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EURailNoise: a study of European priorities and strategies for railway noise abatement

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Abstract

The European Union is developing its noise policy by using a number of expert groups on specific noise issues. One of the most relevant noise problems is railway traffic which is dealt with by Working Group 6 (WG 6). The Commission of the European Union appointed a consortium of six consultants and experts in railway noise to prepare a study on European priorities and strategies for railway noise abatement. The main purpose of this study was to support the work within WG 6 and to create an inventory of measures for future railway noise abatement policy of the European Union. The EURailNoise study was to be completed in autumn 2001. The countries included the European Union member states, together with Norway, and Switzerland, and three prospective members (Hungary, the Czech Republic, and Poland).

The EURailNoise study consisted of three main parts. The baseline was a review of current European legislation on railway noise generation as well as noise perception. In parallel a documentation of cases, where technical measures against railway noise had been successfully applied, was prepared using a classification of "good practice", "promising new technology", and "promising research results".

The second part covered the potential for further noise reduction demonstrated for High Speed Passenger Traffic, S-Trains, Locomotives, Trams, Freight Traffic, Track Design and finally Wheels and Track Monitoring and Maintenance. Thirdly, a strategy for future activities of the Commission concerning the reduction of rail noise was to be proposed including a proposal for noise emission limits. This paper summarizes the results of the EURailNoise study.

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1. Introduction

For many years most of the EU member states have had national noise reception limits for road, rail, and airport noise. Furthermore, the EU Commission has had limits for noise emitted from road vehicles and has adopted international limits on noise emitted from aircraft. An obvious void concerns limits for noise emitted from railbound vehicles. Therefore, the Commission of the European Communities, Directorate General for Energy and Transport (DG TREN) has awarded a contract to study European priorities and strategies for railway noise abatement. The authors of this paper worked on the study and contributed to the final report that was published [1]. That report reviewed European national railway noise legislation, used the review to propose a strategy and identify priorities, and carried out a case study on low noise products. The overall goal of the study was to support the EU Commission to:

- Enlarge the single market to the railway industry.
- Support the political target to increase the competitiveness of the railways by moving freight from road to the railway and moving passengers from aircraft to high-speed trains.
- Enlarge the existing transport noise policy of the EU to include railways.
- Reduce the noise level along railway lines.

In this paper the focus is on the survey of the noise legislation. Existing and proposed new legislation for all the EU member states as well as Norway, Switzerland, Poland, Hungary and the Czech Republic has been collected. The legislation reviewed in this report will only comprise airborne noise transmission from train traffic to the surrounding environment. Structure-borne noise transmission is not part of the study. The legislation reviewed includes both noise generation and noise reception. The noise limits in the different states are based on slightly different definitions. Consequently, it has been necessary to normalize the limits in order to compare the levels from the different states.

2. Legislation for noise reception

Almost all the countries investigated in this report have railway noise reception limits for new lines and substantially upgraded lines. The exceptions are Ireland, Luxembourg, Spain and Greece. Only a few countries have noise reception limits for existing railways. Some countries have the same limits for noise from rail and road traffic. However, when this is the case a rail bonus is often introduced. Generally, noise reception limits are difficult to compare as they differ in the use of the measurement parameters such as the noise criterion used, the definition of the reference period, and the reception position. The limits also vary with type of railway activity, residential situation and the weather conditions when measuring or predicting the noise reception level at a reception point.

2.1. Noise criteria

All countries use the A-weighted equivalent continuous sound pressure level L_{Aeq} although there are different reference periods and in some cases a rail bonus included. The rail bonus is used

when the regulation is valid for both road and rail traffic. The rail bonus reduces the measured or calculated noise level prior to comparison with the noise limit and can have values between 3 and 15 dB. The rail bonus is introduced because most psychological and sociological studies have shown differences in annoyance from rail traffic noise compared to noise from road traffic for the same L_{Aeq}.

In most of the countries the noise reception level is defined as a free field value. In some cases the value is defined at the facade or at 1 or 2 m distance from the facade, which will result in a 3 dB correction to the measured or predicted noise level. In order to allow for comparison of the difference in national legislation, the respective limits and individual corrections have been normalized and presented in Figs. 1 and 2. The noise parameter used here is the equivalent continuous sound pressure level L_{Aeq} (free field value).

A few countries such as Belgium, Germany, The Netherlands, Italy and Sweden have indoor noise limits as a supplement to the outdoor noise limits. A few countries also use maximum sound pressure levels ($L_{A\,max}$). $L_{A\,max}$ is the maximum noise level occurring during a single train passage regardless of duration or number of train passages. This parameter is not discussed here.

2.2. Reference time periods

Most countries operate with two noise limits. One limit concerns the day-time period and another limit concerns the night-night period. The times dividing the day and night periods are slightly different. Three countries use a 24-h value, and one country uses three periods (day, evening, night). One line in Belgium has four periods (morning, day, evening, night). The typical day period seems to be from 0600 h until 2200 h.

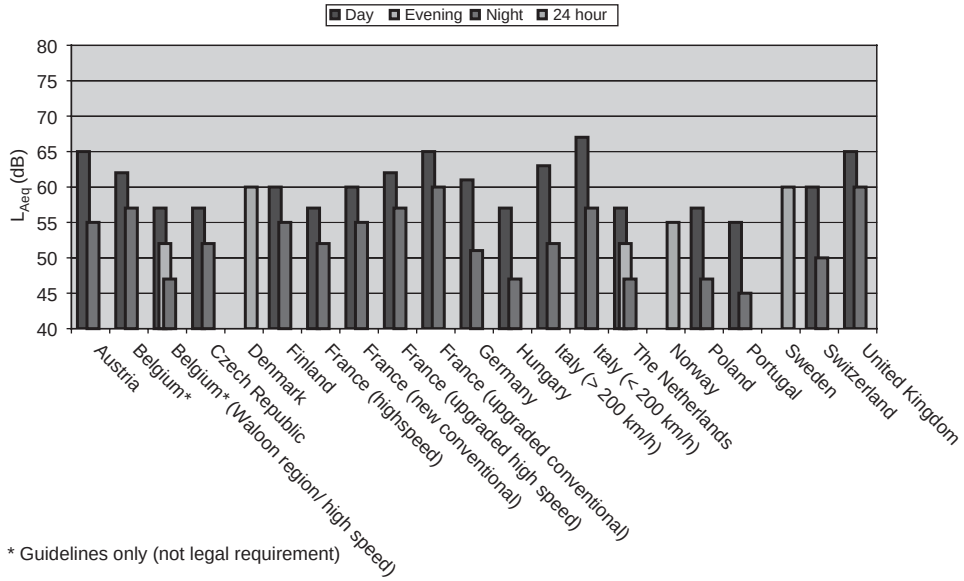

Fig. 1. Exterior residential (L_{Aeq}) noise limits for new and upgraded railway lines (normalized to free field).

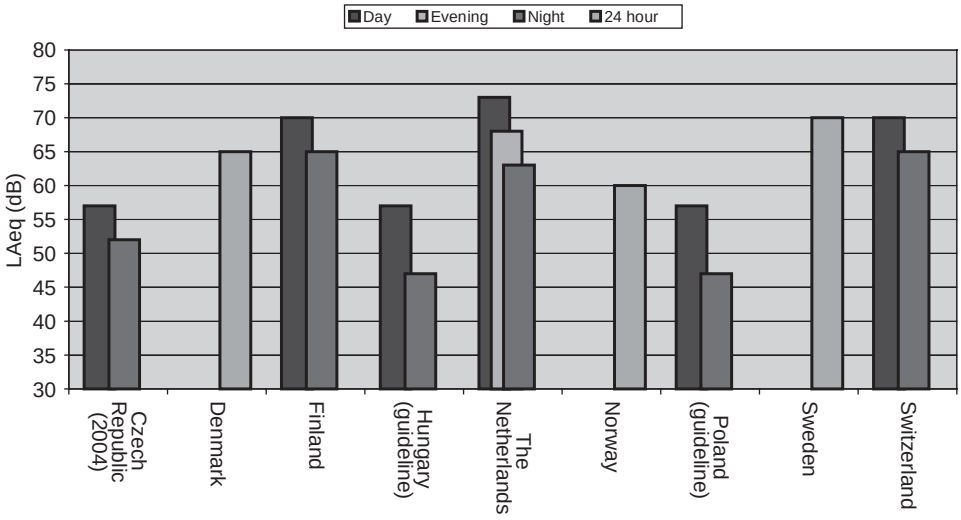

Fig. 2. Exterior residential (L_{Aeq}) noise limits for existing railway lines (normalized to free field).

2.3. Noise limits

Fig. 1 shows the noise limits from the different countries for new and existing rail lines. As mentioned previously, the various national corrections have been normalized in order to compare the levels. It can be seen that for new lines the maximum allowable noise levels are in the range 55–73 dB for the day period and 45–66 dB for the night period. Only some of the countries have regulations for existing lines (Fig. 2). The trend is that the noise limits for existing lines are 5–10 dB higher than new and upgraded lines. Italy and Sweden also have requirements for the indoor noise level for existing lines.

3. Legislation for noise emission

3.1. Legislation available

The legislation for noise emission from trains and track is relatively new. However, it seems likely that some legislation of this type will come into force in more countries in the future. Austria did set out noise emission limits for single vehicles in 1993. The emission limits for freight wagons were reduced by 10 dB in 2002. Italy has published emission limits in 1998/1999, however they came into force 2002 and the limits will be reduced by 2 dB in 2012.

Germany is at present discussing and preparing regulations and limits. The preliminary proposals of the German Environmental Agency (UBA) are rather strict. The plan is to set noise limits, and, after a period of 10 years, to reduce these limits by 8 dB. In Finland noise emission limits have been regulated by Finnish Rail Administration since 2000. In Switzerland emission regulation legislation is in preparation. However, no values have been defined. In Switzerland it is also planned to make legislation for retro-fitting freight wagons.

3.2. Noise criteria

The noise indicator normally used for noise emission is the maximum pass-by noise level ($L_{A\,max}$) measured at 7.5 or 25 m from the track at a given speed. The track must be in "good condition" regarding roughness. However, the regulations are not sufficiently precise with respect to the track conditions. The testing procedures often refer to the ISO 3095 "Railway applications—acoustics—measurement of noise emitted by rail bound vehicles", approved in 1975. A revision of this standard is in progress, which now proposes an equivalent level during pass-by as the criterion for assessing noise generation.

3.3. Noise limits

The few legislative values for noise emission that can be found are presented in Table 1. The ordinance from Austria and the German proposal use 7.5 m from the track. The Italian proposal and the Finish act use 25 m from the track. The noise emission limits are set out for constant speed. The values presented in Figs. 3 and 4 have been normalized to the same speed of 80 km/h in order to compare the levels. The noise levels are shown for a distance of 7.5 and 25 m from the track.

It should be noted that for the conversion of the limits from 25 to 7.5 m, 7 dB have been added. The correction of 7 dB is an approximate average only. The exact correction in dB can be calculated based on more details on any specific train. The expression $30\log(v/80)$ was used to normalize the noise limits from different speeds (v) to 80 km/h.

4. Conclusions

Comparing the legislative rules in all the countries covered is a rather complex task as many details must be evaluated. Secondly, the noise indicators and parameters vary from country to country. Therefore, it has been necessary to adjust for these differences to enable comparison.

4.1. Noise reception

Nearly all EU member states and 5 non-member states have legislation concerning the maximum limit for railway noise reception levels. Some member states have legislation for the maximum emission level for vehicles, whilst other states have published proposals for future maximum emission levels.

4.2. Noise emission

Only very few countries have legislation for noise emission at present. However, it seems likely that some legislation will be introduced in more countries in the future. The following arguments underline the urgent need for common EU legislation to limit noise emission from rolling stock:

- The general EU policy on environmental noise.
- A specific railway company may wish to operate one set of vehicles which is interoperable and another set which is purpose-built for that company, and therefore not interoperable.

Table 1
Noise emission limits for new rolling stocks in Europe in dB(A)

		Measuring distance	7.5 m			25 m		
		Noise indicator	L_{Aeq}	L_{Aeq}	$L_{A\,max}$	L_{Aeq}	$L_{A\,max}$	$L_{A\,max}$
		Legally binding	No	No	Yes	Yes	Yes	Yes
		(from)	(yr 0)	(yr + 10)	(1-1-02)	26-01-00	(1-1-02)	(1-1-12)
		At speed [km/h]						
Austria	Electric locos	80			84			
	EMUs	80			82			
	Diesel locos	80			86			
	DMUs	80			84			
	Coaches cat.1 & 2	80			80			
	Coaches cat.3 & 4	80			83			
	Wagons cat.1	80			81			
	Wagons cat.2	80			83			
	Wagons cat.3	80			85			
Finland	Locos	200				88		
	MUs	200				85		
	Coaches	200				88		
	Wagons	120				87		
Italy	Locos for passenger trains	250					90	88
	Coaches	250					88	86
	Locos for passenger trains	160					85	83
	Coaches	160					83	81
	Locos for freight trains	160					85	83
	Wagons	160					90	88
	Locos for freight trains	90					84	82
	Wagons	90					89	87
	Diesel locos	80					88	86
	Rail cars	80					83	81
Germany	Locos	80	80	72				
	EMUs & DMUs	80	78	70				
	Coaches	80	75	67				
	Wagons	80	80	72				
	Light rail	80	78	70				

- The interoperability of rolling stock may result in a limitation of noise emission from interoperable rolling stock.
- The Freedom of Trade: national regulation, procedures and limits will be an administrative barrier for the railway industry.

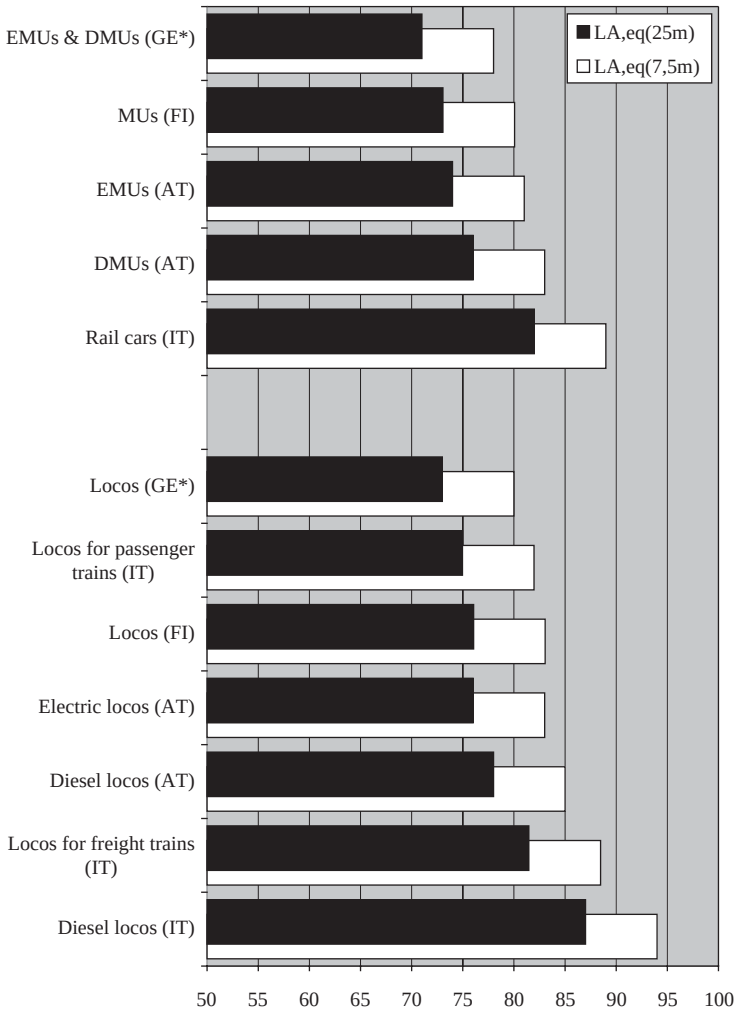

Fig. 3. Noise emission limits in dB(A) (normalized to 80 km/h) for new locomotives and multiple units.

4.3. Strategy

The general principle in noise control that reduction and limitation of generated noise is the most effective strategy, generally also applies railways. The conclusion is that reduction and limitation of noise generation is the essential first step to improve the situation. However, a number of additional measures are necessary to stimulate development of quiet rolling stock and tracks and to stimulate the use of quiet railway technologies and operations. All these measures will now be summarized and a strategy will be proposed.

The authors consider that stationary noise and pass-by noise at constant speed on a straight track must be included in the short-term emission limits. It is clear that these conditions do not cover all the noise sources that could be relevant. The authors of the study are well aware that the proposal does not cover all the sources. However, as a first step, it is essential to cover pass-by

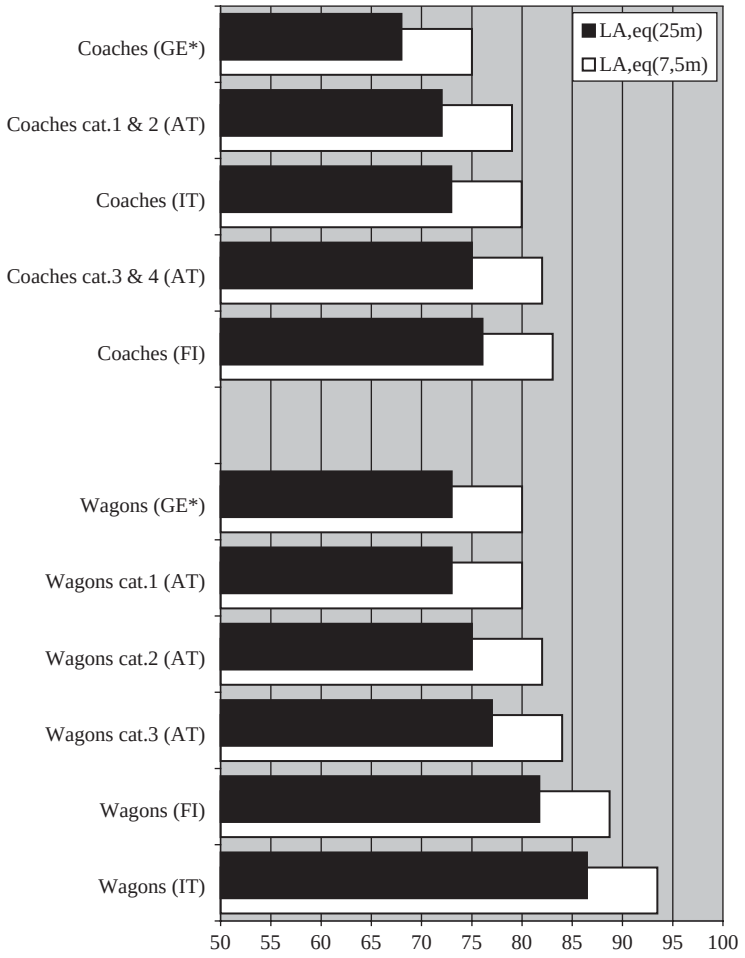

Fig. 4. Noise emission limits in dB(A) (normalized to 80 km/h) for new wagons and coaches.

noise at constant speed. This noise has been dealt with in the past and much information about the noise generation mechanism, as well as the measurement methodologies, is available, which will lead to traceable and reproducible results. Although other operational conditions such as acceleration and braking are covered in prEN ISO 3095 [2], the measurement methodology for those conditions appears not to be sufficiently elaborate to obtain reliable results with low standard deviations. The ISO standard is still under review and there is some national concern about these procedures. This leads to the recommendation to exclude acceleration and braking at this stage of the discussion on emission limits for rolling stock and to postpone regulation of this type of noise.

From the point of view of environmental protection, it seems to be more beneficial to introduce noise limits that cover only 90% of the noise problem, rather than to accept a procedure that that covers more sources and problems, but does not deliver reliable results. Another unsatisfactory solution is to wait some years without any action and then to have an improved procedure that covers only about 92% of the problem. There is another aspect still under discussion in the

Table 2
Noise emission limits for high-speed trains in dB(A)

High-speed trains (HST)		Stationary L_{Aeq} 7.5 m	Pass-by at constant speed TEL 7.5 m		
		—	250 km/h	300 km/h	350 km/h
Short term	New	78	93	96	n/a
	Retrofit	n/a	n/a	n/a	n/a
Long term	New	72	91	93	97
		L_{Aeq} 25 m	TEL 25 m		
		—	250 km/h	300 km/h	350 km/h
Short term	New	n/a	87	91	n/a
	Retrofit	n/a	n/a	n/a	n/a
Long term	New	n/a	85	88	91

Table 3
Noise emission limits for light rail transit (i.e. trams, metros) in dB(A)

Light rail transit (LRT)		Stationary L_{Aeq} 7.5 m	Pass-by at constant speed TEL 7.5 m	
		—	40 km/h	80 km/h
Short term	New	60[a]	72	80
	Retrofit	n/a	n/a	n/a
Long term	New	57[a]	69	77

[a] Without air-conditioning 5 dB(A) less.

scientific community; namely the influence of track and track conditions on vehicle pass-by noise. Research in this area, which aims to separate the noise contributions from the track and the vehicle, is under way but a practically tested method is not yet ready. Rail roughness is well covered by prEN ISO 3095 but also other factors such as pad stiffness can influence results by around 3–4 dB. The numbers in Tables 2–4 below are based on a low-noise standard track as described in the annex of prEN ISO 3095. This track comprises concrete sleepers with UIC 60 rail profile and acoustically optimized (stiffness) pads.

In the longer term, acceleration and braking should be included. In order to specify a sound methodology for these operational conditions and to be able to determine limit values for all listed operating conditions, it will be necessary to carry out further R&D work. Tables 2–4 show the noise creation limits proposed by the authors for future EU legislation. For LRT and HST the values for pass-by noise cover the speed range from the minimum to the maximum speeds within each category. Limits for a maximum speed in between these values can be derived by linear interpolation. For the Conventional Rail System only one level for 80 km/h $L(80)$ is given. The limit for maximum speed, where V_{max} is higher than 80 km/h, $L(V_{max})$ can be derived using the following formula based on a cubic speed dependency: $L(V_{max}) = L(80) + 30\log(V_{max}/80)$.

Table 4
Noise emission limits for Conventional Railway systems in dB(A)

Conventional Railway Systems			Stationary L_{Aeq} 7.5 m —	Pass-by at const. speed TEL 7.5 m 80 km/h	Speed correction
Short term	New	Locomotives	74	80	$L(V_{max}) = L(80) + 30\log(V_{max}/80)$
		Conventional multiple units and railcars	63	80	
		Passenger coaches (including parcels vans)	60	75	
		Freight wagons	n/a	81	
	Existing (retrofit)	Locomotives	n/a	n/a	
		Conventional multiple units and railcars	n/a	n/a	
		Passenger coaches (including parcels vans)	n/a	82	
		Freight wagons	n/a	85	
Long term	New	Locomotives	72	78	
		Conventional multiple units and railcars	60	78	
		Passenger coaches (including parcels vans)	57	72	
		Freight wagons	n/a	77	

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[2] prEN ISO 3095, Railway applications—acoustics—measurement of noise emitted by rail bound vehicles, January 2001.