UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Noise Creation Limits for Railways

- Main Report -

27/08/02

1. Introduction

The UIC (International Union of Railways) has co-ordinated the activity of railways since 1922. All the principal operating and infrastructure companies are members. For a number of years it has worked to co-ordinate its members' efforts to minimise the impact of railway activities upon the environment. Among these impacts, the noise created by railway operations is of particular concern. Consequently UIC has played a central role over the past 30 years in co-ordinating the research activities of its members in the area of railway acoustics. This research work forms the foundations for this report, which sets out current knowledge of the phenomenon of railway noise and the potential of technical measures to mitigate it. The report also contains proposals for future achievable and affordable noise creation limits which are based on this knowledge.[1]

2. Policy background

2.1 EU policy issues

An overarching policy objective of the European Union is to achieve sustainable economic development. This requires economic growth without any additional adverse environmental impact. In practice economic activity creates impacts upon the environment at both global and local levels. At the global level a reduction in the emission of "greenhouse gases", which are responsible for global warming and associated climate change, is a major policy objective of the EU. A substantial contribution to the EU's emissions of greenhouse gases comes from transport activity, in particular from road transport. Shifting the balance between road and rail transport (where the emission of greenhouse gas per passenger/km and tonne/km is much less), is accordingly a major objective of EU transport policy.

But transport activity also creates adverse impacts upon the environment at a local level. The two most serious impacts are local air pollution caused by the exhaust gases from internal combustion engines and excessive noise. The significant proportion of railway operation in Europe performed by electric trains means that a shift from road to rail will reduce air pollution at the local level, with the most notable effect being experienced in urban areas. However, such a shift may aggravate the noise nuisance for local communities unless steps are taken to reduce the noise created by rail operations. At the same time it is imperative that these steps do not result in an additional cost burden upon rail transport of a scale which jeopardises the achievement of the overall policy objective of sharpening rail competitiveness and thereby ensuring the desired shift from road to rail. This paper examines the technical issues involved in reducing the noise created by rail operations and proposes noise creation limits which can be achieved without jeopardising competitiveness.

2.2 Recent developments

During the past decade the EC has approached the question of environmental noise from the perspective of noise reception; this has culminated in the recent adoption of the 'Directive relating to the assessment and management of environmental noise'. The principal thrust of this Directive is to force member states to identify "hot spots" where environmental noise is excessive and to create action plans to tackle them. It is anticipated that the majority of these cases will concern road transport. Tackling the much smaller number of railway "hot spots" will probably involve a combination of infrastructure-and vehicle based measures. The details of any

[1] Additional details are laid down in the document 'Background Information from UIC SC Noise and Vibration'.

action plans will depend on the noise reduction required and the source of the highest noise levels in any particular location.

The EU working group no. 6 on railway noise has initiated discussions on the issue of noise creation. As part of this initiative DG TREN has commissioned external consultants led by ØDS[2] to review best practice. The final report by the consultants has just been published. This report suggests the implementation of noise creation limits and proposes values. Unfortunately the ØDS report is selective in its assessment of the evidence and fails to reflect the body of knowledge on the subject of railway noise which has been built up by research endeavour over the past 30 years. Such a review – together with conclusions concerning achievable and affordable limit values – is the principal purpose of this paper.

The legal framework for the adoption of any noise creation limit values will be provided by the Directive on conventional interoperability. The Directive requires the development of Technical Standards for Interoperability (TSI) including one related to noise creation. For high speed trains those TSIs have already been developed.[3]

2.3 Noise creation limit values: homologation issues

For road vehicles limit values for maximum noise creation have been an element of EC policy for many years as they form an integral part of the Single Market initiative. However, an important criticism of the type approval limits for road vehicles in the EU is that the limit values and the method by which compliance is checked, is not at all representative of the normal operating conditions. As a consequence, limit values have been reduced several times on a periodic basis, without much noticeable effect to the noise creation by traffic flows. For road vehicles one reason of these levels not being related is that the type approval test is dominated by engine noise, whereas in normal operation tire/road noise is dominant. Another reason is that the gear/engine speed combination which is to be maintained during the type approval test is not representative for most of the engine conditions during normal traffic.

In rail traffic one would like to avoid a similar situation. Therefore, conditions can be defined for the limit values to be set. These values need to be accurate, well-defined, reproducible, mutually comparable, recognisable, and most important they need to be representative for real operations.[4]

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[2] ØDS Ødegaard &Danneskiold-Samsøe A/S

[3] It has to be kept in mind that normally TSI specifications are <u>minimum</u> requirements for interoperability. In the case of noise creation, the limit values will be the <u>maximum</u> level permitted.

[4] All noise levels stated in this document noise levels are Transit Exposure Levels (TEL), expressed in dB(A), assessed at a horizontal distance of 25 m from the centre line of the nearest track, at a height of 3.5 meters above rail head (majority of measured and historical data is available for this position of the microphone). For high speed 25 m is preferred (No houses are as close as 7.5 m to such new railways) Measurements at 25 m are in practice at SNCF and DB for all trains. However measurements at 7.5 m are technically preferable in some cases as stated in pr. EN 3095. The final proposals for limits in this report will be normalised to a reference speed of 80 km/h with a 30 log (V / 80) speed dependence where it is necessary to correct data from other speeds.

2.4 National initiatives for railway noise creation limits

Few countries have taken the initiative of setting noise creation limits for railways:

Italy will set limit values in two stages (2002, 2012). The legislation concerns new vehicles and foresees periodic checks every 5-6 years under defined measurement conditions. The indicator is LA_{max}.

In **Switzerland** values were fixed in 1994 for new passenger coaches, locomotives and EMU. LpA_{max} values were also recommended for existing passenger coaches, locomotives and EMU with disc or sinter bloc brakes and for existing passenger coaches, locomotives and EMU with cast iron brakes. In 2001 the Railway Abatement Act also sets limits for retrofitted passenger coaches but no values are set for the moment for freight wagons. A measurement campaign of the ministries for environment and traffic is expected to provide data to fix those values within the next 1-2 years.

Austria has issued its railway vehicle noise approval directive (25 June 1993), which distinguishes 7 vehicle categories and sets for three time periods limits for freight vehicles, the last limit entered into force 1st January 2002. The limits apply to vehicles which are submitted for registration in Austria. In the case where the limits can not be complied with, the manufacturer will decide to have the vehicle registered somewhere else, where no limits apply. Once registered, the vehicle will then have to be admitted to the Austrian network, in conformity with international agreements.

Concluding comment: Strong regulations may consequently be ineffective if the limits are too tight. Austria has set very tight values for new freight wagons; it is understood that as a consequence only a small number of freight wagons have been registered in Austria since the new limits came into force.

3. Technical background

Since the question of noise creation levels from railways is not new, this chapter aims at giving background information and explaining how official values for railway noise creation are already in use in legal process in different countries, even if formal limits are not set. Previous studies, where noise creation levels from railways were gathered from an European point of view, have also been reviewed, the results are summarized in chapter 3.2.

3.1 National noise prediction models

In many countries in the EU noise prediction is required for legal procedures, e.g. in relation to new urban developments in the vicinity of existing railways or new railways close to existing dwellings. Prediction methods have been developed in the Nordic countries, in the Netherlands, in Germany, in France, in the UK, in Switzerland and in Italy. Usually the predicted value is a long term average, equivalent sound pressure level at a certain reception point. The input then consists of traffic data (number of trains per train type per unit time, their speed) and track data (track type). The methods are based on experimental data on train pass-by measurements. These results can be used to obtain the "survey on the performance of existing rolling stock". However, the following conditions should be observed:

- it is usually necessary to correct the "emission" value in the prediction method into a value which can be compared for type testing. Assumptions would have to be made on the properties of the soil between track and receiver point and also on wind speed and direction.
- The track conditions which form the basis of the large databases for noise prediction methods usually reflect the average track conditions of the particular network. These will in general differ from the track conditions which are prescribed for type testing. This has to be kept in mind when comparing type testing and prediction data.

At 80 km/h the different national prediction models give the following levels for train categories:

TEL in dB (A) at 25 m	Cast iron tread braked passenger	Disc braked passenger	Cast iron tread braked freight
Holland	80 – 81	76 – 78	85
Germany	85	74* - 77	85
Switzerland	85	72-74	84
France	87	76	88
UK	80 – 84	75 – 81	85

* ICE with wheel dampers on track with stiff rail pads

This would suggest that current practice for trains in service as recognized by laws in different countries gives the following noise levels (TEL at 25 m from the track):

4 axled disc braked passenger vehicles	75 dB(A) @ 80 km/h
	84 dB(A) @ 160 km/h
	87 dB(A) @ 200 km/h
tread braked freight vehicles	85 dB(A) @ 80 km/h
	88 dB(A) @ 100 km/h
	90 dB(A) @ 120 km/h

These results are reasonably consistent with measurements presented in chapter 3.2. These figures, cross-checked with an updated state of the art of creation levels, will be used to develop proposals for future noise creation levels.

3.2 Noise creation values of different existing rolling stock

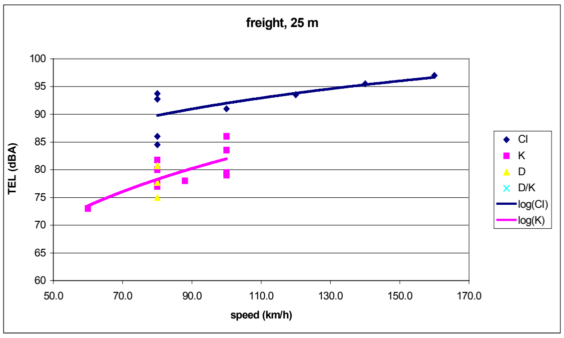
3.2.1 Measuring noise creation: some problems

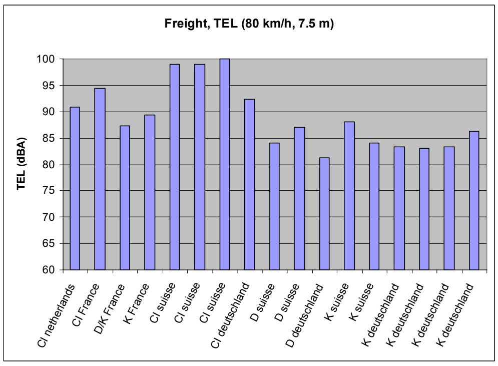
For many years interpretation of empirical data has been complicated by the spread of observations even for a single vehicle type at the same site; it is normal for this spread to be at least 2 dB (A).

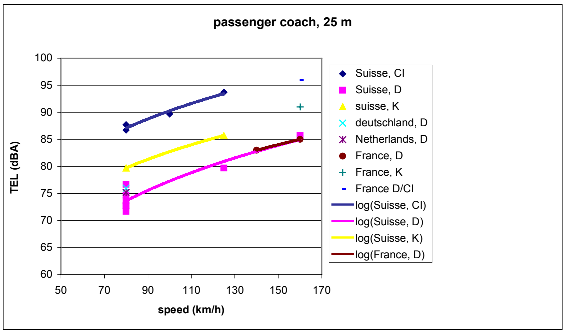
The traditional method of analysis has been to carry out best fit regression to the data to quantify this trend with speed. Thus for a standard deviation of 2 dB (A), 5% of the data will be more than 4 dB(A) noisier than the average and 5 % will be more than 4 dB (A) quieter. This demonstrates the potential pitfalls of inferring general trends from single measurements or even from a small data base of measurements.

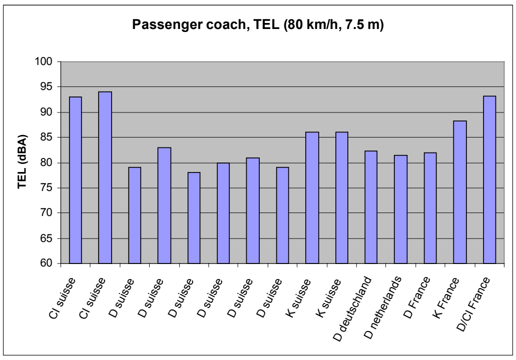
3.2.2 Conventional rolling stock

From data provided by various operators noise levels of all different types of rolling stock (freight wagons, diesel & electrical driven multiple units, locomotives and passenger coaches), were categorized by type of braking and analyzed. The results have been plotted first in a speed TEL graph (see below left side) and in addition the values were converted into TEL(80,7.5m) to give a global picture of the situation with respect to the proposals of the Study for the Commission (see below right side). Although there were differences in the actual measurement techniques of the different railway administrations, these results showed good agreement between different countries and current noise levels. As an example[5] results are given of freight wagons, using the following symbols to define braking type categories: D: Disk, CI: Cast iron, K: K composite blocks









From this overview of different European trains of the same generic design, current noise levels (± 3 dB (A)), can be summarized as follows (TEL at 25 m from the track):

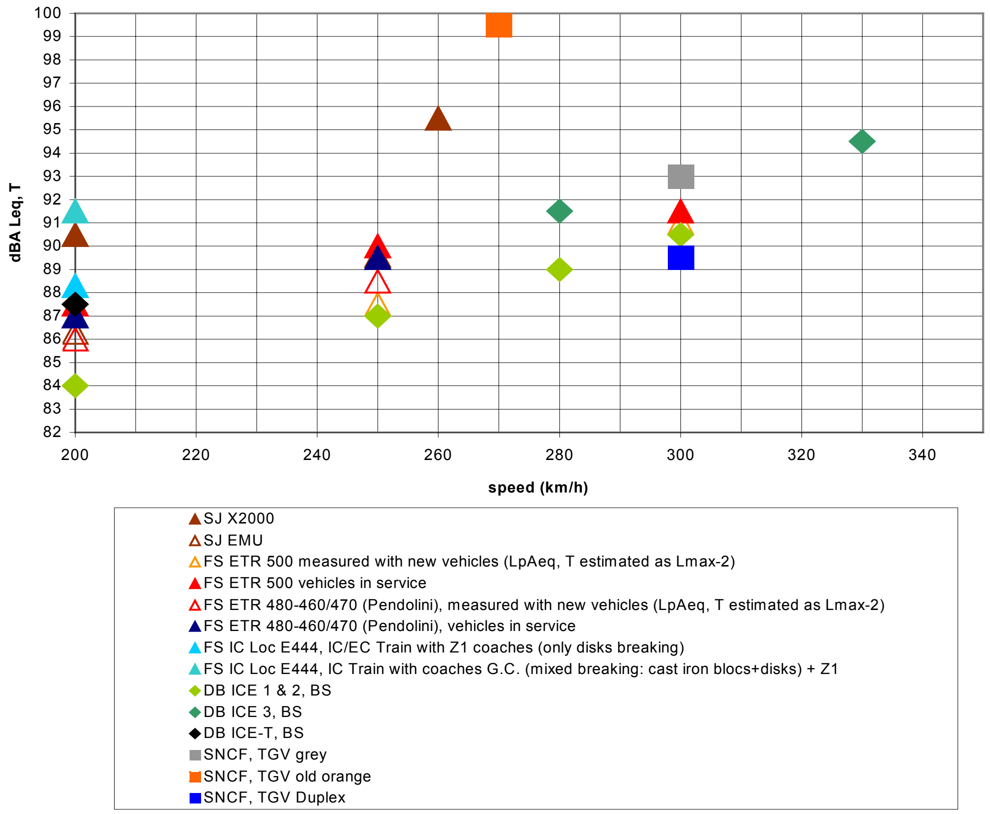
Cast Iron tread braked freight @ 100 km/h	= 91 dB(A)
Disc braked passenger vehicles @ 100 km/h	= 80 dB(A)
Cast iron tread braked passenger vehicles @ 100 km/h	= 88 dB(A)
Cast iron tread braked passenger vehicles @ 160 km/h	= 94 dB(A)
Disc braked passenger vehicles @ 160 km/h	= 85 dB(A)

The difference in noise creation at 80 km/h of each brake type category clearly appears in the above figures. These levels have to be taken as starting points for the limit proposals.

[5] Full data see report 'Background information from UIC Subcommission Noise and Vibration'

3.2.3 High Speed Trains

A synthesis of noise levels of the different high speed trains in Europe, is given below:



3.3 Reduction potentials

Apart from freight wagons, where technology has not improved in recent years, significant progress has already been made for most classical and high speed applications.

3.3.1 Noise reduction research results

The basic results that have come out of rolling noise research are that the following two steps have to be considered for rolling noise reduction

1 - **<u>Reducing roughness</u> on both wheel and track**:

These solutions consist of:

- introducing disk brake or composite brake blocks,
- grinding the track.

Their application has been delayed because they incur additional cost burden.

Smooth wheels and rails can reduce both the wheel and track components of rolling noise. Wheel roughness is controlled by the type of braking used. For some years the use of disc brakes on passenger vehicles has shown a reduction of about 8 dB(A) when compared to the noise from cast iron tread braked vehicles at the same speed. For example TGV Duplex double decker trains (disk braked only) are about 10 dB(A) quieter, at equal speed, than the first generation (orange) train- sets. Brakes made of composite materials give noise characteristics similar to disc braked vehicles on passenger vehicles.

A number of railway administrations are currently looking at rail grinding, based on acoustic criteria, as a means of noise reduction. DB, for its high speed lines uses "acoustic grinding criteria" which allows a reduction of 3 dB(A) in the calculated noise reception levels relative to track with normal roughness.

2 – **Reducing vibration or radiation from both components** wheel and rail.

The efficiency of such measures depends on the balance of the initial contribution of wheel and track. For instance, when high speed vehicles operate on tracks with hard rail pads, wheel noise will tend to dominate over track noise. In this situation low noise wheel components such as wheel dampers may be effective. An example is the ICE operating on high speed DB tracks. For tracks with softer rail pads (the more normal situation in Europe) and at lower speeds, the track noise will dominate over wheel noise. In these situations low noise wheel components in isolation will be ineffective and quieter railways will only results when measures are first applied to the track. This was demonstrated in the Silent Track project.

From this knowledge, concepts of prototype for noise-optimised components were developed, based on the well known fact that reducing roughness, particularly on wheels, was the most efficient measure in a first instance. Examples: Introducing disk braked rolling stock on a number of Intercity coaches resulted in a nearly 10 dB(A) noise reduction with respect to the noise from cast iron braked rolling stock.

The development of prototypes for optimised solutions was recognised through TWINS simulations to be necessary for both wheel and track. The relevant projects, dedicated to these developments have been the "OF-WHAT" (Optimised Freight Wheel and Track) project, done by ERRI and the projects SILENT FREIGHT and SILENT TRACK, both EU-sponsored. In the OF-WHAT project noise reductions at 60 and 80 km/h ranging from 4 dB(A) for track measures to 7 dB(A) for a combination of track and wheel solutions, were obtained. Experimental results obtained with prototype test wheels on a test track confirmed TWINS calculations carried out before the tests. Further developments of more industrialised prototypes were undertaken, in cooperation with the industry within the frame of the SILENT FREIGHT and SILENT TRACK projects. Prototypes for optimised wheels and damping elements for wheels and tracks have been developed. Wheel treatments reduced wheel radiated noise by up to 7 dB(A) and track treatments achieved similar reductions for track radiated noise. Furthermore, concepts of bogie shrouds coupled with low track side barriers were also investigated. The compliance of the latter concepts with UIC gauge resulted in a reduced acoustic efficiency.

3.3.2 Case studies freight and passenger

In the following, an assessment of potential reductions to be obtained for different cases has been derived using TWINS simulations and the result of EU projects SILENT FREIGHT and SILENT TRACK. The main important cases of freight and Intercity passenger vehicles have been carried out and are summarised below. Detailed analyses are in the report 'Background information'. The starting point for current designs are for freight wagons with cast iron braking shoes and for passenger coaches with 4 axle fitted with disc braked, straight webbed wheels with either web mounted or axled mounted disc blocks, i.e. optimised cross section.

Design	Freight vehicle Noise level 25 m, 100 km/h	Freight vehicle Noise level 25 m, 80 km/h	Passenger coaches Noise level 25 m, 160 km/h	Passenger coaches Noise level 25 m, 80 km/h
4 axled disc braked passenger vehicle			84	75
Cast iron tread braked freight vehicle	88	85		
Smooth wheels/composite brake (no shape optimisation)	84-85	81-82		75
Disc brake (including shape optimisation)	80-82	77-79	84	75
Wheel tuned absorbers	88	85		74.5
Wheel web shields	87	84	Not investigated	
Composite Brake + wheel tuned absorbers	83-84	80-81	Not investigated	
Composite Brake + wheel web shields	82-83	79-80	Not investigated	
Rail tuned absorbers	75-82	72-79	Not investigated	
Longitudinal ground track	Not investigated			72.5
Damped track	Not investigated			70.5
Damped track + wheel	Not investigated			68

This table is illustrative of the technologies that are necessary to reach levels down to values announced in e.g. the ØDS report. They represent one element among others used to set the final proposal for noise creation limits.

3.3.3 Comments

Because of the dominance of track radiation, vehicle treatments in isolation, that do not affect wheel roughness will have little effect on total rolling noise. Lower levels can only be achieved with damping **measures applied to the track**. Such measures would make further technological well known systems (damped wheels) really efficient and would allow global lower levels.

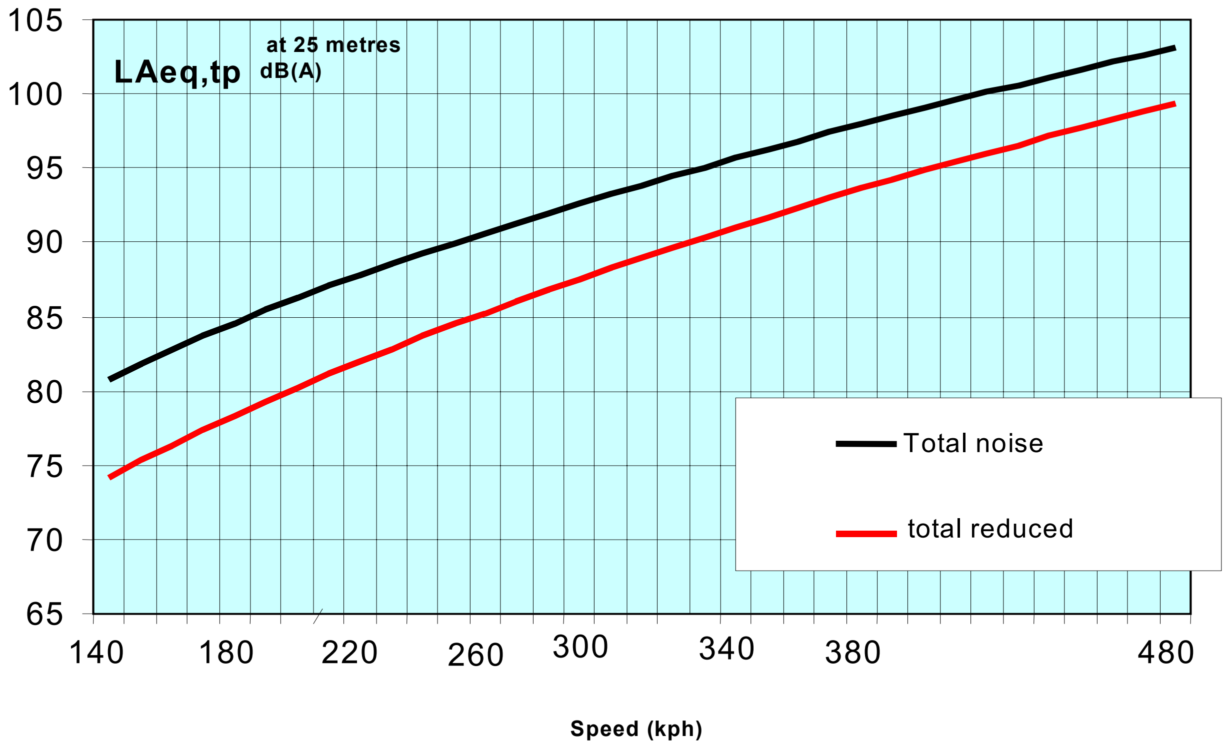
Acoustic grinding is predicted to have little benefit at conventional train speeds.

3.3.4 Case studies High Speed

Much progress was already achieved on noise for high speed trains with for example the introduction of disk- brakes only on the trailing cars of the French TGVs. The total noise reduction from the first series (TGV-PSE) to the latest (TGV Duplex) reaches nearly 10 dB(A), at equivalent speed. Experiments carried on also on high speed trains TGV Réseau in France demonstrated however a potential of 7 dB(A) reduction on rolling noise coming from the association of wheel and track absorbers.

The reduction of rolling noise already carried out emphasized the potential importance of aerodynamic noise which was the field of important research programs (DEUFRAKO, ATREBAT)

As an example, the following diagram shows the noise reduction obtained for a typical high speed train set (black: current high speed train on operational track; red: same train equipped



with wheel and track dampers, and bogie shrouds on motor coaches), where 7 dB(A) reduction are achieved on rolling noise and 3 dB(A) reductions on aerodynamic noise.

4. Proposals for values

4.1 Basic requirements

Any limit value for noise creation must meet two requirements;

- it should be technically feasible
- it should be affordable i.e. the cost of implementing the technical measures must not jeopardize the competitiveness of the rail mode.

4.2 Cost-effectiveness analysis

In recent years a number of studies have been carried out where the cost effectiveness of different railway noise control options have been compared with the traditional use of trackside noise barriers and sound insulation in nearby property. These studies include:

- A cost-benefit study carried out in 1999 for UIC,
- An economic study for Silent Freight, Silent Track and Eurosabot projects (1999 - 2000),
- An extension of the 1999 study to cover the whole of the EU and parts of Europe in the STAIRRS project, and
- Costs associated with the implementation of composite brake blocks on freight vehicles in the UIC Noise Reduction Action Plan.

STAIRRS and the UIC Action Plan are current but the earlier studies concluded that the use of low noise components on wheels and tracks provided alternative means at competitive costs, of achieving target environmental noise reception levels with a greatly reduced requirement for high lineside noise barriers. Implementation of such designs would have a significant positive effect on the visual impact of a railway incorporating noise control at source.

Smooth wheels and smooth rails are essential elements of a low noise railway system and the first step in achieving this will be the replacement of cast iron tread brakes on freight vehicles with brake blocks made of composite materials. A cost-benefit analysis is currently being carried out at UIC level within the freight noise wagon noise programme. Preliminary costs for retrofitting of freight wagons (€/Wagon) are the following:

	2 axled cars		4 axled cars	
	With exchange of wheels	Without exchange of wheels	With exchange of wheels	Without exchange of wheels
K-Blocks	€~6‘000	€~3'750	€~10‘000	€~5'500

The indicated costs are the average cost per wagon in EURO. For the European fleet this would require investments around € 3 billion.

Smooth rails may be achieved by additional maintenance through rail grinding which currently costs about 5 EURO per track metre per year. Additional grinding will increase this cost.

To achieve lower noise levels than given in the table in Section 4.3.1 of this report smooth wheels and smooth rails will be insufficient and further measures will need to be applied to vehicles and track.

For freight vehicles, track noise tends to dominate vehicle noise, therefore further reduction of freight vehicle noise can only be achieved if **low noise track measures** are implemented. Currently the only known solution is the rail tuned absorber developed in the Silent Track project. Costs for these absorbers were included in the economic study carried out for Silent Track, Silent Freight and Eurosabot projects. Because the inclusion of rail absorbers is critical in an effective noise control programme their costs are a dominant factor in providing a cost effective option. The economic study showed that a unit cost of 200 € per track metre (fitted) was necessary to achieve this objective. No product at such a price is currently available, but the suppliers are confident that this can be achieved in volume production.

It can be assumed that if wheels are replaced at the end of their useful life there will be no additional cost associated with providing a **wheel to which noise reduction measures are to be attached**. There will be an additional cost, however, associated with the known options of wheel tuned absorbers or web shields and it was estimated that these could vary between € 140 and € 1100 per wheel. This should be compared to a wheel cost of approximately € 560.

These additional components will require increased inspection for maintenance purposes with an associated increased cost throughout their life. The overall costs need to be compared with the costs of noise barriers and sound insulation. Current studies assume the following:

- 2m high barrier 810 €/m (single side)
- 3m high barrier 1080 €/m (single side)
- 4m high barrier 1350 €/m (single side)
- sound insulation 8000 € per house

The STAIRRS project is currently reviewing comparative costs of different mitigation options taking into account initial cost, time period of programme implementation, maintenance costs and lifespan of a measure. As first cost estimation resulting from STAIRRS show investment need of some € 40 to 60 billion for a European wide installation of noise barriers, there is no reason to doubt that the results will confirm conclusions from previous studies that low noise components are viable alternatives to noise barriers and sound insulation.

Although it is unlikely that sufficient noise reduction at source will be achieved in the short to medium term to eliminate the need for barriers and insulation completely and still meet environmental noise reception targets with a commercially competitive railway.

4.3 UIC noise creation limit proposals

The noise creation limits presented in this chapter are based on the background data summarised in section 3.1, updated measurements in section 3.2, the latest vehicle specifications of different railways and TWINS simulations of more mitigation presented in section 3.3. A full description can be found in Annex I ‘Background Information of UIC SC Noise’.

4.3.1 Classical speeds

The following proposal can be made for classical rolling stock, considering the current state of technology of rolling stock and the achievable noise reductions studied above. As mentioned before, they have been developed first for a reference distance of 25 m and then been transformed to a distance of 7.5 m for comparison with ØDS proposals. They have to be applied for new interoperable trains only. As retrofitting of rolling stock, especially for freight trains is in discussion, corresponding values are presented for the case that such programmes will be funded and started. Short term is defined for design, starting at the time when TSI comes into force, long term design to be applied within 10 years or about 2012-2015.

No track measures are considered in the suggested limits.

All TEL at 80 km/h	Conventional railway systems	UIC-Proposal: Pass-by at 25m	UIC-Proposal: Pass-by at 7.5m	ØDS report: Pass-by at 7.5m
Diesel locomotives	Short term new	78	85	80
	Long term new	78*		78
Electrical locomotives	Short term new	77	84	80
	Long term new	77*		78
EMU’s	Short term new	74	81	80
	Long term new	74*		78
DMU’s	Short term new	74	81	80
	Long term new	74*		78
Passenger coaches	Short term new	73	80	75
	retrofit	78	85	80
	Long term new	73*		72
Freight wagons	Short term new	80	87	81
	retrofit	80	87	85
	Long term new	(1)78 (2)75	85	77

(1) k block;

(2) disk brakes

*long-term values are same as the short term provided track measures are not in use.

The values proposed by UIC are based on existing trains on good track conditions. On test type track conditions they may be 2 dB lower. This must be verified for different train types by tests and measurements in the same way as it currently foreseen for high speed trains.

Comments:

The values suggested in the ØDS report are not at all coherent with the present situation in Europe, not only in terms of general values of noise of current type of rolling stocks, but even in terms of latest generations and progress to be expected. The identified gaps are between 4 to 5 dB(A) for locomotives, 1 to 2 dB(A) for EMU's and DMU'S, 5 dB(A) for passenger cars, and 6 to 8 dB(A) for freight wagons.

Conclusions:

Proposed potential limits by the ØDS study set at 7.5 m at about 80 dB(A) for new vehicles (short term) could have actually been met only by a small minority of existing vehicles, actually using high speed technology and too costly for normal speed use.

Longer term limit proposals targeted 78 or 72 dB(A) a gap of 4 to more than 10 dB(A) exists between the present situation and the limit proposals.

A gap of 10 to 15 dB(A) exists between the noise level of a very significant number of existing rolling stock (mostly freight, some locomotives) and proposals for limits to retrofitted vehicles (80 dB(A) for passenger and 85 dB(A) for freight vehicles).

4.3.2 High speed

Before implementing these values, an experimental verification of their applicability should be carried out at European level. These measurements are necessary to provide significant values for speeds higher than 330 km/h. For that reason, any proposal for speed 350 km/h has to be postponed, till experimental test results are available.

The following proposals of values are recommended to be substituted to those currently adopted by E.C. Refers to chapter nrs in TSI.

TEL in dB(A) at 25 m	250 km/h	300 km/h	320 km/h
4.1.8 future rolling stock	88	91	92
7.3.2 existing rolling stock	88 ± 2	91 ± 2	92 ± 2
7.4.2 recommendation for 2010	86 ± 1	89 ± 1	

Comments:

As high speed is concerned, the values to applied for existing and future rolling stock are confirmed. The target values recommended by the Commission following ØDS for 2005 are considered to be theoretical ones, corresponding to research objectives. The 2010 target values are too optimistic, as much progress, proposed by ØDS is already in use (i. e. wheel absorbers) and will not give twice a noise reduction. Further progress involving skirts has other system or safety implications (axle boxes and wheelset temperature) deserving careful studies. Due to the needed industrial developments practical applications in new design will be delayed till later than 2005. The target of 2010 seems more realistic.

4.3.3 Stationary noise

This chapter covers the noise emitted by vehicles at standstill, i.e. in the stations. The proposals below come from current specifications for rolling stock and include progress from the existing situation.

Stationary noise

LAeq at 7.5 m	Conventional railway systems	Proposal:	ØDS
Diesel locomotives	Short term new	75	**75**
	Long term new		**75**
Electrical locomotives	Short term new	75-73 idling	**75**
	Long term new		**75**
EMUs	Short term new	65	**63**
	Long term new		**63**
DMUs	Short term new	73	**73**
	Long term new		**73**
Passenger coaches	Short term new	65	**60**
	Long term new		**57**

5. Conclusions

- The developing EU policy framework for environmental noise will require noise creation limits for rail vehicles. It is essential that the limit values adopted are technically feasible and affordable.
- Measuring noise created by moving trains is problematic; empirical observations, (for the same type of train at the same site), often show considerable variability. Any discussion about noise creation values must acknowledge this variability.
- Several countries have introduced noise creation limits. They have limited effect in the absence of a Europe-wide initiative.
- There is considerable empirical knowledge of the noise performance of existing trains; the results of collaborative railway research endeavour over many years have identified a number of technical measures which will reduce noise creation.

  Application of these measures to existing vehicles is much more expensive than incorporation in new designs (as the UIC Action Programme for retrofitting freight vehicles with 'k'block tread brakes has demonstrated).
- The paper proposes limit values for noise creation by conventional vehicles, by high speed trains and by stationary trains. These are technically feasible and will be affordable when incorporated in the specification of new designs.
- The paper also proposes limit values for noise creation by freight vehicles, which are retrofitted. Although technically feasible retrofitting with the existing technology is not cost neutral to date. To find financing solutions is an essential prerequisite if an early reduction in the noise created by the existing freight vehicles is to be achieved.