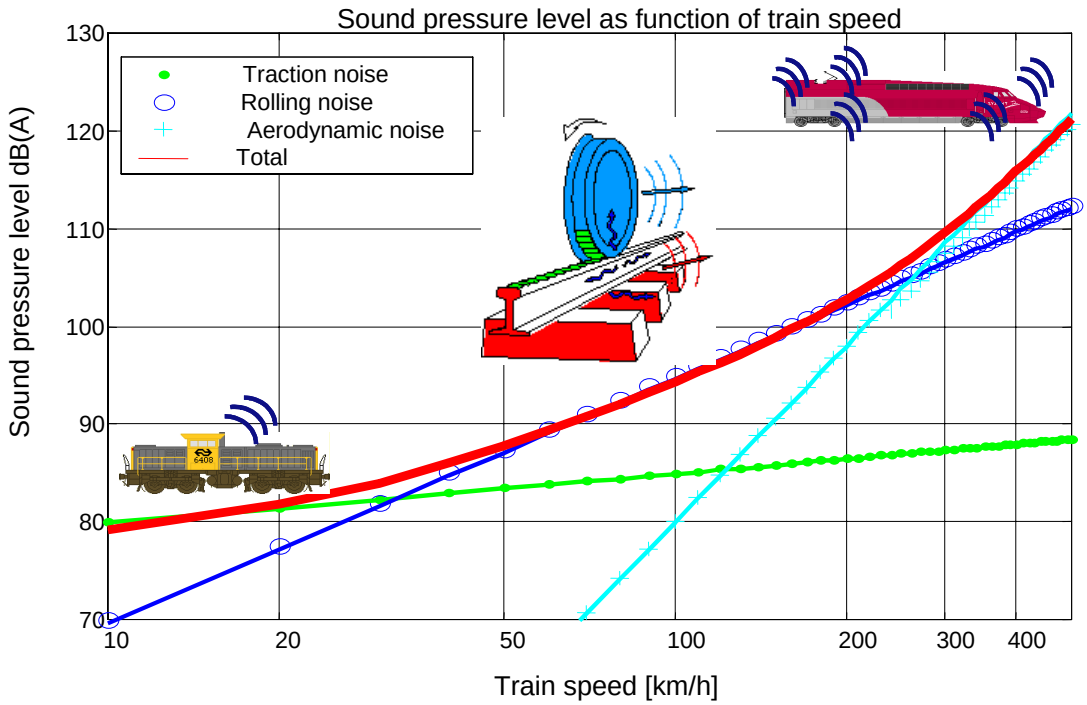


Figure 2: Railway exterior sound sources and typical dependence on train speed

1.2.2 The high importance of maintenance

Surface roughness levels of rails and wheels even grow during normal operation. Figure 3 shows the roughness levels for different conditions of the rail surface and the wheel tread [20]. Between perfectly smooth and highly corrugated rails there is a significant increase in roughness levels. In extreme situations, the variation in emission levels can be as much as +20 dB(A)[17] Such a high noise increase will only occur with the special test vehicle with perfect wheels. In normal maintenance situations a variation of +/-3dB(A) is found[18].

Figure 4 shows the increase of the noise emission levels in Germany[19] over a number of years after the rails have been acoustically ground. The increase depends on the vehicle type in use on the track following grinding, for the quietest vehicles (disc braked with smoother wheels) it is with 0.9 dB(A)/year about three times as high as for cast iron block braked freight wagons where the difference is almost negligible. About 8 years after grinding the noise emission levels correspond to an average smooth rail[20]. Therefore figure 4 also shows the reduction potential of improved rail grinding which is larger, the smoother the wheels are

[17] see measurements of the Deutsche Bahn AG on 13700 km of main routes with a measurement wagon in 1998. Measurements made in 2002 showed that 25% of the network is the same quality as acoustically ground track and some 70% is the same quality as acoustically ground track plus 5dB (based on measurement of 2000 km of track)

[18] See Siv Leth: "Noise Reduction Scenarios for Compliance With Future Noise Legislation" 7th IWRN 2001 Portland, Maine.

[19] The data are based on numerous measurements made by the German Environmental Agency (UBA) [21] on the network of the Deutsche Bahn AG. Acoustic grinding is based on special grinding techniques which reduce the rail roughness levels (see curve "very smooth" in figure 3)

[20] Normal maintenance grinding intervalls are shorter: in Switzerland the average intervall is four years, in France on the TGV lines two years.

("synergy effect"). The cost / benefit consequences of additional grinding need further analysis.

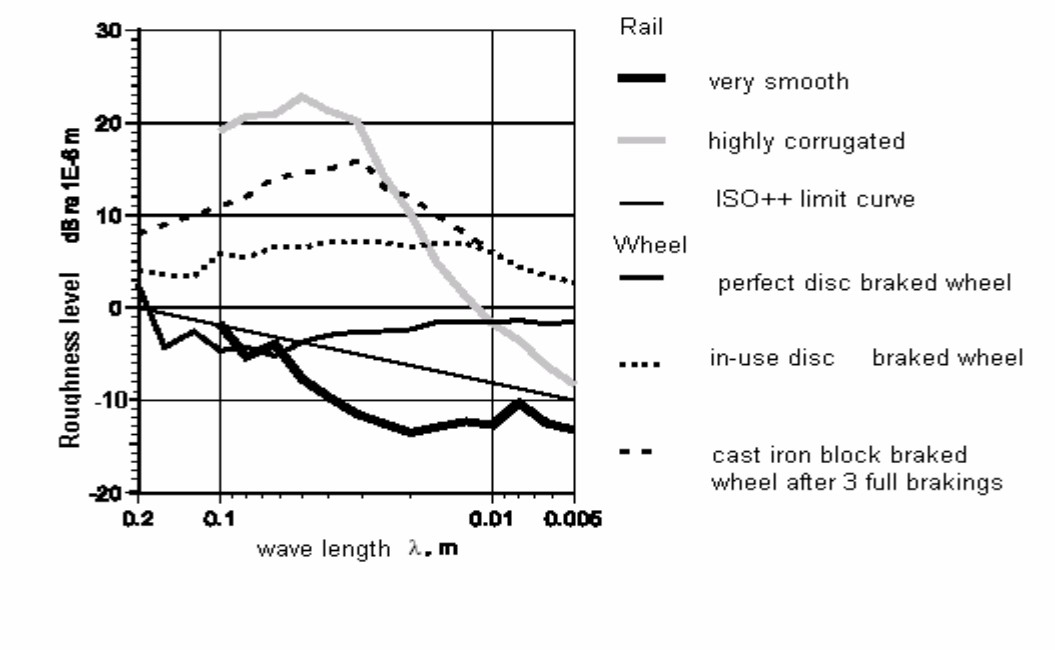


Figure 3: Roughness level spectra for different rail and wheel conditions

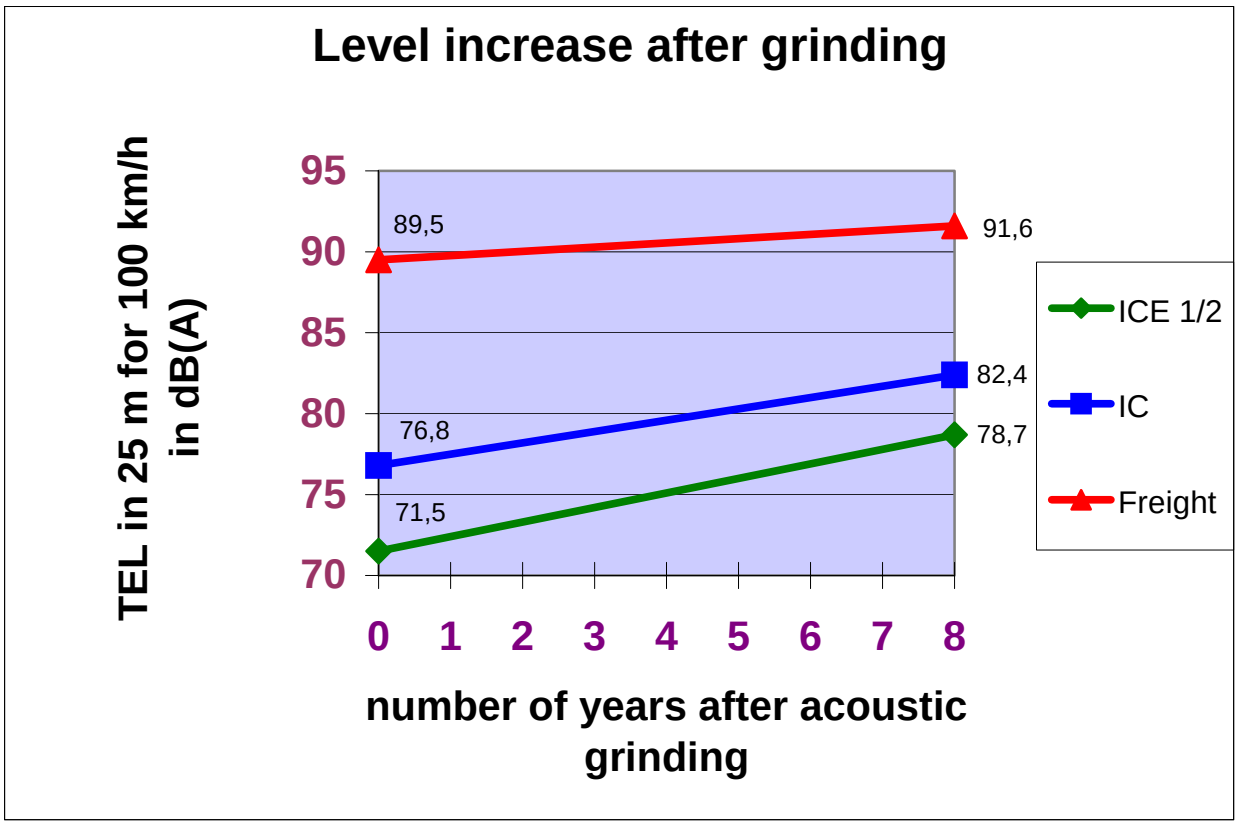


Figure 4: Simulation of increase of noise emission levels after acoustic rail grinding (combining measurements of noise level increase following acoustic grinding for 3 years and for operational grinding after 3 years)

A study sponsored by the EU-project Promain may provide data on the actual rail roughness on the European Railway Network in 2003.

1.2.3 Railway noise abatement in the past and current noise problems

In the past railway noise has been reduced. The equipping of most new coaches with disc brakes instead of cast iron block brakes has led to a significant reduction of noise generation. Since cast iron block braked vehicles have rougher wheels than disc braked ones and wheel/rail roughness is the main driver for rolling noise, focus has to be put on the replacement of cast iron brake blocks.

The replacement of jointed track with continuously welded rail across much of the European network has also lead to significant local reductions in noise creation[21].

However, the progress was not primarily planned as a noise reduction measure but was due to other operational requirements. Disc brakes had to be used on modern coaches to allow speeds above 140 km/h. This was not required for freight wagons, which is why noise generation from this type of rolling stock did not change significantly during the last decades. This lack of technical progress has made noise from freight wagons the predominant railway noise issue in Europe particularly for operation at night.

Present plans in Europe foresee high speed trains running at speeds up to 350 km/h to form a Trans-European high speed railway network. Noise from high speed lines mostly operating during the day-time is the second main noise issue . The issue offen arises at the planning stage of new high speed lines or services when noise mitigation becomes a key requirement. Noise from high speed trains (at speeds above 250km/h) has different characteristics to that of freight wagons. With increasing speed aerodynamic noise from the upper part of the train becomes dominant with the pantograph and recess, cab profile and gaps between carriages as a significant problem since most of the noise barriers are too low to shield this source.

The third issue is urban rail transport. Trams and urban light rail systems mainly operate in densely populated areas sometimes on a separate track but in many cases on roads together with road vehicles.

Finally, there are local railway noise issues such as curve squeal, brake screech, noise while passing railway stations, noise in shunting yards or on un-ballasted steel bridges which do not concern as many people as freight and high speed traffic but nevertheless can lead to a significant local annoyance.

1.2.4 Current railway noise exposure data

Until recently only very general data on noise exposure were available in Europe, with the exception of some countries. Furthermore, these data are not comparable as they are based on diverging calculation schemes[22]. The European Environment Agency estimates in its TERM 2001 report [18] “that 30% of Europeans are exposed to road noise levels, and around 10% to rail noise levels above 55 L_{dn} dB(A) (L_{dn} day/night level over the whole day with a 10 dB(A)

[21] NL noise prediction scheme shows overall reduction of 4-7dB between jointed track and continuous welded rail.

[22] The Directive relating to the assessment and management of environmental noise will be an important step in gathering harmonised data on noise exposures in Europe, see: [2]

penalty for night time noise [22:00 to 7:00])". The national exposure data[23] for rail transport show that night is the critical period in countries where there is night freight.

Examples of national noise levels are:

- Germany: 3.1% of the population exposed to levels at day time above 65 dB(A), but 10,3% at night time above L_n 55 dB(A);
- Switzerland during the daytime, 1.5% to 6.6% are exposed to similar levels of railway noise, but 8% to 27% to road noise and at night 1% to 4% are exposed to rail, but 8 to 32% to road noise[24];
- the mean noise reception levels at 25m from the track on the Italian lines Firenze-Bologna and Torino-Modane are 70 to 71 dB(A) at night and higher than during the day time);
- highest recorded levels in Germany at night are up to 79 dB(A) (L_{eq} at 25 m distance from the track centre line) caused by freight traffic.Compared with the short term reduction targets (see Chapter 1.1.2) this implies a necessary reduction, at specific problem sites such as this, of up to 19 to 24 dB(A) (this would include use of secondary measures) depending on whether or not the "railway bonus" is applied. Further reductions will be needed if the aspired modal shift is implemented.

It would therefore seem likely that a goal of a 10-15 dB(A) reduction in exposure (focussing on the most noisy sources) is necessary across Europe in the near future to provide a significant improvement in noise exposure levels for the majority of the population affected by railway noise. Further action will obviously be required in severe situations which may include secondary measures.

1.3 Differences in the member states

There are many differences in the member states concerning railway noise:

- **magnitude of exposure**: This varies depending on the population density, the traffic volume and characteristics (e.g.vehicle park & it's emissions), geographical topology, network topology and density;
- **importance** of railway noise relative to other environmental problems;
- **policy**: The level of awareness and the priority given to environmental noise varies. Some states (NL, UK) are even taking action to protect quiet rural areas;
- **legislation**: Most of the member states have railway noise legislation for new lines, only few for existing lines and vehicles (see for reception limits 2.4.2, emission limits 2.4.5);
- **methodology**: In those states that have a national prediction scheme, those schemes show significant differences as a result of the methodology used and differences in track and vehicle characteristics. Also the fleet composition differs from country to country;
- **population density**: High population density in combination with a dense and expanding rail network increases the need to address the railway noise issue. Especially in areas

[23] see National Reports for the 2nd WG Railway Noise meeting

[24] Report ‚Umwelt in der Schweiz' BUWAL und BFS 1999

where new housing closes in on existing or new lines the potential for noise problems is enlarged;

- **investment, maintenance and public funding**: The differing levels of investment and maintenance of tracks and vehicles result in differences in noise emission and exposure levels between member states, although this seems to principally relate to conventional and urban railways. The level of investment also affects the amount and type of noise abatement measures taken.

1.3.1 The development of abatement

The reduction of railway noise reception levels can be achieved by three essential types of measures: on the vehicles, on the tracks or in the sound propagation path. In the past the latter type of measures was most common. As current practice measures such as barriers (with high costs) or sound insulating windows (with limited effect) are mostly chosen instead of cost-effective source-related measures (Betuwe line in the Netherlands, Italy). The reasons for this include:

- the sound propagation measures were normally taken due to noise reception limits which have to be observed **locally** whereas the vehicles are often of **global** origin and beyond the influence of the local auhorities;
- vehicle emission limits which could enforce measures on the rolling stock exist only in few countries;
- instruments to evaluate the best solutions from a cost benefit point of view and to apportion the contributions of vehicles and tracks and the associated responsibilities have only been developed recently;
- the application of traditional barriers and sound insulating windows does not need much innovation;
- lack of knowledge of viable alternatives at project management level.

In some cases vehicle-based measures were also implemented, for example:

- in urban rail networks with propriety vehicles and limited applicability of secondary measures;
- for completely new lines with special vehicles (high speed lines) and in countries with vehicle noise emission limits;
- on new passenger vehicles and on a few new freight vehicles due to procurement specifications.

Recent investigations have illustrated the important contribution of measures at the source to cost-effective solutions (Swiss railway noise abatement programme (see box, section 2.4.11), UIC “cost&benefit analysis study”, STAIRRS project). Therefore the principal instruments for railway noise abatement have to be assessed with respect to the enforcement or stimulation of this type of measures, and links for a common effective approach as well as instruments for the apportioning of responsibilities have to be developed.

1.3.2 The splitting of responsibilities

The process of railway reform in the last ten years started with the EU Directive 91/440 is also characterised by changes in responsibilities or functions. Although there are different institutional settings in the various EU Member States (integrated companies with a split of functions or separated companies) it is commonplace to have a variety of different entities: operators, vehicle owners, maintenance companies for rolling stock or infrastructure, infrastructure mangers and manufacturing industry[25]. This results in several formally separated parties responsible for railway noise abatement which makes it even more important to create links for a common cost-effective strategy.

The Organisation of Railway Transport in the UK

The UK railways were restructured and privatised as part of the Railways Act 1993.British Rail was split into over 130 parts, most of which were privatised during 1994.

Passenger services are run by 25 train operators under franchises let by the Strategic Rail Authority. The train operators lease stock from rolling stock operating companies (ROSCOs) and stations and depots from Network Rail. Freight services are run by owner operators using their own locos and either their own or privately owned wagons. The train and freight operators obtain use of the tracks by means of access agreements with Network Rail. Within the contracts between Network Rail and the operators there is a performance regime which places a value on all minutes on the network. Whenever delays occur on the network the value of the minutes lost are assigned and paid for by the industry party responsible. For example where delays are caused by a signalling failure, Network Rail compensates TOCs/FOCs for minutes lost.

ROSCOs buy and lease rolling stock to the operators. Light maintenance of rolling stock is carried out by the train operators themselves at depots leased from Network Rail or by contractors who run the depots on behalf of the TOCs. Heavy maintenance is contracted out by both the ROSCOs and TOCs to heavy maintenance suppliers.

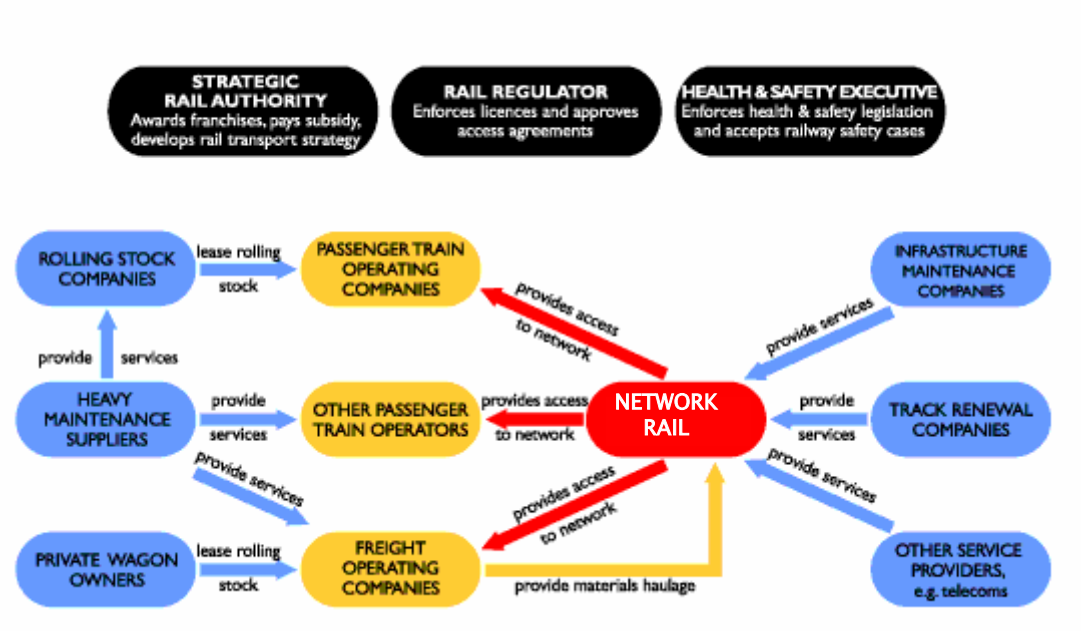
Network Rail was set up as the owner, operator, maintainer and developer of the infrastructure. Network Rail is responsible for the development of the national rail timetable. The company owns 30,000 kms of track, 2,500 stations, 90 light maintenance depots, 40,000 bridges and tunnels, 1,100 signal boxes and over 1,000 freight terminal connections. The majority of Network Rail's income is determined by the industry's financial regulator, the Office of the Rail Regulator (ORR), in a periodic review conducted every five years.

All maintenance, renewal and upgrading work managed by Network Rail is carried out through contractors. Maintenance of the network is let on large long term contracts to infrastructure maintenance contractors on an area basis. There are currently seven maintenance contractors

None of the contracts between parties in the industry specifically deal with noise. The contracts between Network Rail and Train Operators includes an environmental clause placing responsibility for investigating and deciding action on environmental conditions. Under this clause Network Rail can decide on action to be taken by the Train Operators but have few contractual levers to force them to comply. The access charging regime does not currently have any provision for differential charging based on environmental criteria, including noise. No parties in the UK currently have a duty to map noise

[25] As an example see box: The Organisation of Railway Transport in the UK.

Diagram Showing a Simplified Model of the UK Rail Industry



1.4 The European railways' competitive situation

The evolution of the modal split has been unfavourable to the railways in Europe (especially in the freight sector: from 21% in 1970 to 8% in 1998[26]). There are several reasons for this: the lower productivity of the railways compared to other modes (especially in international transport due to complicated procedures at border crossings and insufficient interoperability) and European and national transport policies in favour of other modes (partly because account is not taken of their higher social costs). As a consequence of the competitive situation the railway companies insist on at least cost-neutral mitigation strategies (see proposal of a voluntary agreement to the Commission for the improvement of freight wagons). The WG Railway Noise is proposing an approach which corresponds with the general environmental policy of the Union, which takes the full range of noise reduction technology into consideration, evaluates the corresponding costs and takes into account the aim of the European transport policy to shift from road transport to rail. It is matter of policy to assess the mitigation options, to implement reduction targets and to design a corresponding transport policy (including appropriate State and/or EU aid) which prevents noise abatement from jeopardizing the railway competitiveness.

[26] Considered modes are road, rail, inland waterways, sea (intra-EU), pipelins, air, see [13]

1.5 The long life of railway vehicles

In comparison to road vehicles, railbound vehicles have a much longer life(10 in comparison to about 40 years respectively) with benefits in terms of resource consumption. As regulations are normally only applied to new vehicles, product solutions or procedures must be found to accelerate the implementation of noise reductions for vehicles already in use. The figure 5 shows the slow pace of reduction of average levels if old vehicles are replaced with a constant rate of 2.5% per year by new wagons with a noise emission reduction of 10 dB(A). After 20 years the levels will be reduced by only 2.6 dB(A).

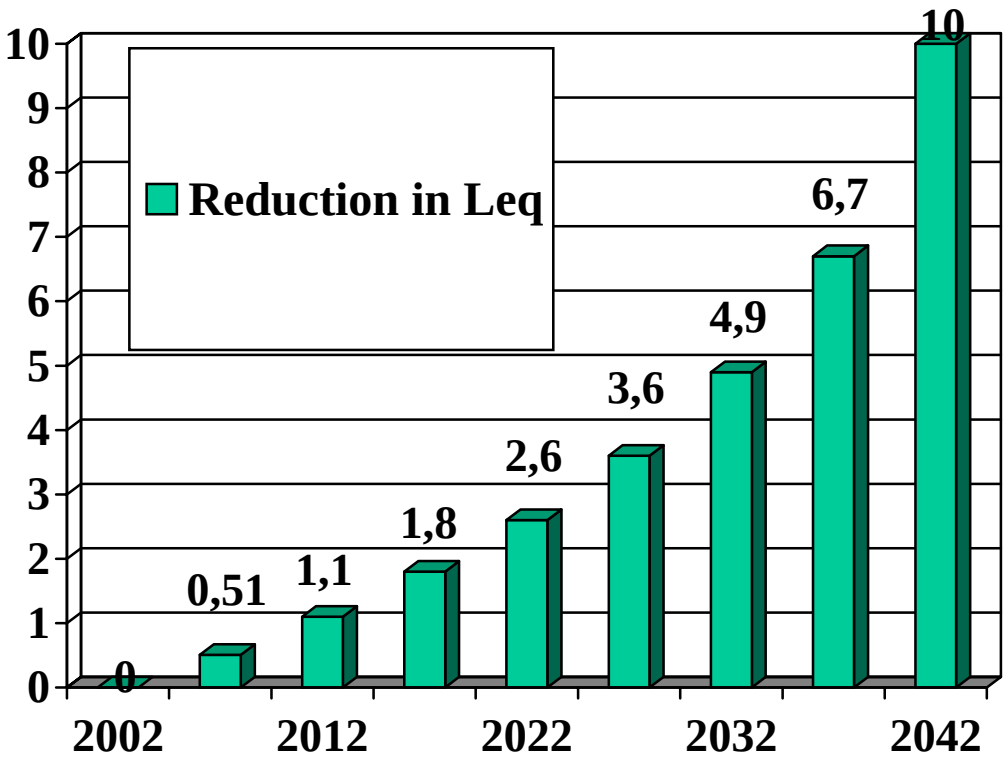


Figure 5: Reduction of average levels due to new vehicles with ΔL = 10 dB(A) (linear substitution of old vehicles, assumed life time 40 years)

1.6 The international character of rail transport

Due to the international nature of rail transport a large amount of the vehicles running on most of the national network are of foreign origin. As already a small number of noisy vehicles determines the noise impact national or European abatement strategies need to be complemented by measures which address these “extra communitarian” vehicles. Of course, the enlargement of the EU will bring these vehicles under European regulations which will have additional financing implications in particular for any retrofitting programme.

1.7 The basic principles and instruments for the reduction of railway noise

1.7.1 General Principles for reduction of negative effects of Transport

In general the following are essential principles in reducing the negative effects of transport[27]:

- avoiding transportation or making transport more efficient[28];
- hifting to modes with lower environmental impacts;
- reduction of the emissions (measures at the sources):
  - technical measures on the vehicles and on the traffic lines;
  - operational restrictions (speed, volume, nighttime restrictions);

To address local problems, additional reception-related measures are available:

- land use planning (new lines and/or residential areas);
- measures applied in the propagation path;
- traffic regulation (bundling, use of less sensitive areas for transport);
- measures applied to the buildings.

This Position Paper concentrates on the **technical measures at the source** considering that:

- the reduction of noise **emissions** is the main task of the WG;
- operational restrictions would counteract the transport policy target of the European Union and of the member states to shift transport volumes to rail;
- measures at the source generally have a favourable cost-benefit ratio (see Box ”General overview of Swiss Railway Noise Abatement Program”, section 2.4.11 and the results of the STAIRRS project).

1.7.2 Measures at the source

The main railway noise sources are traction noise, rolling noise and aerodynamic noise (see section 1.2.1 for illustration). Noise control on these sources can be applied in new design or redesign (retrofit) and has to be retained by maintenance of vehicles and tracks.

For **rolling noise** the following applies

- smooth wheels and smooth tracks ensure minimal **noise generation**; this implies
  - the use of braking systems that maintain smooth wheel running surface such as disc or drum brakes or composite-block brakes for block-braked vehicles, and
  - appropriate maintenance of the tracks and the wheels;
- compact, massive design incorporating vibration isolation and high damping ensures a minimum of **structure-borne noise transmission** in the track and the wheels. Examples are:

[27] This is true for all transport modes

[28] for example by increasing the occupancy rate

- smaller wheels and/or wheel dampers, optimised wheel geometry;
- fewer wheels;
- wheel-mounted disc brakes;
- optimised track design, or rail damping devices in combination with railpad selection;

- shielding (secondary measures) can reduce radiated sound, by applying
  - wheel-mounted, bogie-mounted or vehicle-mounted shrouds;
  - low noise barriers close to the rail.

For **traction** noise the following applies:

- for diesel driven locomotives or trainsets, a low noise design should be ensured for new vehicles, although retrofit may be possible. Noise control measures are:
  - appropriate exhaust and intake design (high insertion loss);
  - effective engine enclosure and vibration isolation;
  - selection of quieter components such as turbocharger, compressors and fans.

A fundamental issue is that noise specifications are often set for unloaded pass-by, whereas in many operational conditions, locomotives pull a heavy load, producing high noise levels.

- For **electric** locomotives and high speed trains, especially the noise from the cooling equipment can be a problem. This is best tackled in the design stage, although sometimes retrofit may be possible. This might include:
  - elimination or smoothening of obstacles in ducts, intake and outlet;
  - quieter fan design;
  - increase in fan efficiency by selecting the best working point.

- For lower speeds gear noise can be a problem. This must be dealt with in the design phase. One reduction technique is to create sufficient overall contact ratio in the gear mesh.

For **aerodynamic** noise the following applies:

- for high-speed trains the aerodynamic noise can be a predominant noise source at speeds above 250 km/h, with contributions from various heights. Noise barriers lower than 4m have insufficient effect on sources located at the top of the vehicle such as the pantographs and their recesses. Aerodynamic noise can be reduced by:
  - streamlined covers for the bogies;
  - avoiding extruding parts or cavities along the train;
  - streamlining and covering of the pantograph and its recess area;
  - streamlined front of the vehicle.

Measures – Availability of technology

At present, the following technology is available for the various noise sources:

- traction noise: in principle, all of the above mentioned noise control measures are available to minimise traction noise at the design stage. The remaining issues are then the cost and maintainability. Retrofitting only for the purpose of noise reduction is generally not economically feasible;
- rolling noise: the most effective means of control is that of wheel and rail roughness. Here the technology is available (K-blocks/disc brakes, rail grinding systems) but also depends on the cost. Add-on systems such as rail and wheel dampers are available but have limited effect; in particular the effect is not always measured properly, if wheel and track contributions are not separated. The same is true for wheel and bogie shielding. New design of wheels and tracks provides the next best option after roughness control; vehicles with smaller and less wheels, and quieter track design are longer term, but beneficial investments. Local application of low noise track has the potential to reduce noise at low and medium speeds. This can even apply for cast iron brake blocked vehicles, thereby adding to the effects of long term retrofit programmes before all retrofitting is complete;
- aerodynamic noise: recent generations of high speed trains have illustrated the improvements in this field; the streamline design of new trains often benefits both noise and energy consumption. Further streamlining is possible, in particularly the covering of the bogie areas; this however has cost and maintenance consequences.

1.7.3 Measures applied in the propagation path

Noise barriers are the most commonly applied noise abatement measure applied in the propagation path. They are applied on a wide scale both on existing and new lines. Typical noise reductions are up to 10 dB depending on the barrier height, distance to source and receiver, and barrier absorption. In many cases barrier performance is severely limited by the track layout (e.g. multiple tracks), the height of the sources and by the height of adjacent multi-storey residential buildings. Barrier performance is best if the barrier is close to the source or to the receiver. Noise barriers are generally less cost effective than noise control measures at the source. This has been demonstrated in the STAIRRS project (see Annex II) and other studies. Barriers also have other disadvantages such as visual intrusion and high cost.

Another way of reducing sound propagation near railways is the construction of non-noise sensitive buildings between the railway and other residential buildings.

2 Instruments of implementation of noise reduction

2.1 General remarks

On the following pages the principal instruments for railway noise abatement in Europe will be presented and evaluated. 17 main instruments have been identified. In the course of the evaluation some main instruments have been divided into subinstruments (e.g. noise emission limits into noise emission limits for interoperable and non interoperable vehicles). The evaluation is performed for both types of instrument. An overview is given in the following table and on pages 71 to 74.

Para-graph	Instrument	Area of application	WG Evaluation	
			Priority	accepted
2.4.1	**Retrofitting of existing railway rolling stock**	**Emissions from existing vehicles**	**high**	**yes**
2.4.2	**Noise reception limits (for existing line)**	**Exposure along existing lines**	**low**	**no**
2.4.2 a	National noise reception limits		medium	yes
2.4.2.b	National noise reception limits for new houses along existing lines		high	yes
2.4.2.c	limits should reflect thresholds for serious health effects		medium	yes
2.4.2. d	level increase due to higher speeds or traffic volumes to be treated as substantial upgrading		low	yes
2.4.3	**Noise emission ceiling**	**Emissions from tracks and vehicles**	**low**	**no**
2.4.4	**Access restrictions for noisy vehicles types / trains**	**Vehicles**	**low**	**yes**
2.4.5	**Noise emission regulations for vehicles**	**Emissions from new vehicles**	**medium**	**yes**
2.4.5 a	limits for new interoperable vehicles		high	**yes**
2.4.5.b	limits for new non-interoperable vehicles		high	yes
2.4.5.c	regulations should deal with in-use compliance of vehicles		low	no
2.4.6	**Programmes to Manage Rail Roughness**	**Emissions from tracks**	**medium**	**yes**
2.4.6 a	normal maintenance grinding programmes should take noise emissions into consideration		high	yes
2.4.6.b	acoustic grinding is recommended		medium	yes
2.4.7	**Instrument for track upgrading or new design**	**Emissions from tracks**	**high**	**yes**
2.4.8	**Regulations for tracks**	**Emissions from tracks**	**low**	**yes**
2.4.8 a	EU track regulations as implementation of the TSI		low	no
2.4.8.b	national regulations for tracks (e.g. roughness limits)		low	yes

Para-graph	Instrument	Area of application	WG Evaluation	
			Priority	accepted
2.4.8 c	declaration of track quality and maintance schemes to EU (TEN-T) or national notified bodies by the infrastructure manager		medium	yes
2.4.9	**Specifications for the noise emissions in procuring/ordering new vehicles and tracks**	**Emissions from new vehicles and tracks**	**high**	**yes**
2.4.10	**Incentives for the use of low noise vehicles**	**Vehicles**	**high**	**yes**
2.4.11	**Public funding for noise abatement programmes**	**Exposure along existing lines**	**high**	**yes**
2.4.12	**Voluntary agreements**	**Vehicles and tracks**	**medium**	**yes**
2.4.13	**Member State and EU funding for research and development**	**Vehicles and tracks**	**high**	**yes**
2.4.14	**Information to stakeholders**	**Emissions and exposures**	**medium**	**yes**
2.5.1	**Improved measurement standard for railway exterior noise**	**Vehicle and track**	**high**	**yes**
2.5.2	**Comprehensive noise prediction scheme**	**Exposures**	**medium**	**yes**
2.5.3	**Information and participation of the public**	**Emissions and exposures**	**low**	**Equal votes yes/no**

Table 3: Instruments/subinstruments for the abatement of railway noise and the evaluation of the WG (grey areas: instruments rejected by a majority of the votes)

2.2 The principal instruments

There is a wide range from the classical stringent instruments such as state regulations to soft instruments such as public awareness. In general the scope of the noise problem with its complex responsibilities requires the application of a well-balanced mix of the following instruments:

- mandatory regulations, especially limits for noise emission and reception levels;
- economic and operational incentives such as track access benefits for low noise vehicles;
- procurement specifications;
- land use planning;
- European Union and/or State funding for noise abatement programmes;
- voluntary agreements;

- European Union and/or State funding for research and development;
- information and public awareness.

The instruments will be divided in two parts: “direct” instruments which directly lead to noise reductions or will enforce them (section 2.4) and instruments which are prerequisites and have to accompany the direct ones such as reliable and reduction-oriented assessment standards for noise or information to the public.

2.3 The principal stakeholders

Various stakeholders have an interest in the development of this strategy. Some are responsible for and others participate in the implementation of the instruments mentioned above. This shared responsibility should be in line with the principle of subsidiarity[29]. The following stakeholders will be addressed or included in the suggestions made by the WG:

Parties responsible for aspects of implementation are:

- the European Union (Commission, Council and Parliament);
- the Member States (governments, parliaments, agencies);
- regional and local authorities;
- the Railways:
  - infrastructure;
  - operators;
  - vehicle owners;
  - maintenance companies;
- manufacturers:
  - vehicles;
  - vehicle components;
  - tracks;
  - track components.

Parties who **participate** in implementation:

- rail passengers, for example in stations and for interior train noise;
- rail freight users with environmental requirements;

---

[29] Article 5 (ex Article 3b) of the CONSOLIDATED VERSION OF THE TREATY ESTABLISHING THE EUROPEAN COMMUNITY
Official Journal C 340, 10.11.1997, pp. 173-308
The Community shall act within the limits of the powers conferred upon it by this Treaty and of the objectives assigned to it therein.
In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of **subsidiarity**, only if and insofar as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community. Any action by the Community shall not go beyond what is necessary to achieve the objectives of this Treaty.

- the affected population.

2.4 Direct Instruments

2.4.1 Retrofitting of existing railway rolling stock

Definition of the instrument

It is commonly known, that wheel roughness together with rail roughness are the main parameters influencing railway noise. The main cause of wheel roughness is the use of cast iron braking shoes on older rolling stock. In the braking process, these braking shoes are applied to the running surface of the wheel causing metallurgic changes on the surface resulting in rough wheels. Such a wheel increases noise levels between 8 – 10 dB in comparison to a smooth wheel.

Composite materials have been available for several years to replace cast iron braking shoes. Using this technology results in a smother wheel surface and reduces the rolling noise of the vehicle by an estimated 10 dB, which in general halves the perceived noise. Unfortunately, composite braking shoes ("K-blocks") usually demonstrate different braking characteristics to cast iron braking shoes. This requires changes in the braking system leading to additional costs.

No composite braking shoes are available, which would allow cost neutral retrofitting.

General evaluation of the instrument

In the conventional networks, noise from vehicles (especially from the freight wagons) using cast iron braking shoes is the predominant railway noise source. A retrofitting programme dealing with large parts of these materials will result in the fastest and most cost-effective noise reduction possible. For good results large parts of the existing fleets must be involved. The measure is also very effective in combination with other measures. When applied in combination with noise barriers or tuned track absorbers, the noise reduction can be summated; this can lead to lower and thereby cheaper barriers, for example. It has been suggested that the gradual replacement of the existing fleet by new wagons would be sufficient for railway noise abatement. Since the European railways order between 1000 to 10'000 vehicles a year this is unlikely to be adequate. The existing freight fleet consists of approximately 1.2 Million vehicles; the UIC Action Program for the noise reduction of freight traffic estimates that about 650'000 of these will still be in use in the next decades. The replacement of the older vehicles by new low noise vehicles will therefore take several decades and the overall noise reduction will take a long time to set in (see figure 5).

Current implementation

In 1998 UIC/CER proposed the 'Action Programme Noise Reduction Freight Traffic' which aims to retrofit the European freight fleet in use during the next decade. The programme, however, has not started due to technical problems and most importantly due to lack of funding.

In the context of the proposed dialogue between the European Commission and the Industry on the issue of voluntary measures regarding noise emissions, the railway organisations (UIC, UIP, CER, UIRR & UNIFE) with the support of the Comission are carrying out a study addressing the following elements:

- analysis of the different technical options for retrofitting by especially taking into account

their availability and their life-cycle costs;

- investigation of the status of the existing fleet (its present age, use, adaptation to customer requirements) including a survey of existing plans to develop or renew the fleet through procurement, scrapping or upgrading;
- proposal of different retrofitting scenarios;
- assessment and proposal of funding schemes in the light of current of EU and Member State legislation and investigation of alternative financing instruments.

(see also 2.4.12 Voluntary agreements)

In a national referendum Switzerland decided in 1998 to retrofit the entire Swiss fleet until 2009. The programme is funded to a large part by taxes on lorries and fuel.

First steps towards similar programmes are being discussed in France, Germany and Italy.

Suggestions

In the Working Group there is a large consensus, that this instrument provides the most efficient means of reducing railway noise and must be promoted as a first priority for cast-iron block braked freight wagons.

To speed up implementation funding questions have to be solved. One possible approach would include using financial resources allocated to noise barriers to pay for retrofitting. Retrofitting should begin with the wagons with the highest annual mileage.

2.4.2 Noise reception limits

Definition of the instrument

Noise reception limits are commonly defined as maximum allowed average outdoor levels (L_{eq}) at the receiver. In some cases peak levels are also limited (L_{max}). The lower annoyance of railway noise with respect to road traffic noise is reflected in the application of the so-called “railway bonus” by which either the exposure levels are reduced or the limits are increased for railway noise.

The limits generally correspond to a calculation scheme for the exposure levels which includes assumptions on source emission levels and locations and on propagation models. Compliance with the limits is, in some cases such as France, checked by actual noise measurement. The limits can be achieved by source-related measures (vehicles, tracks), by measures to reduce sound propagation such as noise screens, sound shielding or insulation windows and by operational measures (speed, volume reduction) (see section 1.7).

General evaluation of the instrument

Noise reception limits can be the most effective solution for the protection of the community, if the financing of the required noise abatement measures is safeguarded. Optimisation of the measures to reduce noise reception is vital as existing studies on cost and benefits of noise abatement measures show (see above: splitting of responsibilities, section 1.3.2). If the limit applies only to the infrastructure manager and there is no incentive for operators to reduce noise emissions, this can lead to sub-optimal economic solutions (such as barriers).

Current implementation

Noise reception limits exist on a national level in various forms (see the WG Progress Report 2000 [6], Study Strategies [3], Annex I, national reports) mainly for new and substantially upgraded lines (see figure 6 from [3], Annex I). Limits for existing lines are only in force in Switzerland, Denmark, Italy and will be in Sweden from 2015 on. Mandatory reception limits or insulation standards for new buildings along existing railway lines are, for example, in force in Finland, France and Switzerland.

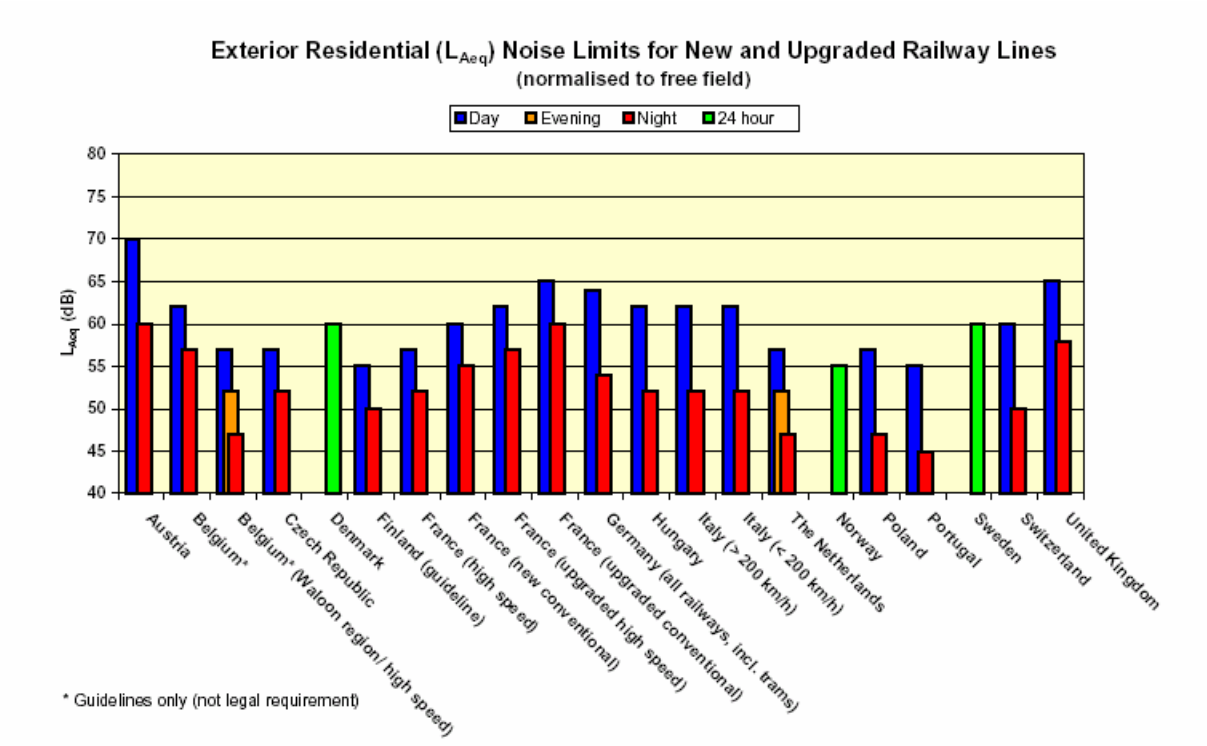


Figure 6: Exterior Residential (L_{pAeq}) Noise Limits for New and Upgraded Railway Lines Only (normalised to free field)

The national limits are not completely comparable, as they differ in terms of:

- Indicators;
- reference times;
- receiver locations (free-field (reflection at the building not considered) or at the façade); the difference in levels amounts to 3 dB(A));
- bonus b (reduction of exposure level due to minor annoyance with respect to road traffic);
- emission assumptions (levels, location);
- transmission factors (e.g. weather conditions etc);
- definition of substantial upgrading;
- sometimes the limits are increased depending on existing exposure levels (Austria, France). In Italy limits depend on the distance from the track.

The existing limits are outdoor noise reception limits which generally are only applied where technically possible and economically viable. This is handled differently from one member state to another. In some cases the regulations place an obligation on the authorities without giving any entitlement to the public.

Evaluation of the practice

The current regulations have two major deficits in general:

- in most countries, they do not cover existing lines;
- they normally imply that substantial upgradings are related to infrastructural changes. Level increases due to higher speeds or traffic volumes are not considered. In Switzerland, substantial change in transport volume is also a parameter, indicating whether a change is substantial or not.

Suggestions

This instrument in general is rejected by the WG because there is concern about the financial implications and enforceability. For its introduction at a national level there is a majority in favour and a medium priority. This instrument should only be implemented if it is applied to all sources of traffic noise.

As a medium priority the reception limits for existing lines should reflect the thresholds for noise exposure which should avoid serious health effects (see section 1.1.2) According to the Swiss experience they should also reflect the costs of implementation. There is a general agreement that reception limits for new buildings along existing railway lines should also be introduced. Alongside such schemes the EU should address the harmonisation[30] of the calculation schemes which underlie the reception limits.

Noise reception limits should be part of a source-related strategy (emission regulations and incentives for low noise railbound vehicles and/or funding for retrofitting existing vehicles still with a significant remaining lifetime).

2.4.3 Noise emission ceiling

Definition of the instrument

The noise emission ceiling is a new concept proposed by the Netherlands. It is part of the Swiss railway noise legislation. The daily averaged emission at a certain location point along the line is given a limit value in relation to the local reception levels and limits. The infrastructure managers and the operators may then utilize tracks or vehicles with lower emissions to increase the number and/or the speed of trains without exceeding limits. To a certain extent the noise emission ceiling works in the same way as a noise reception limit. Where changes are made to the number, speed, frequency or emission levels of trains, or the track characteristics, responsibility to demonstrate compliance with the ceiling would rest with the infrastructure manager (or the timetable authority).

[30] This is already started with the Directive relating to the assessment and management of environmental noise [2]

General evaluation of the instrument

The noise emission ceiling will give an incentive to use low noise vehicles in order to increase the traffic volume or speeds. Noise reception limits are a prerequisite for this instrument. Noise emission ceilings in combination with reception limits enable potential level changes due to an increase in traffic volume and speeds to be managed. The Swiss example shows this instrument as a significant part of implementation of a complete noise abatement programme.

Current implementation

The instrument is proposed in the Netherlands and will be used in Switzerland

Suggestions

A majority of the WG rejects this instrument and gives it a low priority. The noise emission ceiling should be related to and combined with targets for noise reception levels and noise abatement programmes. Then it provides a better protection against unacceptable noise exposure than mere reception limits.

2.4.4 Access restrictions for noisy vehicles types / trains

Definition of the instrument

On certain sensitive lines and/or at certain times access for noisy vehicles types or train formations is restricted. The prerequisite of access restrictions will be a classification and identification of single vehicles according to their noise emission.

General evaluation of the instrument

Access restrictions can yield a high level of protection and might be a very efficient instrument in initiating the introduction of low noise vehicles[31] if these are generally available and affordable. It is not a long term solution as it will hinder the free circulation of railway vehicles and is contradictory to the EU Transport Policy goals with the target of shifting the balance of the modes in favour of rail transport.

There is again a close relationship to noise reception limits and to emission related access charges (see “Incentives”, section 2.4.10). The conditions under which. national restrictions for noisy **interoperable** vehicles can be used must be clarified . It has to be checked for example whether a clause in the interoperability regulations could allow the national authorities to limit access for **existing** noisy vehicles[32]. At present its application to single

[31] Compare the Austrian night time lorry ban with the exemption for low noise lorries on the transit motorways since December 1989: it led to an accelerated introduction of low noise lorries.

[32] Compare Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors
Article 17:
”Regulation of use
The provisions of this Directive shall not prevent Member States' entitlement to lay down, in due observance of the Treaty:
- measures to regulate the use of equipment referred to in Article 2(1) in areas which they consider sensitive, including the possibility of **restricting the working hours of the equipment**,…”

vehicle is not practical, but it might be taken into account for whole trains. In order to implement this instrument it must work at the logistics planning stage.

Current implementation

The Netherlands plan access restrictions for certain lines in the evening and night time (see Box "**New National Regulation in the Netherlands for Goods trains")**

Suggestions

The WG gave this instrument a low priority. As flexible instruments like emission-related access charges could yield similar results, priority should be given to those instruments. It would be worthwhile evaluating the effectiveness of this instrument for specific cases based on practice.

New National Regulation in the Netherlands for Goods trains

Source: Parliamentary View on the Railway line Utrecht-Arnhem of the Minister of Transport in agreement with the Minister of Housing, Spatial Planning and Environment

June 15th 2001

(Free translation by M. Dittrich of selected section)

New regulations pertaining to noise have been introduced for a particular railway line in the Netherlands from Utrecht to the German border, which is designated for upgrading to allow for high speed trains (ICE). These regulations are outlined below. Noise is the most important topic during discussions with affected residents. The objections against noise barriers are that they form a barrier in the area and a visual obstruction. Residents are also apprehensive about barrier design and graffiti, and often doubt the effectiveness of barriers. The desired alternative of tunnelling was considered too expensive by the government.

The government has therefore stated that noise control measures at the source are preferred to noise barriers. These measures include:

- ban of the noisy freight and passenger trains, starting with the evening and night period

(there is a new freight route under construction);

- 'quieter' track (grinding and rail dampers);

both of the above in combination with lower and less noise barriers, and sound insulation for dwellings.

Agreements are to be made with operators for the transition period, on the usage of quieter rolling stock in the transition period.

The Railways Act is being changed to assign line capacity to quieter trains, and to formulate rules of usage in relation to noise emission. The Minister of Transport has stated to the Parliament that she is already fully authorised to apply these rules.

In the Ministerial decision on the ‘Hanzelijn’, the missing link for freight between Rotterdam and the Northern Part of the Netherlands, it is stated that some years before opening there will be a decision about the required noise perfomance of the trains.

2.4.5 Noise emission regulations for vehicles

Definition of the instrument

Noise emission limits for railbound vehicles define legally binding maximum allowable sound power or pressure levels for the different relevant operating conditions such as

- maximum constant speed,
- stationary operation,
- acceleration and deceleration,
- other specified conditions,

measured according to a particular protocol.

Currently, they are only used for type approval of new vehicle types.

Both maximum and average sound pressure levels are in use, also for different measurement distances from the vehicle.

Most crucial for the reproducibility of the limit tests are the specifications for the test track (see prEN ISO 3095, Annex E [4]).

The effectiveness of statutory noise limits has to be compared to that of other instruments for enforcing noise reduction measures on the vehicles such as noise specifications in ordering vehicles[33].

General evaluation of the instrument

Advantages of this instrument are :

- it will be a key control mechanism for noise reduction;
- noise emission regulations activate measures at source (complementing reception limits) which in general have a better overall cost & benefit ratio for noise abatement;
- low noise vehicles are effective in the whole network (including existing lines!);
- the principle of reduction of pollution at source is observed and the responsibility for railway noise abatement is shared;
- promotion of a single market, harmonised procurement specifications and certainty for the planning by the manufacturers.

Emission regulations for road vehicles have been in place since the 1970s and have been effective in reducing noise pollution from the sources targeted such as engine noise.

Noise emission regulations are in line with the general environmental policy of the EU including the Green Paper on Noise Policy, Council resolution of October 1999 and the END.

At the 2nd STAIRRS workshop [10] there was a general consensus among the participants that strict legislation would be required for vehicles.

[33]{ In the past decades the railways have reduced their noise generation in the passenger traffic about by the factor 2 in ordering new rolling stock including low noise techniques. Examples: TGV, Intercity coaches. In contrary no significant reduction could be achieved for the great part of the freight wagon fleet}

Current implementation

Currently, where applied, they are only used for the approval of new vehicle types in some European states and in the EU.

European States

Noise emission limits for new railbound vehicles are in force in Austria, Finland, Italy and Switzerland; the German Environmental Agency (UBA) has developed limit proposals for a possible German legislation which include in- service vehicles (see Study Strategies [3], Annex I, Retrieval of legislation). The limits in force for freight wagons are presented in figure 7[34], proposed limits are presented in figure 8. The following tables show the limits in force.

Austria:

$L_{A,max\ (fast)}$ in 7.5m/1.2m and 7.5m/3.5m		stationary	pass-by at 80 km/h	speed correction
Electric Locomotives		74 dB(A)	84 dB(A)	L(V) = L(80) + 30 lg (V/80)
Electric Multiple Units		74 dB(A)	82 dB(A)	
Diesel Locomotives		80 dB(A)	86 dB(A)	
Diesel Multiple Unit		76 dB(A)	84 dB(A)	
Maintenance vehicles		78 dB(A)	86 dB(A)	
Coaches	Cat.1	71 dB(A)	80 dB(A)	
	Cat.2	71 dB(A)	80 dB(A)	
	Cat.3	74 dB(A)	83 dB(A)	
	Cat.4	74 dB(A)	83 dB(A)	
Wagons	Cat.1	-	81 dB(A)	
	Cat.2	-	83 dB(A)	
	Cat.3	-	85 dB(A)	

Coaches Cat.1: C. for internat. Trains, sleeping cars, dining cars
Coaches Cat.2: all other long distance coaches
Coaches Cat.3: parcel vans
Coaches Cat.1: C. for regional trains
Wagons Cat.1: flats, container wagons, sliding side vans
Wagons Cat.2: other vans, hoppers
Wagons Cat.3: open wagons, tank wagons

[34] The limit indicator in figures 7 and 8 is the maximum pass-by level L_{AFmax}, which is about 1 dB(A) higher than the TEL

Finland:

$TEL_{,A}$ in 25m/3.5m	pass-by	at speed	speed correction
Locomotives	88 dB(A)	200 km/h	+1dB per 20 km/h above 200km/h
Motor Units	85 dB(A)		
Coaches	88 dB(A)		
Wagons	85 dB(A)	100 km/h	
	87 dB(A)	120 km/h	
Track construction & maintenance machinery	85 dB(A)		

Italy:

$L_{A,max\ (fast)}$ in 25m/3.5m rolling stock entering service from	pass-by **2002-01-01**	pass-by **2012-01-01**	at speed
Locomotives for Passenger Traffic	90 dB(A)	88 dB(A)	250 km/h
	85 dB(A)	83 dB(A)	160 km/h
Locomotives for Freight Traffic	85 dB(A)	83 dB(A)	160 km/h
	84 dB(A)	82 dB(A)	90 km/h
Diesel Locomotives	88 dB(A)	86 dB(A)	80 km/h
Rail Cars	83 dB(A)	81 dB(A)	80 km/h
Coaches	88 dB(A)	86 dB(A)	250 km/h
	83 dB(A)	81 dB(A)	160 km/h
Wagons	90 dB(A)	88 dB(A)	160 km/h
	89 dB(A)	87 dB(A)	90 km/h

Switzerland:

TEL in 7.5m/1.2m	pass-by at 80 km/h
retrofitted coaches	84 dB(A)

European Union

In 1983 a first EU noise emission regulation for railway vehicles was drafted[35]. Due to the problems caused by the international character of railway transport (see above) this draft was withdrawn in 1993.

[35] see the limit proposals in figures 7 and 8.

With the **Technical Specifications for Interoperability** (TSI) the Commission is currently enforcing noise emission limits for high speed trains (adopted in May 2002) and conventional trains (enforcement in spring 2004) operating on the trans-European network (TEN-T) ("interoperable vehicles"). The legal form of these regulations will be **Decisions** of the Commission instead of Directives of the Council and the Parliament. Participation of the Member States is ensured through the Article 21 - Committee as set out in the Interoperability Directive for high speed trainsets [23]. The European Parliament has the right to be informed and to react.

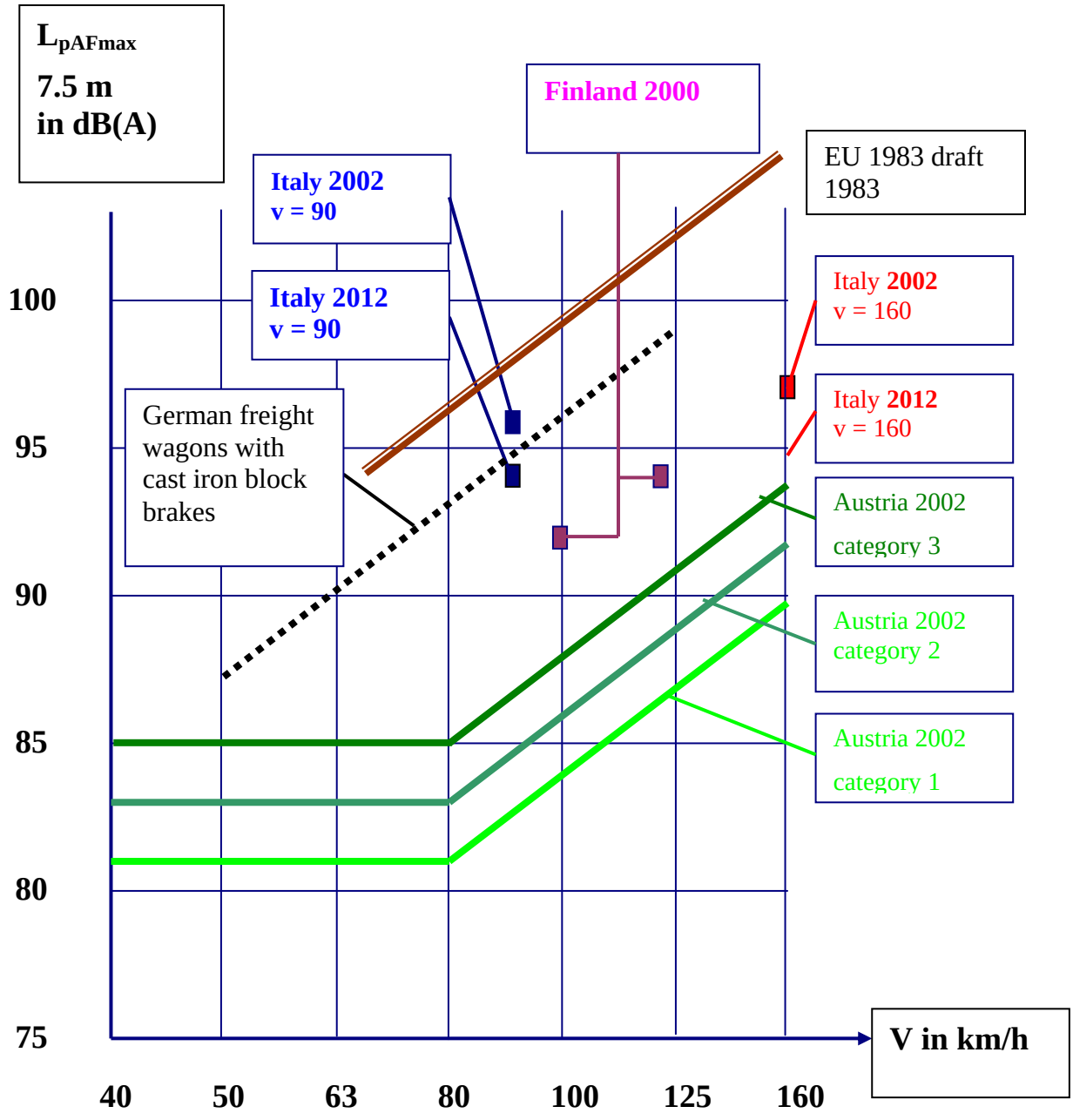


*Figure 7: Noise emission limits for **new freight wagons** in Europe: pass-by level at 7.5 m for constant speed in dB(A)*

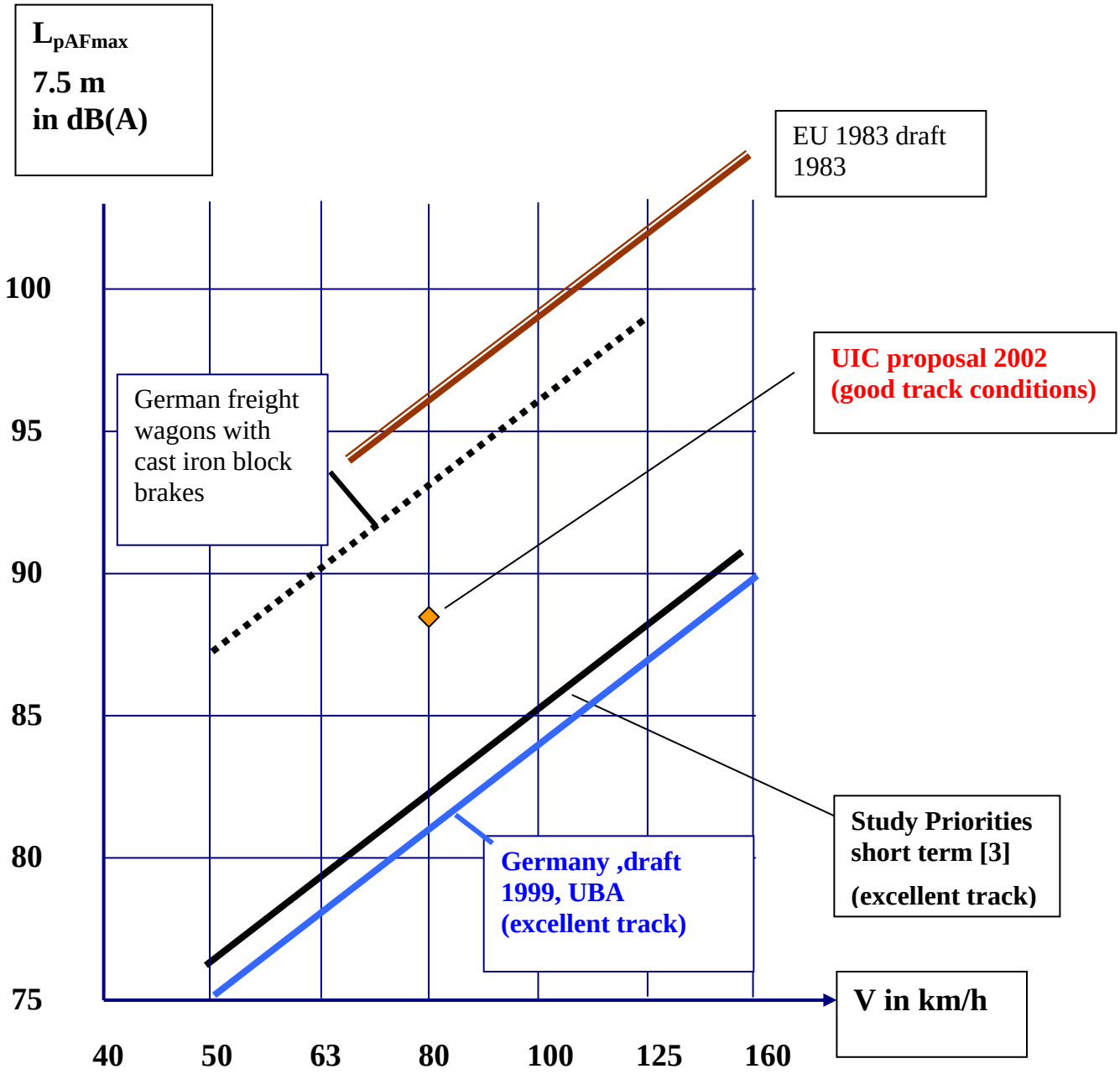


*Figure 8: Noise emission limit **proposals** for **new freight wagons** in Europe: pass-by level at 7.5 m for constant speed in dB(A)*

The **AEIF** (Association Européenne pour l'Interopérabilité Ferroviaire – European Association for Railway Interoperability, formed by UIC, UNIFE UITP) has the official mandate for the development of limit proposals. On the basis of the AEIF proposals and with the additional support from the **WG Railway Noise** the **Commission** proposes limits to the **committee according to Art. 21** of the Interoperability Directives. This committee consists of the representatives of the member states (mainly from the ministries of transport) and is chaired by the Commission. If there is no agreement between the Commission and the Art. 21 committee the **Council** has to decide.

The WG Railway Noise participates in the **noise limit setting** as an advisory body to the Commission and as guest of the AEIF Noise Expert Group.

The noise emission limits for high speed trains adopted by the Commission[36] are shown in table 4, based on the agreement with the Member States at the Art. 21 Committee meeting on the 18th December 2001. The limits are based on a low noise test track, especially by introducing lower rail roughness levels than specified in the ISO 3095 ("ISO++, defined in the TSI)".

	Speed in km/h				Standard
	250	300	320	350	
Agreement Art 21 Com **(1 dB(A) increase due to measurement uncertainties)**	**88**	**92**	**93**		ISO++
Agreement Art 21 Com **existing design** (transitional period of 24 months)	**90**	**93**	**94**		ISO++
Agreement Art 21 Com **Recommendations** (new orders after 2004)	**86**	**89**	**90**	**-3dB(A)**[37] (?)	ISO++

Table 4: Noise Limits for high speed trains at constant maximum speed (Transit Exposure Level TEL at 25m distance from the track centre line according to prEN ISO 3095)

For the **noise limit setting for conventional trains** AEIF has installed a Noise Expert Group in which the WG Railway Noise participates with 5 members. The AEIF working plan is firstly dealing with the noise regulations for **freight** vehicles.

Evaluation of the practice

With the enforcement of noise emission limits via the TSI, the European Union is going to close an important gap in emission regulations. The results seem to be satisfactory: for high speed trains ambitious limits have been introduced in a relatively short time. The two step

[36] European Commission: Technical Specifications for Interoperability relating to the Rolling Stock Subsystem, COM(2002)1952, Annex

[37] From previous versions of the TSI it can be concluded that an absolute value of 92 dB(A) is meant.

approach gives clear signals for future reductions. But the regulations and the measurement specifications are not sufficiently clear.

Furthermore, there is still a lack of regulations for non-interoperable vehicles.

The main problem with respect to limit setting is the **existing fleet**. Noise emission limits in the context of the Interoperability Directives are only applicable for new and substantially upgraded vehicles[38].

Furthermore, state regulations for compliance of railbound vehicles in-use do not exist; here the TSIs are supposed to implement regulations[39]

An additional unresolved problem are the vehicles from outside the European Union: but the effectiveness of emission regulations will be increased in the short term due to the forthcoming enlargement of the Union and the widespread adoption of EU regulations outside the Union. In addition, the introduction of incentives for the use of low noise railbound vehicles which complement emission regulations within the EU may stimulate the use of quieter extra-communitarian vehicles. Furthermore, in the short term in the framework of the new railway infrastructure package, the European Commission proposed the Council adopt a mandate to authorise the Commission to negotiate the conditions for Community accession to the Convention concerning International Carriage by Rail (COTIF) of 9 May 1980, as amended by the Vilnius Protocol of 3 June 1999 (COM(2002) 24 final). It is essential that the Community accede to COTIF in order to exercise within OTIF its powers in the railway sector.

Suggestions

The application of this instrument to **interoperable** vehicles has, in parallel with the retrofitting of the existing freight wagons, the highest priority in the WG. For **non-interoperable** vehicles there is less consent but it still amongst the instruments with high priority. Regulations of **in-use compliance** of vehicles is rejected by a majority of the WG.

Proposals for the formal legal procedures of limit setting

The current policy, to set noise emission limits by TSI, might not be optimal in terms of the broader participation of concerned stakeholders, in particular the affected population. On the other hand the current process has the advantage of a faster enforcement of limits.

To overcome the shortcomings of the current procedure it is therefore recommended that the national ministries of environment and the Environment Council as well as the Parliament are more intensively involved in the limit setting procedure through the TSI for interoperable vehicles.
Furthermore, as a first step, the Community established a framework for progressively setting

[38] See Article 1 of the Interoperability Directive 2001/16/EC [19]
1. This Directive sets out to establish the conditions to be met to achieve interoperability within the Community territory of the trans-European conventional rail system, as described in Annex I. These conditions concern the design, construction, putting into service, upgrading, renewal, operation and maintenance of the parts of this system **put into service after the date of entry into force of this Directive**, as well as the professional qualifications and health and safety conditions of the staff who contribute to its operation.

[39] Directive 2001/16/EC Article 5 : [19] ……
2. Subsystems shall comply with the TSIs; this compliance shall be **permanently maintained** while each subsystem is in use.

standards on the interoperability of rail systems (Directives 96/48/EC and 2001/16/EC). The second package of measures on rail transport is designed to expand this approach, by adding the safety aspects, extending the work on interoperability to new areas and putting it all into a comprehensive, clear and consistent context. In order to perform these tasks and prepare the individual proposals, a balance must be struck between, on the one hand, the public authorities, which must be subject to democratic control, and, on the other, the players on the market, whose expertise lies at the heart of the process. The balance existing, to one degree or another, in the Member States must also be maintained at European level. To achieve this, it is essential to create a centre of expertise at Community level alongside the public authorities to give guidance on this process. In this respect, the Commission proposes to establish a **European Railway Agency** for safety and interoperability (COM(2002) 23 final).

With respect to noise emission limits for non-interoperable vehicles and single market aspects a European regulation would be preferable[40] (see box "UNIFE Position on limits for non-interoperable vehicles").

UNIFE Position on limits for non-interoperable vehicles

At the present time procurement specifications is the only limit setting instrument for non-interoperable vehicles and these vehicles are also excluded in the Directive 2001/16/EC.

The main advantage with EU-wide emission limits is believed to be the promotion of a single market and harmonised procurement specifications. Due to the big differences between member states concerning noise reception limits it will be very difficult to get acceptance for tough limits meaning that operators in states with tough reception limits combined with dense traffic still will have procurement specifications lower than the maximum limits.

In order to have a truly single market we need to have limits that set the procurement specifications and this will not be possible before we have harmonised reception limits.

The introduction of EU-wide emission limits could however ensure that all new vehicles fulfil at least a minimum standard. The implementation of such limits requires a completely different procedure than for interoperable vehicles.

Further process of limit setting

For the further process of limit setting for new vehicles (revision of the high speed train levels, proposal for conventional trains and vehicles) the following principles are recommended:

- the state of the art, emission statistics and physical limits for noise reduction should be taken into account;
- options of limit values should correlate reduction potentials to costs (life cycle costs, see

[40] In their 57th conference of 29th/30th November 2001 the German Ministers of Environment have asked the federal government to take the initiative for a noise emission regulation for trams by the European Union

below, Cost Benefit Analysis);

- various limit proposals should be taken into account such as those made in the Study Priorities [3][41] and by the UIC [24], as well as by various other experts: the German Federal Environmental Agency [20], the German Association of Railway Manufacturers VDB etc;
- limits should be proposed in a two or more step approach in order to give clear signals to the manufacturers for their long-term planning at an early stage;
- the type testing methods must be defined precisely. It was a common position of the WG that the original AEIF proposals for the type testing of high speed trains of April 2000 were not sufficient. The evaluation of prEN ISO 3095 by a subgroup of the WG (see Study ISO 3095 [5]) has shown that this standard is only a sufficient basis for type testing "if the track conditions are more tightly specified";
- the compliance of vehicles in-use was rejected by the working group;
- for vehicles not covered by the TSI proposals for a separate noise emission directive should be developed (high priority);
- further information on noise abatement measures for railway vehicles (reduction potential, costs, side effects) has to be collected;
- research needs for further reduction of limits have to be derived. Priority should be given to the noise reduction for freight wagons and high speed trains; for the latter, research should concentrate on the implementation of the recommendations for the 2nd step.

2.4.6 Programmes to Manage Rail Roughness

Definition of the instrument

Rail roughness can have a substantial influence on rolling noise, if it exceeds wheel roughness. Therefore vehicles with smooth wheels such as disc-braked and K-block braked vehicles will retain their low noise emission only if low rail roughness is maintained. This can be achieved by means of a grinding programme. Normal maintenance grinding is already common practice on most networks to maintain structural integrity, and is performed at certain intervals (0.5 to 15 years) in relation to the traffic volume and observed wear.

Rail roughness can be maintained in certain degrees, the two key factors being grinding frequency and quality. The options in order of increasing effect are the following:

1. Ensure that normal grinding actually is performed
2. Apply normal grinding at optimal intervals, either based on known roughness growth or by regular monitoring
3. Apply higher grinding quality at optimal intervals, either based on known roughness growth or based on regular noise or roughness monitoring; this is known as 'Acoustic grinding'[42].

Monitoring of rail roughness in the network can be performed by means of special measuring vehicles (commonly via noise or vibration).

[41] see figure 7 for freight wagons

[42] An improved definition of acoustic grinding is needed

The larger the interval between grinding, generally the more material is removed. It is known that shorter grinding intervals generally require less material removal and lead to net savings due to longer lifespan of the rails. If higher grinding quality is applied, a rail roughness can be produced that is below the wheel roughness.

Roughness control programmes can either be optional or regulated at national level to maintain the noise emission of selected lines (e.g. high speed) or the whole network.

General evaluation of the instrument

It is generally agreed that the application of normal grinding is important to maintain noise levels of vehicles with smooth wheels. Financial provision must be made to enable this type of work. Normal maintenance grinding is proven technology; where this is not optimised the shortening of grinding intervals will reduce the emission levels and will even be beneficial for the lifespan of the rails. Programs to manage roughness are beneficial if

- the line or location is noise sensitive, and rolling noise is dominant;
- the rail roughness deteriorates over time.

Acoustic grinding is beneficial if most of the rolling stock at the sites concerned has smooth wheels.

The growth of rail roughness depends on many factors such as track loading, traffic intensity and types, track components and others.

In Germany acoustic grinding has been shown to be a cost-effective measure[43].

As the roughness of rails in service gradually increases, it must be maintained below a certain level during the whole lifespan. It is however current track maintenance practice to prevent extensive roughness growth, as excessive rail roughness reduces the rail life significantly and has safety implications. Unfortunately, sometimes available maintenance budgets do not allow timely normal rail grinding, then impacting on both overall maintenance cost and noise.

Current implementation

Implementation of normal grinding already can vary considerably between railway companies. Only Germany has an acoustic grinding programme, although other countries are considering similar programmes. Danish railways have a roughness monitoring programme based on microphone measurements at multiple locations at regular intervals.

Suggestions

The WG points out the importance of optimal normal grinding on a wider scale as one of the instruments with the highest priority , Even if a large minority of the WG rejects acoustic

[43] Acoustically optimised rail grinding un Germany with a reduction of 3 dB(A) corresponds to 1 m height of noise barriers for a reception point close to the track (25m from centreline of double track line); with a barrier on both sides this means 2m. 2m cost 700 €/m , grinding 7€/m and year (operational restriction costs included). With maintenance costs of 2.1%/year and capital costs for a life time of 25 years (annuity factor of 0.0858) for the barrier the cost relation is 7 to 74.76 or 10.7% to 100%) (Database see Study of University of Stuttgart for DB-AG of 2000 and DB AG, FTZ München 11.10.01)

grinding because it is assumed it will be of limited effect, it might be a medium priority and where cost-effective, an additional instrument.

Further research is still required to address questions on actual roughness levels in national networks, roughness growth, monitoring and grinding programmes and processes.

(See section 2.4.8 for regulations on rail grinding.)

2.4.7 Instrument for track upgrading or new design

Definition of the instrument

Besides the wheel and rail roughness, track design is one of the parameters which influence emission of rolling noise. Sleeper type, railpad material and rail damping and geometry can all affect noise emission. The track design is relevant in those situations where noise radiation from the track exceeds that of the vehicle. This is often the case for freight wagons and conventional trains at speeds up to 120 km/h , but also for vehicles with noise abatement measures on the wheels, such as wheel dampers and shrouds. Upgrading or retrofitting of the track can potentially provide an immediate noise reduction of up to several dB(A). So for critical freight traffic at night some reduction can be achieved by a local measure, even for vehicles with cast-iron block brakes.

Further noise reduction is often achievable by the use of rail dampers, if correctly selected. Also railpad parameters (stiffness and damping) may be optimised for a given location. Alternative track designs may in future provide further noise reduction potential when commercially available.

General evaluation of the instrument

Track retrofitting or upgrading may be a good option for reducing noise emission over a limited stretch of track in a given noise-sensitive location, without changing the vehicles. The achievable noise reduction depends on the traffic composition, and the initial track type. For example in the Netherlands, changing a track with wooden sleepers to a track with concrete sleepers and rail dampers might give up to 4 dB noise reduction, even for cast-iron block braked vehicles.

Although the noise reduction potential is not as large as for roughness control, it is an additional measure at the source.

Current implementation

In many countries, wooden sleepers are often replaced by concrete sleepers when the track is relaid, and concrete sleepers are chosen for most new lines. For some high speed lines slab track is used for safety and maintenance reasons even though current design can be noisier than ballasted track. It is also used extensively in tunnels and on tram and metro networks. Noise-optimised slab track has been demonstrated but still requires further development before it will be accepted on a wide scale. Rail pads are sometimes replaced by stiffer or softer pads, depending on the specific situation. Rail dampers are becoming commercially available and are being improved. Tests are ongoing in the Netherlands and France. The recently concluded EU project Silent Track has shown the potential of railpads and rail dampers compared to other measures such as rail and sleeper design. (See article Thompson and Jones ”Low noise track will meet environmental concerns”, Railway Gazette International, July 2002).

Suggestions

This instrument has a medium priority because some WG members doubt the feasibility and effectiveness of very new designs. Better information on track noise performance is needed for designers and planners of new and existing lines, as ’low noise track’ is often only understood as ’smooth track’.

More detailed information on noise abatement measures for railway tracks such as reduction potential, costs and side effects have to be collected (see Study Priorities [3]). Research needs based on the analysis of the considered measures have to be derived.

Until recently, there were no practical measurement methods to characterise track design in terms of noise, and therefore also little data was available. The WG recommends:

- to collect and assess noise characteristics of existing and new track designs, which is partly underway in the STAIRRS project. Such data could then be included in prediction schemes, confronting the planner with the choice of track type and its effect on noise;
- further work on low noise track design may provide beneficial solutions for the future.

2.4.8 Regulations for tracks

Definition of the instrument

Track condition and design can be regulated by specifying

- a well-maintained rail roughness for the network;
- requirements for low-noise track design, either for new or upgraded tracks.

Both of these options can be particularly effective in combination with an emission ceiling or noise reception limits for existing lines.

Rail roughness maintenance can be regulated in several ways:

- a required periodic declaration on the level of track maintenance, distinguishing no grinding – normal grinding – acoustic grinding and the grinding interval. This is checked by confirmation of the grinding having been completed;
- a declaration of the guaranteed roughness level. This is checked by some form of monitoring, either by noise or vibration measurements on a measurement vehicle or by multiple trackside measurements. The results are submitted and corrective grinding confirmed;
- by including rail roughness in the national prediction model a regulatory link can be made with a grinding programme either simply for local hotspots or at a national level. Implicit assumptions on rail roughness are already made within prediction models.

In both cases a bonus or a correction on the predicted noise levels may be given, thereby allowing compliance with limits at hotspots, or higher speeds, more traffic or lower barriers.

At an international level, this could be implemented by including the rail roughness as one of the criteria for belonging to the international high speed or transnational network.

Track design can be regulated in two ways:

- inclusion of correction factors in the national prediction model. This is already the case for several national models (Schall 03, SRM, and others);
- for new or upgraded lines, the environmental authority can require the use of the 'best current practice' track type known to produce the least noise for a given situation.

General evaluation of the instrument

The successful implementation of quieter railways depends not only on the vehicles but also on the quality of the tracks, both in terms of rail roughness maintenance and track design. The principle of smooth wheels on smooth tracks and the low noise design of both the vehicle and the track must be upheld to ensure this. The implementation of regulations such as the German specially monitored track and the inclusion of track design parameters in noise prediction schemes are a clear indication that such regulations are effective.

Track-related measures sometimes have favorable cost-benefit ratios[43] and there is a high synergy of vehicle- and track-related measures with additional gain in noise reduction (see figure 4).

The issues of rail roughness and track design often tend to be confused when discussing 'quiet tracks'.

Current implementation

Only in Germany, a regulation (within Schall 03) is in force for specially monitored track (acoustic grinding is carried out), using a measurement coach. This allows a legislative bonus of 3 dB(A) compared to normally maintained tracks, as long as the track complies to the roughness limits. German citizens in these locations have a legal right to the maintenance of these levels.

In the Netherlands, acoustic rail grinding is being introduced as a measure for critical locations in the network, also included in the national prediction scheme.

Within the political and safety constraints the railway companies often have difficulties or are in practice hindered in maintaining appropriate grinding programs.

The Directive 2001/16 [19] on the interoperability of the trans-European conventional rail system states in Article 23 that among the first priority group of TSI are "noise problems deriving from rolling stock and **infrastructure**". The majority of the WG and of the AEIF noise experts thinks that according to the subsidiarity principle this type of regulations should be left to the national railway noise policy or to the infrastructure manager.

Suggestions

The instrument in general has a low priority in the WG. As a European instrument is rejected by a majority of the WG. As a national instrument it has a small majority. The WG gives medium priority to a requirement for infrastructure in the TEN network to provide regular declarations on track quality and maintenance regimes, simply stating the level of maintenance, for example:

normal grinding + interval or acoustic grinding + roughness level.

Type testing and classification methods for tracks must be improved or be more precisely defined. These could than later be referred to in regulations (including prediction schemes). Major input will come from the STAIRRS project. For example, a characteristic function can be used to quantify the noise emission from the track per unit roughness.

2.4.9 Specifications for the noise emissions in procuring/ordering new vehicles and tracks

Definition of the instrument

This instrument means the specification of permitted noise emission levels (with respect to defined operational conditions and measurement standards) in contracts between the railway companies/vehicle owners and the manufacturers.

General evaluation of the instrument

In the absence of noise emission regulations the specification of the allowable noise emissions is the most important instrument for railway companies to ensure the contribution of the vehicles and the tracks for railway noise reduction (which might be enforced by reception limits). The growing separation of infrastructure and services could mean that without a mechanism for the infrastructure manager to influence operators this instrument would loose its importance for vehicles. It is important that the infrastructure managers, who are in general supposed to be responsible for the overall noise exposure, have direct control over the specification of vehicle noise. They could use access restrictions, acceptance standards or charges instead.

Current implementation

Noise emission specifications for vehicles are widely applied in the railway companies, especially in public transport undertakings. Track specifications with respect to noise are generally not in use.

Evaluation of the practice

Noise specifications differ very much in indicators, measurement standards, operational conditions and limit values. This has been a source of complaints from the railway manufacturers[44].

In some cases noise specifications (sometimes in conjunction with reception limits) have been the major driver of progress in of noise reduction. Examples are the 4th generation S-Train in Copenhagen or the Swiss Lok 2000 (Typ Re 460) (Study Priorities [3], Main Report, p.60f) which are among the quietest European vehicles. Compliance with the strict noise emission specifications was supported by a noise management plan right from the beginning of the project.

[44] See for example: C. Hoffmann, Bombardier Germany "Akustik – Zielkonflikt zwischen Wunsch und Realisierbarkeit" (Acoustics – target conflict between wishes and feasibility" in UBA: Materialien zum UBA-Fachgespräch "Minderungen der Geräuschemissionen des Schienenpersonennahverkehrs" June 1999 (Documents of the UBA- Workshop "Noise emission reduction of local rail transport"

Often compliance with noise specifications has a lower priority (compared to safety standards, local peculiarities, comfort, costs, weight, energy consumption etc) and very ambitious specifications are not complied with.

Suggestions

This instrument has a high priority in the WG:.

- as long as there are no statutory regulations for the noise emissions of new railway equipment procurement specifications should be used to order or railbound vehicles etc with lower emission levels;
- European, National and regional authorities / institutions which contribute to the financing of new rolling stock or other railway equipments should link noise emission specifications to this;
- in particular for local operators or small companies guidelines for ambitious noise specifications would be helpful. These guidelines should be prepared at a European level either by the operators' associations[45] (UITP, CER, UIP etc) or by European institutions. The guidelines should cover emission levels, measurement conditions and likely costs;
- it is recommended to that the implementation of ambitious or progressive noise emission specifications are accompanied by a noise quality management from the beginning of the vehicle development.
- the standard by which noise emission is specified should also include unambiguous indicators for track characteristics (methods are expected from STAIRRS, see Annex III).

2.4.10 Incentives for the use of low noise vehicles

Definition of the instrument

This instrument means that operating low noise vehicles leads to financial and/or operational benefits which are higher than the additional abatement costs. It has two main characteristics:

- noise emission related track charges (as implemented in Switzerland for passenger trains);
- exemptions of track access restrictions for low noise vehicles (as proposed by the Netherlands).

General evaluation of the instrument

Incentives for the use of low noise vehicles have some advantages compared with emission limits:

- they are effective before the introduction of limits;
- they are effective for operators outside the EU;
- they represent an important economic link between infrastructure and service (shared polluter payment);

[45] The VDV (Assocation of German Public Transport Companies) gives noise emission recommendations for rail vehicles in local transport (VDV Schrift 154 "Geräusche von Nahverkehrsfahrzeugen nach BOStrab (Noise emissions from local railbound vehicles)", August 2002

- and they can stimulate the retrofitting of vehicles currently in use.

On a European level they require the harmonisation of charges, their implementation requires the classification and identification of single vehicle emissions (see emission ceiling) and the economic viability of this instrument which depends on the relationship of track charge reduction and vehicle noise abatement costs.

Incentives are more flexible than access restrictions.

Noise emission-related charges are in line with European abatement strategies (see Proposal Dir COM(1998) 480 on levying of charges states: they „may be modified by a charge to take account of the cost of external effects ..." (Art 8, Nr.5)[46].

Despite the obvious advantages of this instrument some WG members express their resistance to it due to legal and technical obstacles. They fear loss in competitiveness, less flexibility and high administration costs. Therefore efficient and viable procedures for its implementation have to be developed.

Current implementation

First application of this technique has been in place since 1. 2. 2002 in Switzerland. (see box "Swiss Infrastructure Charging System implies a noise-reduction bonus")

At present there are no harmonised track access charges in use in Europe. Some countries use track access charges covering full costs, others are on a free of charge basis.

Suggestions

Incentives for the use of low noise vehicles have a high priority in the WG:

- a policy aim should be the harmonisation of track access charges and the complete internalisation of external effects for all transport modes;
- implementation should focus first on whole trains;
- the technical problem of single vehicle identification has to be solved. Noise emission related vehicle identification should be integrated into improved fleet management systems[47] and maintenance procedures;
- the feasibility of this instrument should be tested, probably in pilot projects.

[46] A working group set up by the Commission under the Developing European Railways Committee (Directive 91/440) currently discusses charging principles:
Annoyance studies show that noise costs vary between € 0.02 and 0.34 per 100 passenger-kilometre and between 0.04 and 0.69 per 100 tonne-kilometre. The values increase by between 0.2 and 1.4 % per dB(A) depending on different background factors. It is assumed that charges based on noise emissions could provide a superior ongoing incentive to reduce noise levels and that the cost-benefit assessment for different measures was very good.

[47] The Commission is planning to launch a study on future registration systems for railway rolling stock

Swiss Infrastructure Charging System implies a noise-reduction bonus

The charging regime for the Infrastructure of Swiss Federal Railways is determined in pricing level by the federal office of transport. The regime as set out in federal legislation is based on marginal cost philosophy – so in principal each user is paying for those costs he caused to the system. This makes the charging regime fair and encourages competition – but it makes the charging system complicated as well. To charge the infrastructure clients on a marginal cost basis, you would need four elements based on five different parameters.

Since the 1st of January 2002 this is done using the following elements:

- Operating costs (according to train kilometres)
- Maintenance costs (according to gross ton kilometres)
- Energy costs (according to energy consumption and day or night tariff) and
- Revenue share (in % of transport revenue)

A fifth element has now been added to the system: Since January 2002 a noise reduction bonus is encouraging infrastructure users to employ low-noise rolling stock. To qualify for the bonus the use of advanced brake technology is necessary (composite blocks, disk-brakes or comparable).

The bonus is in practice about 5 percent of the total infrastructure charge. It will be doubled at the beginning of 2004.

The amount of the bonus thereafter is determined by the resulting axle kilometres driven. The more kilometres and / or the more low-noise axles, the higher the bonus refund . For making the system operable the number of low-noise rolling stock axles are not determined in the operating process. It is essential that these figures are estimated on the basis of low-noise rolling stock numbers and the yearly circulation planning declared by the train operating company. It is the federal office of transportation that will monitor those declarations of TOCs by samples.

2.4.11 Public funding for noise abatement programmes

Definition of the instrument

This instrument means the implementation of noise abatement programs with financial support by the state. The relevant features of these programmes are the targets for noise abatement (reduction of annoyed persons or exposure above certain target levels), the quantity of the financial aid, the kind of measures which can be financed, and the timetable for implementation.

General evaluation of the instrument

State aid programmes are not consistent with the polluter pay principle. Nevertheless, state aid has been accepted for other modes of transport; and it seems to be necessary for the short-term solution of the main railway noise problem, the freight wagons with cast-iron block brakes.

In addition if funding falls within the definition of state aid, restrictions apply to the use of public funds in order to avoid unpermitted subsidies. According to a yet unofficial position of the Commission an aid scheme that will provide financial support for the adaption of **old** rolling stock in order to fulfil the requirements of the TSI may be permissible under the Commission's Guidelines for Environmental aid (OJ C 72, 10.3.1994), (aid for investment in e.g. equipment intended to reduce or eliminate pollution and nuisances or to adapt production methods in order to protect the environment may be allowed). However, such a scheme must be open for all on a non-discriminatory basis and the financial support should not exceed 30 % of the eligible costs. In any event the aid has to be proportional to the improvement of the environment that is achieved and to the investment necessary for achieving this improvement.

A European funding of railway noise abatement (especially for retrofitting of in-use vehicles) was recommended in the WG discussions but up to now no corresponding programmes have been identified.

Current implementation

Those programmes are implemented in many states in Europe. The most advanced one is the Swiss remedial programme, covering the whole network and using funding from heavy lorry taxes, fuel tax and which gives priority to the retrofitting of vehicles and includes barriers and secondary measures like sound insulating windows (see Box ”General overview of Swiss Railway Noise Abatement Programme” below). In Germany an abatement programme started in 1999 and in addition to secondary measures rail grinding is applied. Many member states have set the target to reduce the high exposure (“hot spots”) by a certain date.

Evaluation of the practice

Currently only the Swiss remedial programme includes retrofitting of cast-iron block braked vehicles (substitution by composite blocks). Thus the high reduction potential of retrofitting this wagon type has not been used yet elsewhere.

Suggestions

Public funding has a high priority in the WG:

- it is recommended that noise remedial programmes should give priority to the

implementation of measures at the source (retrofitting of cast-iron block braked vehicles, measures at the track);

- as for the vehicles these programmes should be implemented and coordinated at a European level because of the international character of rail freight transport: the full benefit of the emission reductions requires the retrofitting of the complete fleet;
- the European Union should participate in these programmes:
  - by officially defining what state aid might be allowable;
  - and by financial means (they should be linked to additional innovations for the freight fleet in order to improve its competitiveness; an instrument of financing could be scrapping schemes).

General overview of Swiss Railway Noise Abatement Programme

Noise control is important for Swiss environmental Policy and SBB (Swiss Federal Railways)

Focus on noise control is of great importance for the Swiss Federal Railways SBB. Noise control introduces a high financial risk for the railway business and has a large advantage for lineside inhabitants. In Switzerland railway noise affects 260.000 persons and 767 km of the railway network has noise values above legislated threshold values.

Railway noise exceeds legislated noise thresholds

In April 1987 a noise abatement ordinance was enacted to protect the population from different types of noise, with the main focus being on traffic noise including railway noise. Noise mapping is compulsory for all traffic networks. The noise maps are similar to the ones required by the EU Noise Directive. Along the SBB lines the noise maps were completed in 1998. The aim of the noise ordinance is compliance with the given thresholds, by first reducing noise at the source and then influencing noise propagation and finally insulating buildings if the other measures do not have sufficient effect.

The noise ordinance only requires noise reduction measures if these are economically reasonable. Because of the absence of a way to measure economic acceptability a Cost-Benefit Index (CBI) was developed by the SBB in co-operation with the federal administration to ensure equal treatment of all citizens.

Noise impact study demonstrates large benefits with rolling stock modification

Between 1992 and 1995 noise maps were produced for a network of 3.000 km including more than 600 municipalities. The maps were based on a Geographical Information System (GIS) linked to a data bank and computer software that allowed calculation of costs and benefits of different noise abatement programmes. The result of these studies demonstrated the positive effect of rolling stock modification on the overall financial requirements and the optimal CBI value to prevent construction of noise barriers showing low effectiveness.

Based on the above studies priority was given to rolling stock improvement. This programme requires all new passenger rolling stock to be equipped with disc brakes and the retrofitting of all Swiss passenger vehicles and freight wagons in operation. Retrofitting is done by replacing current wheel sets with stress-free wheels and composite brake blocks. This results in a noise reduction of up to 10 dB(A). The cost for retrofitting is estimated at about 600 million Euro and the cost for additional measures such as noise barriers and window

insulation is and additional 600 million Euro. Before calculating the costs and benefits of different noise abatement possibilities, the costs for complying with legislated values was estimated at 4.800 million Euro. The introduction of the CBI for noise barriers reduced the necessary investments about 2.400 million €, while still protecting 2/3 of the affected population. The current mix goes even a step further: The same 2/3 of the population can be protected for 1.200 million Euro.

The cost for railway noise measures is financed by road taxes.

The cost for retrofitting is financed by a federal fund which in turn is fed by fuel taxes, by a tax on heavy road vehicles as well as by general governmental funds. The Swiss electorate accepted this noise abatement program together with a general financing of public transport in a 1998 referendum. The cost for new rolling stock is financed by normal railway budgets. Retrofitting Swiss rolling stock has started and will be complete in 2009. Noise barriers and window insulation will be complete in 2015. Switzerland will benefit from foreign rolling stock improvement, because of the high percentage of foreign rolling stock crossing the Alps. If foreign rolling stock is improved this would significantly reduce the required length of noise barriers as well as the number of insulated windows.

2.4.12 Voluntary agreements

Definition of the instrument

In environmental policy voluntary agreements are commitments of the parties who are fully or partly responsible for negative environmental effects (industry, operators, infrastructure companies etc) to fulfil defined environmental targets within a certain timescale in exchange for benefits from the legislator (exemption from statutory regulations, funding etc). An example for a proposed comitment is the UIC/CER/UIP Action Plan for the reduction of freight wagon noise emissions by replacing the cast-iron block brakes by composite blocks.

General evaluation of the instrument

The main argument for a voluntary agreement on the retrofitting of vehicles is that it tackles the problem of vehicles with a significant remaining life time. In addition, voluntary agreements can be implemented faster than regulations.

For the evaluation of the instrument one has to keep in mind that besides all the benefits of voluntary measures there are also some shortcomings, which should be addressed in the development process of a voluntary agreement:

- It might lead to less ambitious targets and time scales of implementation.[48]
- The involvement of the general public, parliaments and or affected population, is in general lower with voluntary agreements compared to regulations.
- Voluntary agreements are not compulsory in the way that regulations or treaties are. It could be difficult for the railway associations or the EU to force an unwilling operator to fulfil the programme of the agreement. In addition one has to be aware that not all freight transport operators are members of UIC.

[48] The UIC Action Plan for example offers the retrofitting of the freight wagons with a reduction of up to 8 dB(A), although with additional costs additional reductions might technically be possible (wheel absorbers or damping rings, acoustically optimised wheels, bogie shrouds etc.), achieving a noise reduction of at least 10 dB(A).

At the 2nd STAIRRS workshop [10] it was the view of some participants that for the generation of quieter railways in addition to legislation "for existing freight rolling stock operators themselves should make the first step, possibly under the regime of voluntary agreements".

Current implementation

In June 1998 UIC-CER-UIP started their action plan for the reduction of freight wagon noise emissions by replacing the cast-iron block brakes by composite blocks. In their letter of 15th March 1999 they offered the Commission a voluntary agreement on the installation of composite blocks on new wagons and on the cost neutral retrofitting of in-use vehicles with these blocks.

Implementation of the action plan for new wagons has been delayed due to the late and currently only provisional homologation of the K-blocks (28th/29th September 2000). This was due to technical problems. The cost neutral retrofitting of in-use vehicles requires the availability of the LL-blocks which would have the same braking performance as cast iron brake blocks. This technology is still under development and it is not possible to predict when this development will be complete. The alternative – retrofitting with K-blocks – is not cost neutral[49]. Hence the preconditions for a concrete evaluation of the retrofitting part of the action plan are not yet fulfilled.

As for the fitting of new freight wagons with K-blocks even more than one year after their international homologation, a few operators have started with it (SBB, DB Cargo, SNCF, Transwaggon).

Suggestions

Voluntary agreements have been identified as a medium priority by the WG.

The availability of the LL-Blocks is essential for the cost neutral implementation of a retrofit programme . If K-Blocks are to be used the costs of retrofitting are greater and currently cause funding problems. Alternatively it seems to be necessary to continue the determination of the (life cycle) costs and effectiveness of retrofitting with K-blocks. The necessary financial means for corresponding research activities are needed.

A voluntary agreement with the following features between the operators and the European Commission is recommended:

- the voluntary agreement should not only deal with the retrofitting of freight vehicles;
- it should include the commitment of the operators to equip new wagons with composite brake blocks;
- it should include maintenance commitments (vehicles and tracks);
- it should include funding commitments.

[49] though the life cycle costs of K-blocks for retrofitting are not well known.

2.4.13 Member State and EU funding for research and development

Definition of the instrument

Public funds are given to industry and research institutions such as universities in order to develop innovative solutions for noise control.

General evaluation of the instrument

Public sector financial support for research is especially important in those fields where innovation is not initiated by market forces. This is the case for many environmental benefits such as reduced noise exposure.

Current implementation

Railway noise research is funded by the European Union, the member states and by the railways (operators, manufacturers) themselves.

In the European Union the Framework Programmes are the most important ones. Furthermore there are projects directly funded by the General Directorates[50]. Currently the 6th Framework Programme is being prepared. Research with respect to land and marine transport will fall under the programme "Sustainable Development".

In October 1998 the European Rail Research Institute ERRI completed an inventory of its research activities from 1990 to 1998 [51]. Many of the projects have been funded by the European Union. The most important research project in the current 5th Framework Programme is the previously mentioned STAIRRS project.

A complete overview of all the relevant research activities in Europe does not exist yet. Within the CALM network[52] a Status Report on member states and European noise research projects and a Community Noise Research Strategy Plan will be elaborated.

In November 2001 the European Rail Research Advisory Council ERRAC was set in place to advise the Commission and prepare a Strategic Research Agenda for 2020. The final document is now published[53]. Noise plays an important role within the Research Agenda. Railway noise research is also a topic in the "Joint Strategy for European Rail Research 2020 – Towards a Single European Railway System", September 2001 of UNIFE, UIC, CER, UITP [14].

Currently there is a general gap in the implemention of research results: Solutions are not or cannot be brought to a prototype or industrial design, often as a result of cost restraints.

Evaluation of the practice

A comprehensive assessment of the railway noise research effectiveness does not yet exist. It is the impression in the European Commission that other transport modes, above all aeronautics, have been more successful in organising research funding.

---

[50] E.g. both studies directly connected to the WG Railway Noise (Study Priorities,[3], ISO 3095 [5])

[51] B. Hemsworth, W. Bird . Railway Noise Research - Summary of Activities since 1990, ERRI Oct. 1998

[52] CALM network is funded by the European Union in the 5th Framework programme (Promoting Competitive and Sustainable Growth) with the type of action "Coordination Activities/Thematic Networks"

[53] ERRAC: Strategic Rail Research Agenda 2020, September 2002

Suggestions

This instrument has a high priority in the WG

Railway research activities in Europe must be better coordinated and published[54]

- to avoid duplication;
- to gain increased benefit from the results;
- to safeguard implementation of the results;
- to deliver more convincing arguments for further research needs.

The WG Railway Noise has identified the following as most important research topics[55]:

- understanding of roughness growth on rails and wheels (e.g. improved composite braking blocks for the retrofitting of in use vehicles such as freight wagons);
- understanding of screech and squeal effects (curves, disc braking);
- development of wheel absorbers for driven wheels;
- reduction of aerodynamic noise;
- maintenance techniques for noise reduction (e.g. rail grinding);
- development of improved monitoring and type testing techniques of noise emissions (including track specifications, low noise vehicle identification);
- development of models for financial distribution which ensure cost optimal solutions for railway noise abatement in the framework of separated responsibilities (Infrastructure & Operators).

In addition to these research related topics the WG Railway Noise sees a need for programmes for the implementation, testing and evaluation of prototype solutions for railway noise abatement on a European scale including the accession countries. These programmes should inter alia provide information on the potential reduction of the number of people affected by noise from railways. Highest priority should be given to the development of composite brake blocks for the retrofitting of vehicles in use.

[54] Often national research results have insufficient publicity due to language barriers

[55] see also WG Research: Noise Policy – WG Research:Research Priorities, May 2001

2.4.14 Information to stakeholders

Definition of the instrument

This instrument means to disseminate all of the information necessary for the abatement of traffic noise in general and railway noise in particular to stakeholders according to the principle of shared responsibility. Above all this implies the dissemination of information on the most promising reduction strategies, instruments and measures to all parties involved including:

Researchers and consultants, manufacturers, operators of rolling stock and infrastructure, politicians and public administration at the various levels.

General evaluation of the instrument

The provision of information will support all of the noise abatement strategies:

- only the availability of information on the most promising, viable and cost-effective instruments and measures guarantees a satisfactory solution to the noise problem;
- the knowledge of the negative impacts of traffic noise in general and railway noise is essential for the recognition of the importance of noise abatement on the political agenda.

Current implementation

There are a multitude of informal and formal ways of spreading the required information at local, national and European levels or of multilateral information exchange especially in the railway associations[56, 57] at national and international conferences and workshops[58].

Evaluation of the practice

A general assessment of this instrument is not possible due to lack of "information". In general there is good practice with respect to noise problems in projects for new lines or upgrading lines. But despite the manifold information activities there seems to be evidence of some deficits in the general information policy:

- it seems that national noise abatement research results and successful abatement strategies are still not sufficiently spread to other member states or to other stakeholders as a result of language and organisational barriers or former national railway monopolies and peculiarities;
- in particular the smaller entities (local operators or local authorities) do not have sufficient means for information retrieval;
- often the glut of information due to insufficient retrieval and assessment instruments might be the major problem.

[56] See for example the UIC Research Committee, the "UIC Subcommittee Noise and Vibration", where Railway noise problems are an important issue as they are in the ERRI activities

[57] In summer 2001 a Working Group "Acoustics" has been convened in the German association of railway manufacturers (VDB : Verband der deutschen Bahnindustrie)

[58] For example the Consensus Building Workshops within the STAIRRS project (March 2000, 2001, 2002)

Suggestions

This instrument has a medium priority in the WG.

Although a thorough assessment of the current application of this instrument could not be given it can be assumed that further improvements are possible:

The EU should step up its activities in this field. It should gather, assess and harmonise the relevant information:

- with the Directive relating to the assessment and management of environmental noise [2] a first important step will be completed as part of the harmonised assessment of noise exposure in Europe:
- according to the the Interoperability Directives "the member states shall ensure that registers of infrastructure and rolling stock are published and updated annually"[59]. The EU should ensure the harmonisation, editing and publication of the noise emission data in these registers;
- the EU should continue[60] to develop guidelines for the abatement of traffic noise which should be adapted to the different needs of the various stakeholders;
- member states and the railway industry should provide the necessary information to the European institutions.

[59] Directive 2001/16/EC Art 24 (1) [19]

[60] The publication of the Study Priorities[3] and the activities of the WG Railway Noise can be evaluated as first steps

2.5 Accompanying Instruments

2.5.1 Improved measurement standard for railway exterior noise

Definition of the instrument

Internationally accepted standard for measurement of noise emission from railways, providing reproducible measurement data, which can be used for

- contractual limit testing;
- legal limit testing;
- specifying and assessing noise performance of vehicles and tracks, or their components;
- comparing noise emission of design alternatives;
- monitoring (either traffic or individual vehicles);
- collection of emission data for input to calculation schemes.

General evaluation of the instrument

A reliable measurement standard for measurement of noise emission from rail vehicles is a prerequisite for noise abatement. Understanding of achieved noise reductions and reliable emission data can only be provided if measurement data is reproducible. Also limit compliance testing, whether legal or contractual, is only feasible with a reliable standard. Until the 1990s, rail roughness and the effect of the track was insufficiently specified, resulting in large discrepancies in measured data. Consequently, various parties often disagreed about the effect of noise control measures.

Current implementation

Some national measurement standards and one international standard are in use mainly for contractual and legal (emission limits) purposes in some member states. The most recent international standard prEN ISO 3095: January 2001 sets a rail roughness limit for the test site. Additional requirements are set for the track in the new TSI noise limits for high speed trains, both for the rail roughness and the track design.

Suggestions

The instrument has been given a high priority by the WG.

The prEN ISO 3095 standard will still require further improvements in the future to cover all the topics mentioned above (see ’Definition’). Nevertheless, the current draft version and the TSI noise test conditions provide a good basis for the collection of more reliable test data. Given the importance of the track contribution to noise emission, and its long term impact (life cycle, cost etc.) it would be worth paying more attention to this in the standard, which in the title only refers to ’vehicles’. See also the report on Evaluation of the prEN ISO 3095 standard (ref. [5]).

2.5.2 Comprehensive noise prediction scheme

Definition of the instrument

A railway noise prediction scheme is a calculation procedure used to predict the average noise level at receiver positions, based on the traffic composition and speeds and site-specific data such as track type, barriers and other obstacles in the propagation path. It usually has a legal status so it is used as a decision making tool to determine numbers of affected residents and the required noise abatement.

General evaluation of the instrument

Current prediction schemes, many in use since the 1980's, are mostly used for new or upgraded lines, and are used to determine the need for noise barriers and their dimensions or additional measures. They are the main means of assessing the noise exposure along railway lines, as measurement of long term averages has many practical obstacles.

The emission data is mostly not described in terms of the physical parameters such as roughness and acoustic transmission of vehicle and track, but as empirical, vehicle-specific averages based on statistical data collection. Also, many existing schemes work only with overall dB(A) levels. For both of these reasons such schemes can have a considerable error margin.

Current implementation

National noise prediction schemes for railway noise with a legal basis exist currently in a number of European countries including Germany, France, The Netherlands, Switzerland, Scandinavia (Nordic model) and the UK. These prediction schemes vary in complexity, predicted results and legal status. Some schemes are currently being, or recently have been updated.

Suggestions

This instrument has been given a low priority by the WG.

A more up-to-date common prediction model that takes all of the technical abatement options into account, and can be used both for new and existing lines, would provide a firm basis for the future implementation of noise abatement measures. It is a way of providing involved parties with the relevant information in the planning stage. Work on a 'reference model' is currently underway in the EU project Harmonoise (see www.harmonoise.org). This may provide the basis for a harmonised and comprehensive future model. In addition, cost-benefit information on noise abatement measures has been assembled in the STAIRRS-project.

2.5.3 Information and participation of the public

Definition of the instrument

This instrument refers to the provision of the information to the public on all environmental noise issues:

- on current and future noise impacts in a comprehensible way (noise mapping etc);
- the negative effects of noise, even the potential health risks;
- on noise legislation and the contact addresses and persons of the responsible organisations;
- the relevant noise abatement instruments (benefits, costs, side effects);
- and the participation of the public in planning processes and the implementation of action plans for noise abatement.

General evaluation of the instrument

Participation of the public corresponds to democratic procedures.

One of the objectives of the Environmental Noise Directive [2] will be to ensure "that information on environmental noise and its effects is made available to the public" (Art 1(1) b))[61]. This implies also that a successful abatement strategy should be based on public participation.

Timely and fair participation of the public helps to avoid conflicts and complaints due to noise nuisance.

Current implementation

A systematic evaluation of this instrument does not exist on a European scale.

Participation of the public is normally required as part of the planning processes for new railway lines. The instrument seems to be used less for existing situations unless it is part of a noise abatement programme.

It is known that sometimes noise conflicts are increased by late and insufficient information to the public.

The implementation of the Environmental Noise Directive will certainly be an important step in improving the information to the public.

Suggestions

This instrument is given equal votes for and against and a low priority by the WG.

---

[61] also Article 9 Information to the public

1. Member States shall ensure that the strategic noise maps they have made, and where appropriate adopted, and the action plans they have drawn up are made available and disseminated to the public in accordance with relevant Community legislation, in particular Council Directive 90/313/EEC of 7 June 1990 on the freedom of access to information on the environment and in conformity with Annexes IV and V ofto this Directive, including by means of available information technologies.
2. This information shall be clear, comprehensible and accessible. A summary setting out the most important points shall be provided.

Though a thorough assessment of the current application of this instrument could not be given it can be assumed that further improvements are possible:

- the European Union and the member states should provide comprehensible information on the environmental noise issue, in printed form or via internet;
- the railways – as well as other noise sources – should appoint noise contact persons to whom complaints could be directed in a centralised way;
- a common understanding of railway noise assessment could increase the acceptance of new infrastructure projects[62];
- the informing and participation of the public in possible noise conflicts should be improved.

[62] In Germany the organisations of the citizens' action committees against railway noise participate in the revision of the national calculation scheme for railway noise reception levels. It is expected that thereby the acceptance of future noise assessments will be increased.

3 The tasks of the stakeholders

3.1 European Union

The WG Railway Noise fully supports the aim of the European transport policy to revitalise the European railways. The improvement of the railways' competitiveness will facilitate the implementation of noise reduction by for example faster renewal of the fleet.

With respect to noise the most important tasks of the EU are:

- the enforcement of noise emission limits for new vehicles;
  - with the developing Technical Specifications for Interoperability (TSI) for "interoperable" vehicles;
  - and also for non-interoperable vehicles such as public transport;
- voluntary agreements for retrofitting of the existing fleet and allowance for national financing or even support for retrofitting;
- enforcement of maintenance regulations for vehicles[63];
- harmonisation of noise measurement and calculation standards: harmonisation of test tracks and emission data banks[64];
- harmonisation of a test method for the track transfer functions;
- harmonisation of infrastructure cost charging;
- harmonisation of vehicle identification methods;
- information, recommendations and noise abatement guidelines (best practices), information to the public;
- European funding for research with the priority for retrotting solutions (Composite-blocks).

The enforcement of noise emission limits for **existing** railbound vehicles as suggested in the Study Priorities [3] and at the 2nd STAIRRS workshop [10] would need additional types of legislation.

The financing of the TEN-T by the EU should include targets and requirements for noise abatement measures. Also the loans for vehicle procurements by the European Investment Bank should be linked to using low noise emission specifications.

Noise regulations for TEN-T tracks although an element in the TSI with respect to noise, might be dealt with at the national level.

3.2 Member States (MS) (including local authorities)

Member states should implement the following instruments:

- introduction and implementation of cost&benefit optimised national noise abatement programmes[65] following the example of the current best practice in Switzerland:

[63] see Art 8 [19]: interoperability constituents must be maintained; Art 14: subsystems must be maintained in accordance with the essential requirements

[64] compare Art 24 [19]: annually updated registers of infrastructure and rolling stock

[65] It is recommended not to wait for the implementation of the action plans according to the time schedule in [2]

- most important is the inclusion of freight vehicle retrofitting;
- the financing of the programmes should be reliable;

- complementing the European noise emission legislation:
  - possibly for non-interoperable vehicles (urban transport);
- introduction of noise reception limits, emission ceiling, local maintenance regulations for existing lines in conjunction with incentives for the use of low noise vehicles;
- introduction of noise regulations in land use planning;
- information to and involvement of the public in conjunction with the railways;
- the national railway authorities should implement harmonised type test procedures and deliver the test data to the European authorities.

3.3 Railways: Infrastructure

The infrastructure managers should be responsible for/implement:

- noise abatement measures for the tracks such as quieter track concepts;
- incentives for low noise vehicles (track access regulations and charges, local or EU-wide);
- maintenance or even acoustic grinding for noise reduction;
- capacity management in relation to noise emission ceilings;
- making harmonised test tracks available.

3.4 Railways: Operators, Private Wagon Owners

They should take care of:

- demanding procurement specifications for new and upgraded vehicles;
- noise related maintenance schemes by trackside or on-board monitoring systems.

They should only order new freight wagons with low noise components such as composite brake blocks or disc brakes.

3.5 Railway associations

The railway associations play an important role in harmonising and coordinating the noise abatement efforts of their members. They should continue this work especially by:

- promoting and implementing research activities;
- co-ordinating tests of practical solutions throughout Europe;
- producing guidelines on promising abatement strategies and techniques.

It currently seems particularly important to facilitate the use of composite brake blocks for freight vehicles and to ensure that the homologation of these blocks is fully valid.

3.6 Manufacturers

The tasks of the manufacturers (vehicles, components and tracks!) are:

- participation in numerous research activities in which new low-noise designs are tested and developed:
  - reduction of wheel and track roughness;
  - quieter wheel and track design (geometry/dampers);
  - aerodynamic design;
  - optimisation of composite brake blocks;
- information on both acoustic performance and cost for low-noise designs which is needed for a cost-benefit analysis;
- participation in standardisation work;
- integration of noise aspects at an early stage of development, especially implementation of low-noise design in new vehicle concepts (see Box **Pro-active integration of noise aspects in the vehicle design process);**
- provision of noise emission data.

Pro-active integration of noise aspects in the vehicle design process

Noise is an integrated part in the development of a new vehicle concept. During the conceptual study critical noise sources are identified and measures are taken. It could be the introduction of a low noise component e.g. an optimised gearbox where the main additional cost is the engineering work or it could be the introduction of an additional component such as wheel dampers or bogie shrouds. In the latter cases additional production costs are the main cost for the noise design. In the tender phase of a project the predicted noise performance of the vehicle is compared with the procurement specification and further measures are taken if needed. Examples on components that have been improved due to noise aspects are; damped wheels, optimised wheel-shapes, optimised gear-boxes, bogie shields, fans with variable speeds, forced ventilated traction motors, aeroacoustically optimised pantographs, air compressors. There are other technological improvements that also have an impact on the noise emitted such as disc braked wheels, especially efficient with cheek-mounted disc-brakes, and radially steered bogies reducing curve squeal noise. Measures taken to reduce aerodynamic forces such as drag also have a positive effect on the aero-acoustic noise which is important for high-speed trains.

4 Conclusions

4.1 General remarks

The EU Working Group Railway noise proposes a European strategy for railway noise abatement in this position paper. The most promising instruments have been identified, addressing all stakeholders involved. This strategy will support the implementation of the action plans for noise abatement on major railway lines as foreseen by the European Directive on Environmental Noise and the existing national railway noise abatement programmes. This is achieved by recommending technical solutions, by proposing regulatory and financial instruments, by stimulating the provision of information and by encouraging voluntary actions.

Environmental noise from railways has been identified as one of the key sustainability issues for the European railways. The driving forces behind this issue are

- the existing noise exposure due to railway traffic;
- the projected traffic increase, both in speed and vehicle numbers;
- increase in rail traffic at night, especially freight;
- construction of new lines, both freight and high speed;
- increase of numbers of residents affected along lines;
- the policy of road-to-rail modal shift.

The main challenge concerning railway noise in the EU is the reduction of daily average reception levels along existing and new railway lines in a feasible and cost-effective manner. There are also several constraints to be taken into account:

- the international character of rail transport;
- availability of funding for noise abatement;
- balance with action taken for other modes of transport (air and road);
- commercial availability and international acceptance of technical solutions;
- the long life of railway vehicles;
- the splitting of responsibilities for noise abatement;
- the differences in the member states with respect to the noise situation and abatement policy.

The main sources of pass-by noise are traction noise, rolling noise and aerodynamic noise. Other sources such as curve squeal, impact noise, bridge noise and noise in and around stations currently do not have high priority at European level, although they are being addressed at national level in some countries.

Rolling noise is the most important noise source and should be tackled by applying the principle of ‘smooth wheels on smooth rails’, in combination with other abatement measures

on wheels and tracks. Highest priority in this context is the replacement of cast-iron brake blocks in the existing railway freight fleet with composite brake blocks.

Although noise barriers are widely applied the WG recommends more noise control at the source, as barriers are often limited in their effectiveness (e.g. high buildings and multiple tracks) and are relatively expensive and intrusive in the environment. Nevertheless their implementation is sometimes necessary at hot spots.

17 Instruments and 12 subinstruments were identified to address the railway noise issue, listed in the following table. These include technical, regulatory, financial and political approaches. Some instruments impact on existing rolling stock and track infrastructure, whereas others only affect new vehicles and tracks. There are also differences in the speed of the effect of these instruments, the parties involved, and whether they are suitable to be implemented at international or national level.

Paragraph in the PPS	Instrument	Main effect	Key players	Vehicle/track	Technical/ financial/ political/ regulatory	New/ existing veh./track	EU/ National	Currently implemented	WG Evaluation
2.4.1	**Retrofitting existing railway rolling stock**	**Substantial noise reduction in the short term**	**Vehicle owners**	**Vehicle**	**Techn./ financ.**	**Existing**	**EU/National**	**CH**	**high**
2.4.2	**Noise reception limits (for existing line)**	**Retaining of average noise reception of traffic flow at given location**	**Govt./Track auth.**	**Both**	**Regulatory**	**Existing**	**National**	**CH,Dk, I, S (2015)**	**no**
2.4.2 a	National noise reception limits								medium
2.4.2.b	National noise reception limits for new houses along existing lines								high
2.4.2.c	limits should reflect thresholds for serious health effects								medium
2.4.2. d	level increase due to higher speeds or traffic volumes to be treated as substantial upgrading								low
2.4.3	**Noise emission ceiling**	**Retaining of average noise emission of traffic flow at given location**	**Govt./Track auth.**	**Both**	**Techn./regul.**	**Existing**	**National**	**CH**	**no**

Paragraph in the PPS	Instrument	Main effect	Key players	Vehicle/track	Technical/ financial/ political/ regulatory	New/ existing veh./track	EU/ National	Currently implemented	WG Evaluation
2.4.4	**Access restrictions for noisy vehicles types / trains**	**Substantial noise reduction for particular location (line), if traffic not increased**	**Govt./Track auth.**	**Vehicle**	**Regulatory**	**Existing**	**National**	**NL**	**Low**
2.4.5	**Noise emission regulations for vehicles**	**Substantial noise reduction in the long term**	**EU/Govt.**	**Vehicle**	**Regulatory**	**New**	**EU/National**	**EU, A, I, Fin, CH**	**medium**
2.4.5 a	limits for new interoperable vehicles								high
2.4.5.b	limits for new non-interoperable vehicles								high
2.4.5.c	regulations should deal with in-use compliance of vehicles								no
2.4.6	**Programmes to Manage Rail Roughness**	**Retaining of low noise emission for vehicles with smooth wheels**	**Track authorities**	**Track**	**Techn./financ./ regul.**	**Existing**	**National**	**Some countries**	**medium**
2.4.6 a	normal maintenance grinding programmes should take noise emissions into consideration								high
2.4.6.b	acoustic grinding is recommended								medium

Paragraph in the PPS	Instrument	Main effect	Key players	Vehicle/track	Technical/ financial/ political/ regulatory	New/ existing veh./track	EU/ National	Currently implemented	WG Evaluation
2.4.7	**Instrument for track upgrading or new design**	**Instant medium local noise reduction for goods and conventional trains**	**Track authorities**	**Track**	**Techn./financ.**	**Existing**	**National**	**Some countries**	**high**
2.4.8	**Regulations for tracks**	**Enforcement of noise reduction in the short to long term**	**Govt./ Track auth.**	**Track**	**Regulatory**	**Existing/ new**	**National**	**D (büG)**	**low**
2.4.8 a	EU track regulations as implementation of the TSI								no
2.4.8.b	national regulations for tracks (e.g. roughness limits)								low
2.4.8 c	declaration of track quality and maintance schemes to EU (TEN-T) or national notified bodies by the infrastructure manager								medium
2.4.9	**Specifications for the noise emissions in procuring/ordering new vehicles and tracks**	**Enables better comparison and calculation, stimulates noise awareness**	**Vehicle owners/ track auth.**	**Both**	**Technical**	**New**	**National**	**Mostly for vehicles**	**high**
2.4.10	**Incentives for the use of low noise vehicles**	**Substantial noise reduction in the long term**	**Govt.**	**Vehicle**	**Financial**	**Existing/ new**	**National**	**CH**	**high**

Paragraph in the PPS	Instrument	Main effect	Key players	Vehicle/track	Technical/ financial/ political/ regulatory	New/ existing veh./track	EU/ National	Currently implemented	WG Evaluation
2.4.11	Public funding for noise abatement programmes	Speeding up of overall noise abatement	Govt.	Both	Financial	Existing/ new	National	Some countries	high
2.4.12	Voluntary agreements	Speeding up of overall noise abatement	Railways	Both	Technical	Existing/ new	EU/National	Not yet	medium
2.4.13	Member State and EU funding for research and development	Potentially, new solutions for abatement or further noise reduction	Govt./ railways/ R&D orgs.	Both	Techn./financ.	New/ existing	EU/National	Yes	high
2.4.14	Information to stakeholders		Govt./ Railways	Both	Political	New/ existing	EU/National	Partly	medium
2.5.1	Improved measurement standard for railway exterior noise	Enables better comparison and calculation	Railways/ manu-facturers/ R&D	Both	Technical	New/ existing	EU	Later	high
2.5.2	Comprehensive noise prediction scheme	Include and quantify all major noise control measures at planning stage	Govt./Track authorities	Both	Regulatory	New/ upgrade	EU/National	Planned	medium
2.5.3	Information and participation of the public	Avoiding conflicts in noise abatement planning	Govt./ Railways	Both	Political	New/ existing	EU/National	Partly	Low, equal votes

4.2 Priorities

The most important railway noise problem is caused by **freight transport .** The working group has identified **two essential instruments** to address this:

- noise emission limits for new interoperable vehicles;
- the retrofitting of the existing cast iron block braked freight wagons.

A significant noise reduction in the average daily levels will only be achieved when the major part of the fleet in operation is retrofitted. Procedures including financing must be found to accelerate the implementation of noise reduction. The WG recommends an implementation schedule no longer than 10 years.

For the **railway noise problem in general**, the WG Railway Noise has identified the following **most promising additional instruments** :

- normal maintenance grinding programmes should be implemented and should take noise emissions into consideration;
- member state and EU funding for research and development;
- national noise reception limits for new houses along existing lines;
- public funding for noise abatement programmes;
- incentives for the use of low noise vehicles;
- noise emission limits for new **non** interoperable vehicles;
- improved measurement standards for railway exterior noise;
- specifications for the noise emissions in procuring/ordering new vehicles and tracks;
- noise emission reduction by track upgrading or new design

The following instruments are considered to have lower priority but can nevertheless be considered as options for implementation at national or European level:

- implementation of voluntary agreements to upgrade rolling stock, for example the UIC action plan to retrofit cast-iron block-braked vehicles with K-blocks;
- improved grinding techniques such as acoustic grinding;
- the provision of information on available technology, good common practice for the abatement of railway noise to key stakeholders would stimulate further implementation by parties involved. These are manufacturers, operators of rolling stock and infrastructure, politicians at the various levels including local authorities;
- introduction of national noise reception limits for existing lines;
- comprehensive noise prediction scheme ;
- declaration of track quality and maintenance schemes to EU (TEN-T) or national notified bodies by the infrastructure manager;
- if reception limits are introduced they should reflect thresholds for serious health effects.

There are four instruments which a majority of the WG rejects: emission ceiling, noise reception limits in general, regulations for in-use compliance and European track regulations. One instrument got equal votes for and against: information and participation of the public

4.3 Final Remarks

The Working Group is of the opinion that a solution to the major railway noise issues is possible within 10 years if the proposals are implemented as a cost-effective combination of the instruments described. All stakeholders should be involved. Especially the EU has an important role to initiate and stimulate various actions.

Both the Member States and the EU should be prepared to finance some of the measures, for example the retrofitting programme, the further relevant R&D and the steps required to standardise measurement methods.

If implemented successfully the instruments should benefit the European Community both in terms of environmental improvement and in terms of sustainable mobility, thereby strongly supporting the environmental and transport policy of the Commission.

Some instruments described in the paper require further evaluation and assessment. Future revision of instruments may be useful, possibly after a period of 5 years.

5 References

[1] EUROPEAN COMMISSION, DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT
Terms of reference for the working group on railway noise
Brussels, 25 November 2002

[2] **Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise**,
Official Journal of the European Communities
L 189, 18 July 2002

[3] Ødegaard&Danneskiold-Samsøe A/S (ODS), Copenhagen
(with Akustik-Data, PSIA-Consult, STUVA, Frama 01 and Politechnico Torino)
A Study of European Priorities and Strategies for Railway Noise Abatement
Main Report and two annexes
October 2001

[4] Draft prEN ISO 3095
Railway applications – Acoustics – Measurement of noise emitted by railbound vehicles
January 2001

[5] M. G. Dittrich,
The Applicability of prEN ISO 3095 for European Legislation on Railway Noise
TNO-report HAG-RPT-010014
Delft, May 2001

[6] Working Group Railway Noise of the European Commission
Progress Report 2000 for the Steering Group Meeting
Brussels, 13th October 2000

[7] Working Group Railway Noise of the European Commission
Annual Report I/2001 for the Steering Group Meeting
Brussels, 5th June 2001

[8] Working Group Railway Noise of the European Commission
Annual Report II/2001 for the Steering Group Meeting
Brussels, 7th December 2001

[9] ERRI
Documents of the 1st Consensus Building Workshop, 23rd March, Brussels

[10] Paul de Vos
Synthesis and Conclusions of the 2nd Consensus Building Workshop, 6&7 March 2001, Paris
Utrecht 11th October 2001

[11] Green Paper of the European Commission
Future Noise Policy
COM(96) 540 final
Brussels, 4th November 1996

[12] Communication from the European Commission
A Sustainable Europe for a Better World:
A European Union Strategy for Sustainable Development
COM(2001)264 final
Brussels, 15th May 2001

[13] White Paper of the European Commission "
European transport policy for 2012: time to decide"
COM(2001) 370,
Brussels 12 Sept 2001

[14] UNIFE, UIC, CER, UITP
A Joint Strategy for European Rail Research 2020 – Towards a Single European Railway System
September 2001

[15] COUNCIL OF THE EUROPEAN UNION
Proposal for a Decision of the European Parliament and of the Council laying down the Community Environment Action Programme 2001-2010
Interinstitutional File 2001/0029 (COD)
Brussels, 13 June 2001

[16] WHO
Guidelines for Community Noise
Geneva 2000

[17] W. Babisch
Traffic Noise and Cardiovascular Disease: Epidemiological Review and Synthesis, Noise&Health 2000; 8, p 9-32

[18] European Environment Agency
TERM 2001
Indicators tracking transport and environment integration in the European Union
Copenhagen , 2001

[19] DIRECTIVE 2001/16/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
on the interoperability of the trans-European conventional rail system
of 19 March 2001
Official Journal No.L 110 , 20/04/2001 P. 0001 – 0027

[20] U.J. Kurze, R. Diehl, W. Weißenberger, J. Schneider
Geräuschemissionen von Schienenfahrzeugen
(Sound emissions from railbound vehicles)
Bericht 32 211/78 for the UBA project105 05 806 +807
31th March 1999

[21] H.-J. Giesler
Bericht über die Geräuschemission akustisch geschliffener Gleise
(Report on the noise emissions from acoustically ground rails
Umweltbundesamt
Berlin, 4th January 2002

[22] U. Sandberg
Noise Emissions of Road Vehicles
Effect of Regulations
Final Report of the WP-NERV
International Institute of Noise Control Engineering
July 2001

[23] Council Directive 96/48/EC
on the interoperability of the trans-European high-speed rail system
of 23 July 1996
Official Journal No. L 235 , 17/09/1996 P. 0006 - 0024

[24] UIC
Noise Creation Limits for Railways
Main Report on the Railway's Position
June 2002

Annex I

EUROPEAN COMMISSION, DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT
Terms of reference for the working group on railway noise
Brussels, 25 November 2002

Scope

The working group shall elaborate the technical and economic aspects of the reduction of noise emission by rail transport systems, taking into account the results of relevant research and standardisation activities. Its output is intended to support the Common Transport Policy, the development of the EU noise policy for rail transport, and the single market for railway supplies.

Subject is the noise emission from all kinds of rail bound vehicles and all types of track.

From the start of the work priority shall be given to the reduction of noise from freight wagons and to type testing methods for all vehicles and all tracks. During the progress of work noise reduction from other conventional, high-speed and urban rail vehicles as well as other rail transport activities could be considered and common standards for noise emission classification of vehicles and tracks elaborated. The working group shall assist the Commission in developing proposals for noise emission limit values, to facilitate interoperability on the trans-European rail networks and reduce annoyance from railway noise.

Objectives and work to be undertaken

(1) To support the Commission with the development of possible legislation on type testing and noise limit values and to support CEN TC 256 with the development of standards for type testing and monitoring, both in line with existing relevant European and national legislation.

(2) To evaluate the results of the UIC action programme for noise reduction of freight transport and advice the Commission on related actions.

(3) To support the further development of low-noise technology for rail transport and outline priorities for noise abatement.

In relation to these the WG has the following tasks.

Task 1.1: Evaluate the drafts proposed by CEN TC 256/WG3 and identify the areas where further developments of the test methods are necessary, considering also the needs for harmonised testing methods for the implementation of Directive 96/48/EC concerning the interoperability of the trans-European high speed rail system and Directive 2001/16/EC on conventional rail interoperability.

Task 1.2: Evaluate options of limit values based on the classification of railway vehicles and track specifications with cost benefit analysis for high-speed rail, conventional rail and regional and urban rail systems. The economic aspects shall be elaborated in co-operation with the WG “Socio-economic aspects”.

Task 1.3: Stimulate further research on test methods, particularly in view of different track systems.

Task 2.1: Evaluate the results of technical and economic UIC studies on the retrofitting of all existing EU freight wagons with cast iron brake blocks (change to composite brake blocks and adapted wheels) and advise the Commission on related actions. Different scenarios for the retrofitting programme and for the phasing out of non-adapted vehicles shall be evaluated. The economic aspects shall be elaborated in co-operation with the WG "Socio-economic aspects".

Task 3.1: Investigate and evaluate the impact of noise from different rail transport sources and derive priorities for noise abatement. Make a survey of the national approaches to mitigate railway noise in Europe in order to set out proposals for a common European cost-effective strategy for railway noise abatement.

Task 3.2: Stimulate further research and developments of technologies for low-noise rail transport.

Indicative timetable

(Subject to change due to the development of the legislative and standardisation processes and/or availability of technical solutions.)

Start of the work:	December 1999	
Progress reports for the Steering Committee:	Annually	
Draft Position Paper Task 1.1:	March	2001
Draft Position Paper Task 3.1:	December	2001
Final Position Paper Task 3.1:	December	2002
Draft Position Paper Task 1.2:	March	2003
Final Position Paper Task 1.1:	September	2003
Draft Position Paper Task 2.1:	September	2003
Final Position Paper Task 1.2:	September	2003
Final Position Paper Task 2.1:	March 2004	
Stimulation of research:	Continuously	

Reports and position papers shall be adopted by majority decisions of the working group. Minority positions shall, if requested, be reflected as well.

Membership

Member States

Lars Deigaard	Denmark
Michael Dittrich	the Netherlands
Michelle Francis	United Kingdom

Philippe Grall	France	
Michael Jäcker-Cüppers	Germany	Chairman
Manfred Kalivoda	Austria	
Timo Välke	Finland	

Railway industry and organisations

Mads Bergendorff	UIC	
Stefano Ferraiuolo	UNIFE	
Peter Hübner	UIC	Vice-chairman
Friedrich Krüger	UITP	
Sébastien Laurent	UITP	
Siv Leth	UNIFE	
Rolf Tuchhardt	CER	

NGOs

Karl Krook	Transport & Environment

Commission services

Nunzio Bambara	Enterprise
William Bird	Research
Gilles Paque	Environment
Catherine Prudhomme	Energy and Transport

Observers

Werner Breitling	AEIF
Béla Buna	Hungary

Former members of the WG who participated in the preparation of the Position Paper

Christoph Deblanc	France
Janne Färm	UNIFE
Mark Fähndrich	DG Enterprise
Anders Lundström	DG Energy and Transport
Hervé Thoumyre	UIP
Alessandro Cocchi	Italy
Ivon Noël	UITP

Annex II

The STAIRRS Project

Work Package 1

Noise control is a major economic factor for the railways as national and E.U. wide environmental legislation is being enacted. In an effort to determine optimum strategies on a European level, the E.U. 5th framework has co-financed the STAIRRS project (Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems). Additional financing was obtained from the UIC, from the Swiss Government, from DB, SNCF, SBB, Railinfrabeheer, as well as from the Dutch Government.

Work package 1 was designed to develop the software necessary to undertake large scale cost-effectiveness analyses. 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 allows studies on Europe as a whole and in an approximate manner, also on individual countries. In parallel an optimisation algorithm can be used to determine optimum strategies for a specific line under given decision policies.

The STAIRRS project co-ordinator is the European Rail Research Institute, the work package leader for WP1 are the Swiss Federal Railways (SBB) with the participation of AEA Technology Rail BV (NL), German Railways (DB), French Railways (SNCF), PSI-Akustik (A), the Swiss Federal Institute of Technology and the Free University of Brussels.

The conclusions can be summarised as follows:

- **Noise control is very expensive**. For the 21 countries studied, the total extrapolated present costs range from € 3.5 billion (k-blocks on freight wagons) to € 76 billion (allowing a maximum of four meter barriers). These prices increase if perpetual present costs are taken into account (including cost of removal after the end of the lifetime and the replacement of the measure). There the maximum costs are € 109 billion.

- **The benefits of the measures vary.** The best effectiveness can be achieved with a solution combining k-blocks, optimised wheels, tuned rail absorbers, grinding and noise barriers no higher than 2 m. This solution protects almost 95 % of the population (i.e. only 5 % of the lineside population have remaining noise above an L_{den} of 60 dB(A)).

- **Freight rolling stock improvement has the best cost-effectiveness:** With composite brake blocks, for about 5 % of the cost of the option with the largest effectiveness, 38 % of the effectiveness can be achieved.

- **Noise barriers have low efficiency:** Noise barriers, especially if barriers up to 4 m height are allowed, have low efficiency. Their effectiveness and efficiency, however, can be improved, if k-blocks are added, because the total length of noise barriers can be reduced. A similar increase can be expected, if tuned rail absorbers are added, however this combination was not tested.

- **Track measures in combination with rolling stock measures are highly efficient:** Combining rolling stock improvement with track measures decreases costs while retaining same effectiveness. Similarly the effectiveness can be increased and the costs decreased if k-blocks are added to a scenario consisting of only tuned rail absorbers.

- **Acoustic grinding requires smooth wheels:** The price for acoustic grinding is very low (present costs of € 1.3 billion). With rough wheels, the effectiveness is small, it can be increased, however, with measures leading to smooth wheels. This general conclusion is based on TWINS [26] calculations using average roughness data from the literature for cast iron tread braked wheels, disc braked wheels, normal and smooth rails (compare annex 1). A calculation procedure was the only one possible to predict the noise effects for different roughness wavelength spectra taking account of a variety of designs and operating conditions. In absence of other data, Austrian data was used to derive roughness spectra for "longitudinally ground rails". The benefit is predicted to be low because from the data available to us, even for disc braked wheels, wheel roughness still dominates rail roughness. In specific cases, e.g. Germany, measurements indicate a much higher noise reduction from "acoustically ground rails" where a 3 dB(A) benefit is allowed on average for all types of trains irrespective of braking.[66]

- **The costs for insulated windows are very high in situations with low effectiveness.** Freight rolling stock solutions may have an excellent efficiency, however they are only about one third as effective as the maximum solution. Therefore, if all remaining persons with noise reception values above an L_{den} 60 dB(A) receive insulated windows, considerable costs must be expected. These are 4 – 5 times higher than the costs for the freight rolling stock improvement itself.

- **The above conclusions hold in almost all countries.** Exceptions only occur in those countries which have an exceptionally high number of freight or an exceptionally low number of freight wagons. In these cases only the combination of k-blocks with optimised wheels is different, because here the number of freight wagons determines total costs for both elements. **Caution must be exercised concerning the actual number of annoyed persons or persons above an L_{den} of 60 dB(A) in the individual countries.**

[66] In Germany DB AG has developed a procedure called "Specially Monitored Track" (SMT) for the purpose of reducing noise generation at the source. The SMT process involves removing rail corrugations through a special grinding procedure and a periodic acoustic monitoring of the track section. Measurements show that the rolling noise reduction obtainable with the SMT process for non-corrugated wheels (disc-braked wheels or vehicles equipped with k-blocks) can be as much as 8 dB(A) but is considerably less pronounced in the case of trains with cast-iron block brakes. The Federal Railway Agency (EBA) in Germany approved –3dB(A) on an average over all kinds of trains. By making methodical use of the SMT process, around 5 million EURO per year can be saved on conventional noise control measures (e.g. noise barriers).

- **Optimisation tool tested.** The optimisation tool could be shown to work in many instances. For those decision policies, the optimisation process favours rolling stock solutions, thus supporting the conclusions obtained with the comparison of noise control programmes. Further work on input data configuration is needed to allow wide-scale implementation.

Suggestions for further study include improving the data base, especially in terms of urban population densities, calculating the effects of different thresholds and additional promising combinations of measures such as composite brake blocks combined with tuned rail absorbers and noise barriers.

Figures 1 and 2 illustrate the situation without and with insulated windows. For detailed information please consult the STAIRRS final report.

Cost effectiveness of programmes not including insulated windows.

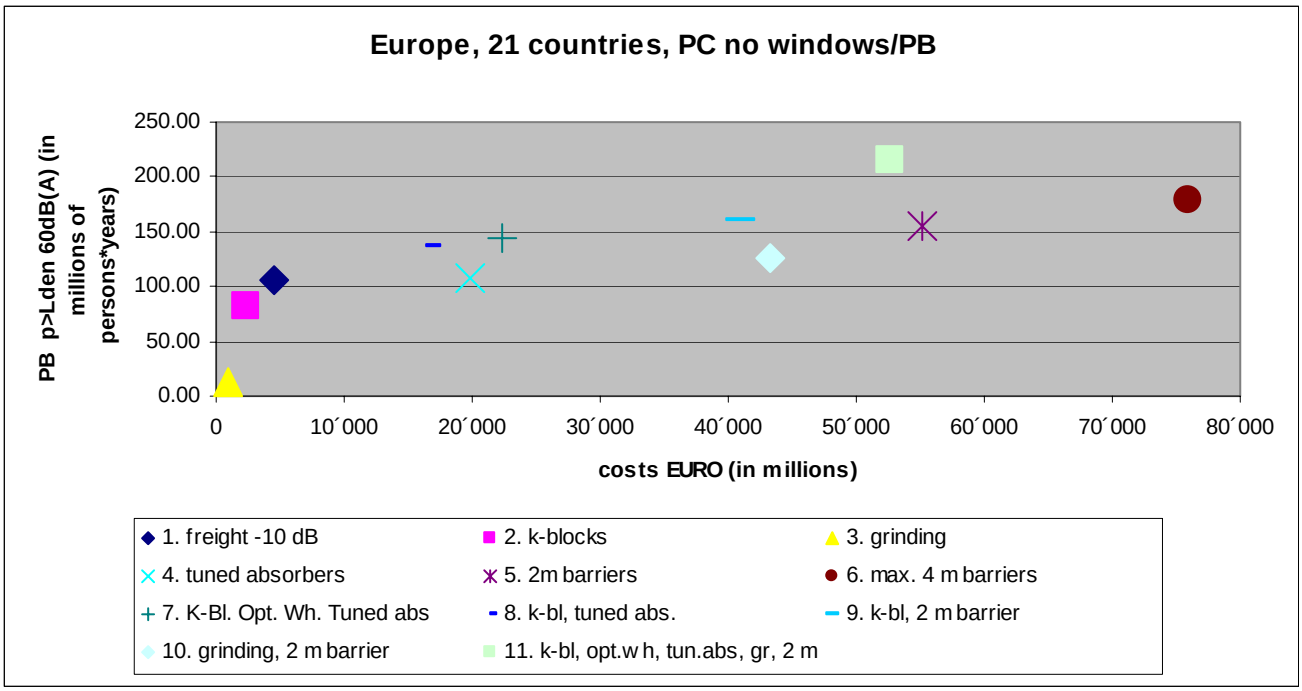


Figure 1: Short term cost-effectiveness of programmes not including windows. Number of wagons from UIC action programme noise reduction freight traffic. PC: present costs, PB: present benefits or effectiveness, PB L_{den} p>60 dB (A): effectiveness as reduction of number of persons above L_{den} of 60 dB(A), k-Bl: composite brake blocks, Opt. Wh.: optimised wheels, tun. abs.: tuned rail absorbers, gr: grinding, 2 m: 2 m noise barriers.

Figure 1 shows the extrapolated data to Europe, not including costs for insulated windows, using the expected number of wagons to be improved based on information from the UIC action programme noise reduction freight traffic (November 2001) for the 21 countries considered.

Cost-effectiveness of programmes including windows

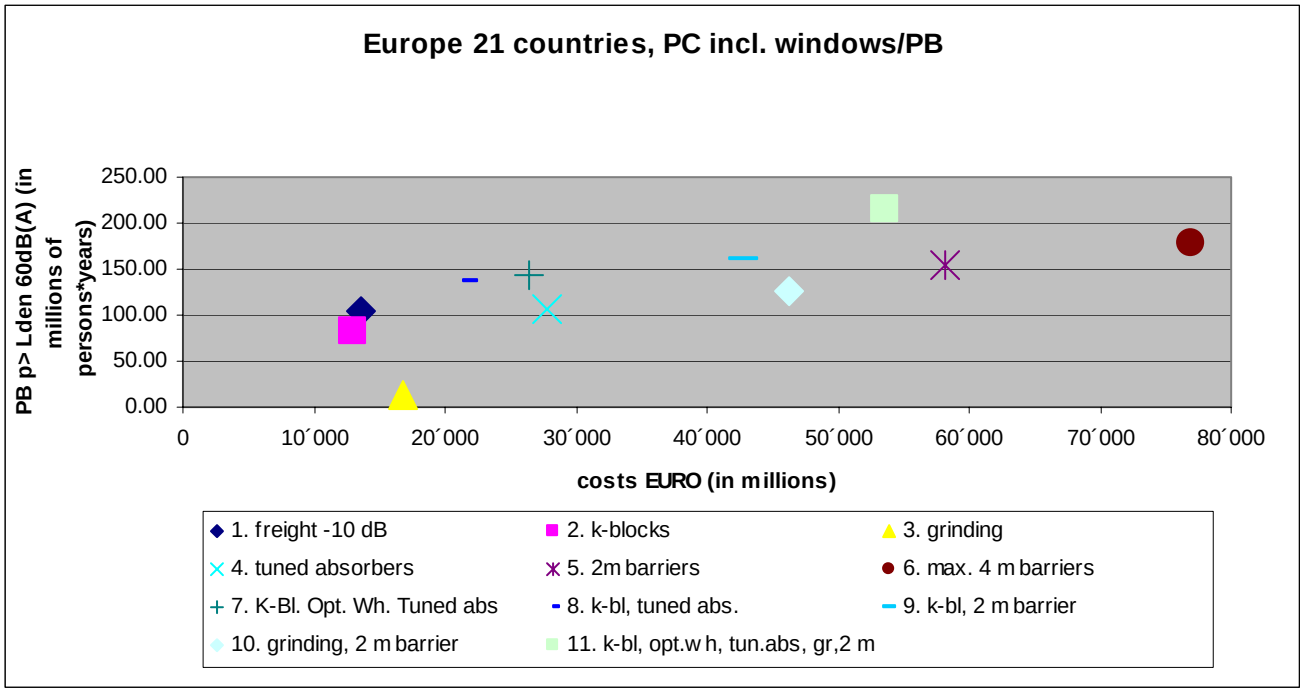


Figure 2: Costs and effectiveness of programmes extrapolated to Europe including costs for insulated windows in all cases where an L_{den} of 60 dB(A)are still exceeded. Short term discounted costs and benefits for the expected number of freight wagons in the 21 countries considered. PC: present costs, PB: present benefits or effectiveness, PB L_{den} p>60 dB (A): effectiveness as reduction of number of persons above L_{den} 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.

Figure 2 illustrates the effects of adding windows in all cases, where an L_{den} of 60 dB(A) ist not attained, in 3.3.3a for the expected number of wagons (UIC action programme steering group scenario for 21 countries).

Annex III

STAIRRS Work Package 2

New Methods and Tools for Railway Noise Measurement

In order to achieve reductions in noise exposure from railways across Europe, emissions from both vehicles and tracks must be driven down together. For the railways, the separation of vehicle operators and infrastructure authorities make it necessary to apportion responsibility between those entities.

The priority given to railway noise reduction, new national and EU legislation and the increased

knowledge on railway rolling noise have led to implementation and testing of various noise control measures on both vehicles and tracks, such as K-block brakes, rail roughness control, rail and wheel dampers and vehicle and track design. In the past, the assessment of such measures was often limited to single microphone measurements which can give varying results depending on test conditions such as track type and condition and vehicle speed.

Acceptance testing, limit conformance testing, assessment of noise control measures, collection of emission data and monitoring are all applications that call for more representative and reproducible measurement methods.

Within the STAIRRS project new methods and tools have been developed to address particular needs in the measurement and characterisation of railway noise. Another part of this work was to collect data using these methods and to propose a classification for vehicles and tracks.

Noise source separation, characterisation and applications

The term 'noise source separation' is used for quantifying the sound radiated by the track and by the vehicle during pass-by. The term 'characterisation' implies any method that quantifies the acoustic properties of vehicle or track, independent of operating conditions. Noise source separation can be carried out to three levels of detail.

Level 1 separates the total noise spectrum into the vehicle noise spectrum and the track noise spectrum. This is needed for the evaluation of noise control measures on vehicle or track.

Level 2 further separates these into a transfer function for each source and a spectrum of combined effective roughness that excites both vehicle and track. These techniques provide a speed independent and portable descriptor of a vehicle type or track type. A database of this information is required for predictions of noise for any vehicle-track combination. Such data allows the division of responsibility for the noise at a particular site between the vehicle

operator and the infrastructure authority. The level 2 approach allows for characterisation not only of vehicle and track but also of physical excitation (roughness) and transfer function, as illustrated below. Both level 1 and 2 measurements can be carried out in the field on service trains.

Level 3 determines all the necessary parameters to predict the noise from a theoretical model.

Developed methods and tools

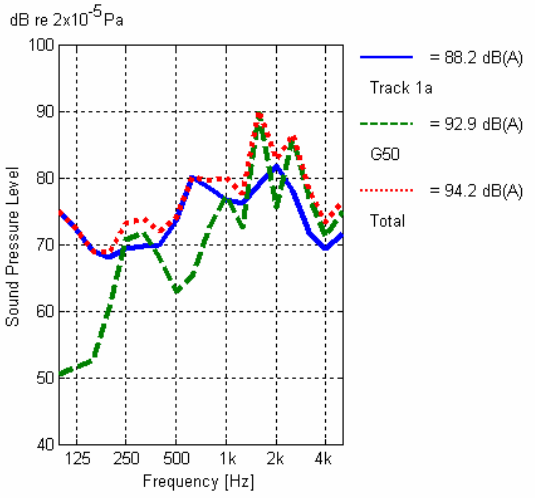
Some of the most promising technologies were chosen for further development, following a survey.

Level 1 methods - Separating vehicle and track noise spectra:

- VTN: using a field microphone, rail vibration measurement and model parameter identification.

- MISO: using a field microphone, an additional microphone close to the track, rail vibration measurement and time windowing.

- Reference vehicle method: using a small-wheel vehicle, rail vibration measurement and a field microphone.



Total, track and vehicle noise at 7,5m for concrete sleeper track with cast-iron block braked freight wagon at 100 km/h

Level 2 methods – Separating roughness and transfer function spectra

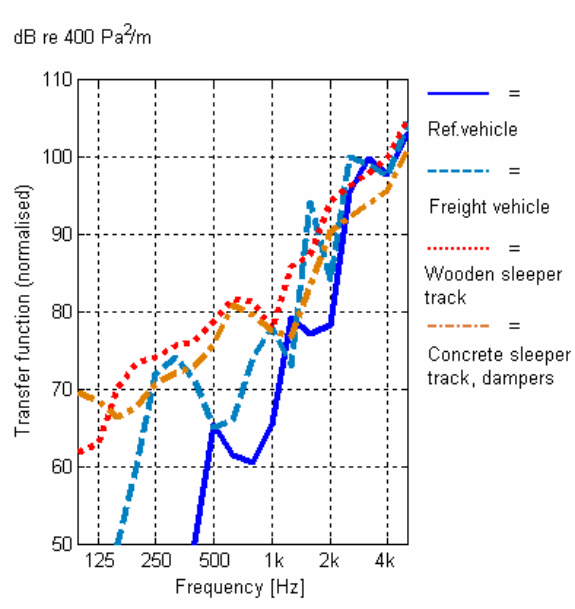
- Direct roughness measurement: data processing procedures in prEN ISO 3095 have been reviewed and improved.

- PBA (Pass-by Analysis for level 2):

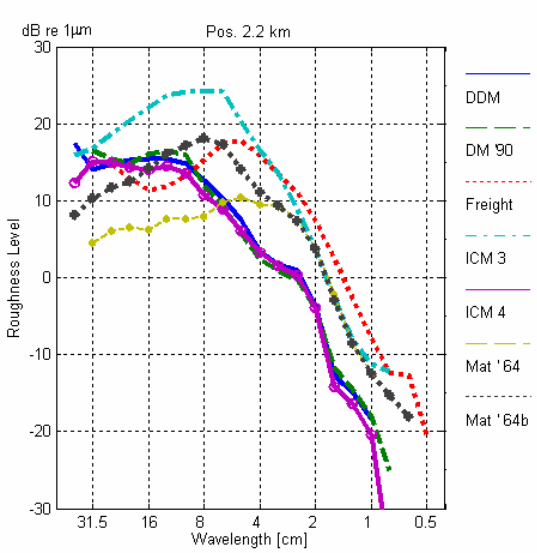
- Indirect roughness method: combined effective wheel-rail roughness is obtained from railhead vibration during pass-by.

- Transfer function measurement: a transfer function from combined effective roughness to sound pressure at the field microphone position. Separation of vehicle and track transfer

functions requires a quiet reference vehicle and a reference track section.



Track and vehicle transfer functions



Indirectly measured combined effective roughness of different train types

Level 3 methods – Model predictions

For new vehicle and track designs, and where measurement data is unobtainable, advanced models are required to accurately predict the transfer functions.

Theoretical basis

Besides measurement campaigns, theoretical studies were also performed to provide a critical assessment of the applicability range of the measurement methods, and their consistency with current modelling with TWINS. These studies covered issues such as wheel size and contact patch in relation to measured rail vibration, and effects of variability of different track parameters.

Validation and data collection

A major validation campaign was performed in Caen, France with a test train running on three specially equipped track sections. This was used both to validate the methods developed and to collect data from several vehicle – track combinations. In addition, several smaller campaigns were performed in different EU member states to collect vehicle and track data using the methods developed.

A substantial amount of data of different trains and tracks was collected in a database developed in STAIRRS WP2, catering for the typical outputs of the STAIRRS methods. A data collection sheet was implemented which could be used as a baseline for future measuring campaigns.

Availability and future use of results

Some of the developed tools have already been made commercially available (VTN by AEAT and PBA by TNO), others are in use within involved companies (MISO by SNCF). Measured data on various European track types and vehicles are also available. A vehicle identification protocol has been proposed that takes noise relevant parameters into account. Several techniques have been developed which are suitable for future versions or parts of measurement standards, including:

- separation techniques for vehicle and track noise
- track characterisation by a single transfer function
- indirect roughness measurement (combined effective roughness)
- improved rail roughness measurement and processing procedure.

The new methods and tools are of particular use to obtain input data for calculation schemes that take roughness and transfer functions for tracks and vehicles into account.

Partners in STAIRRS Work package 2 are: AEAT (NL), SNCF (F), Psi-A (A), Politecnico di Torino (I), ISVR (UK), TNO TPD (NL) and ERRI (NL).

STAIRRS is a project in the fifth framework programme supported by the European Commission's Transport and Energy Directorate (2000-2002).

European Commission

Working Group Railway Noise of the European Commission. Position Paper on the European strategies and priorities for railway noise abatement

Luxembourg: Office for Official Publications of the European Communities

2003 — 92 pp. — 21 x 29,7 cm

ISBN 92-894-6055-5

14 KH-54-03-041-EN-C

ISBN 92-894-6055-5

Publications Office
Publications.eu.int

Environment themes

General

Water

Land

Air

Industry

Waste

Nature

Urban

Funding

Law

Economics

Assessment

Nuclear issues

Risks

Education

See our publications catalogue at:
http://europa.eu.int/comm/environment/pubs/home.htm