Bearable railway noise limits in Europe

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Summary
The question 'What are bearable limits for environmental railway noise?' is discussed regularly in different forums on a national scale and on a European level. A systematic evaluation of all aspects in what 'bearable' could consist of was always missing. The UIC research Project 'Bearable limits and emission ceilings' [1], [2] has brought UIC in the position to propose for the first time a well-balanced limit for noise reception. This noise reception limit is a trade-off between the disturbing impact of noise for line side residents and realistic possibilities for viable railways. Findings are based on an extensive study that was commissioned by the UIC and carried out by dBvision in the Netherlands.

A bearable value of noise reception limits for the night (L_{night}) is not lower than around 55 dB. More stringent limit values are not effective because:

- For values above 55 dB railway noise is the dominant source for sleep disturbed persons in urban areas near railway lines. For values lower than 55 dB, it is more effective to spend money on measures for road traffic noise. This will generally result in more reduction of the overall sleep disturbance.
- Below 50 dB, results show a large increase of cost. Noise limits up to 55 dB are cost-effective.

Results are based on a 202 km railway line sample Rotterdam – Venlo and extrapolation to the ERTMS corridors. These ERTMS corridors are defined in the European Rail Infrastructure Masterplan as the main freight corridors (see figure 1).

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1. Developments

Different developments put pressure on noise limits. The four most important developments are:

1. The European Commission put pressure to prevent an increase of noise due to growth of freight rail traffic [3].
2. The World Health Organization (WHO) put pressure on limits for noise. WHO has proposed stringent limits for night-time environmental noise [4].
3. There is an enormous variation in noise limit values between EU Member States. The limits mainly refer to new lines. In general, a less stringent noise limit applies to upgraded lines and/or existing lines [2], [5].
4. European freight transport by rail is expected to grow by 80% from 2007 until 2020 [6].

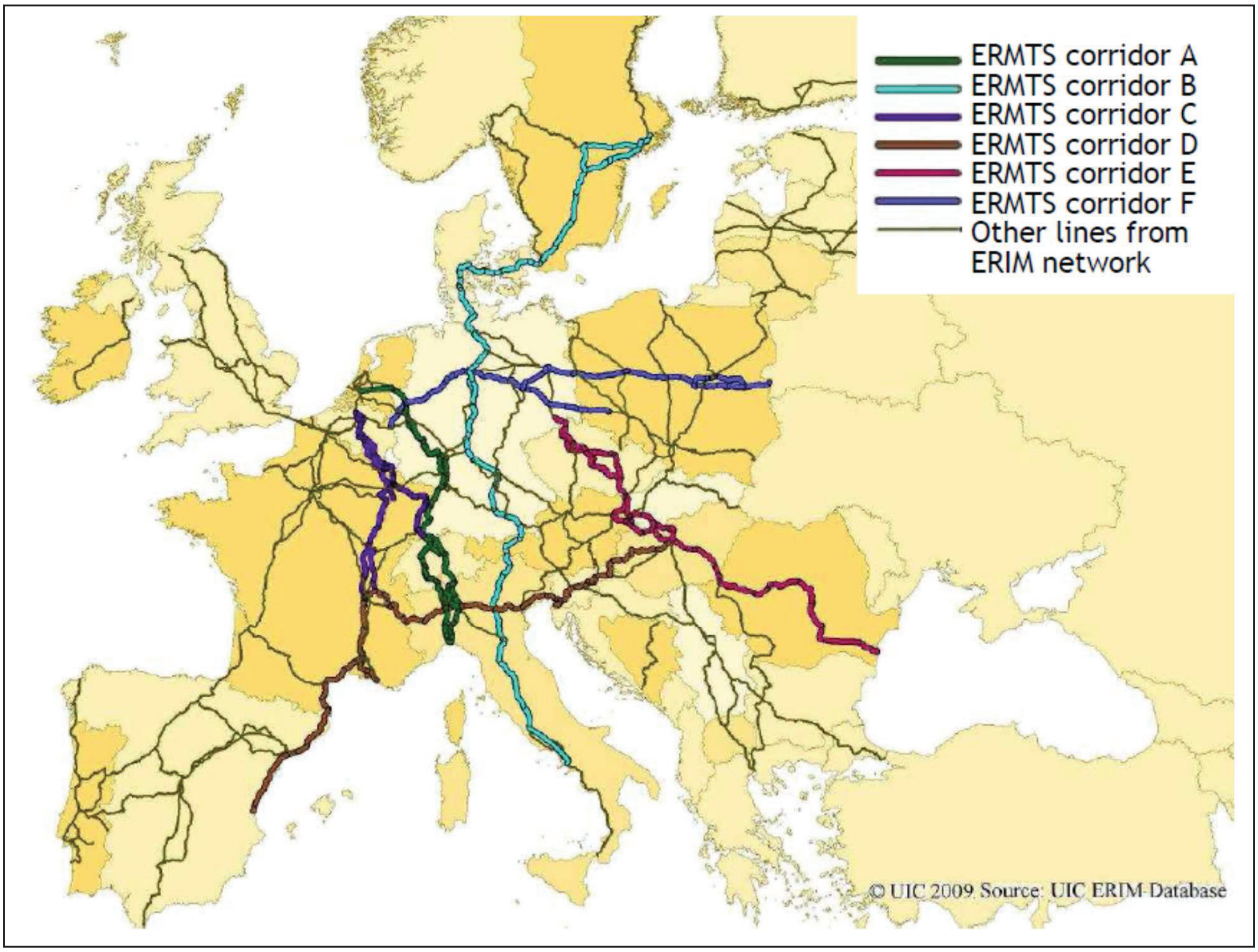

Figure 1. The UIC ERIM network of international rail corridors. This network is mainly for freight on which a European Rail Infrastructure Masterplan could be built (UIC Atlas 2008 of Infrastructure in the ERIM Network).

The next two paragraphs describe items number 1 and 2 in more detail.

1.1. Railway freight noise policy of the EC

Despite its environmentally friendly image, rail transport encounters substantial public opposition to noise in some European regions. The Commission believes that “if no remedial action is taken, this could lead to restrictions in rail freight traffic along the most important European rail corridors. A possible modal shift from rail to road on these corridors would lead to increasing environmental impacts.” [1].

Retrofitting 370 000 freight wagons is the main objective to avoid this scenario. This objective should be achieved by a combination of three policy instruments [3]:

1. Noise-differentiated track access charges (NDTAC);
2. Noise emission ceilings;
3. Voluntary commitments (railway undertakings could pass NDTAC benefits to wagon owners, rail sector could start individual retrofitting programmes).

The noise emission ceilings are proposed as a second step to prevent an increase of noise, after the initial retrofitting programmes have been completed.

1.2. Night Noise Guidelines for Europe

In 2009 the WHO published a report, Night Noise Guidelines for Europe [4], was published in 2009 to serve as guidance for action plans under the Environmental Noise Directive. WHO proposes to adopt the Night Noise Guideline (NNG, 40 dB) as a limit for new projects (road/rail/residential areas), while the Interim Target (IT, 55 dB) can be used for existing cases. The Interim Target, however, is not based on health considerations but on feasibility.

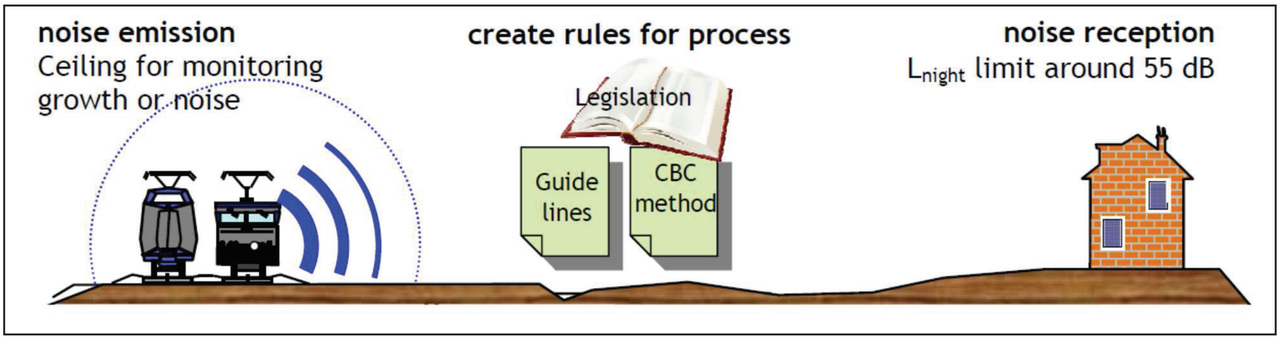

Figure 2. System with noise emission ceiling and noise reception limits. CBC method: cost-benefit criterion.

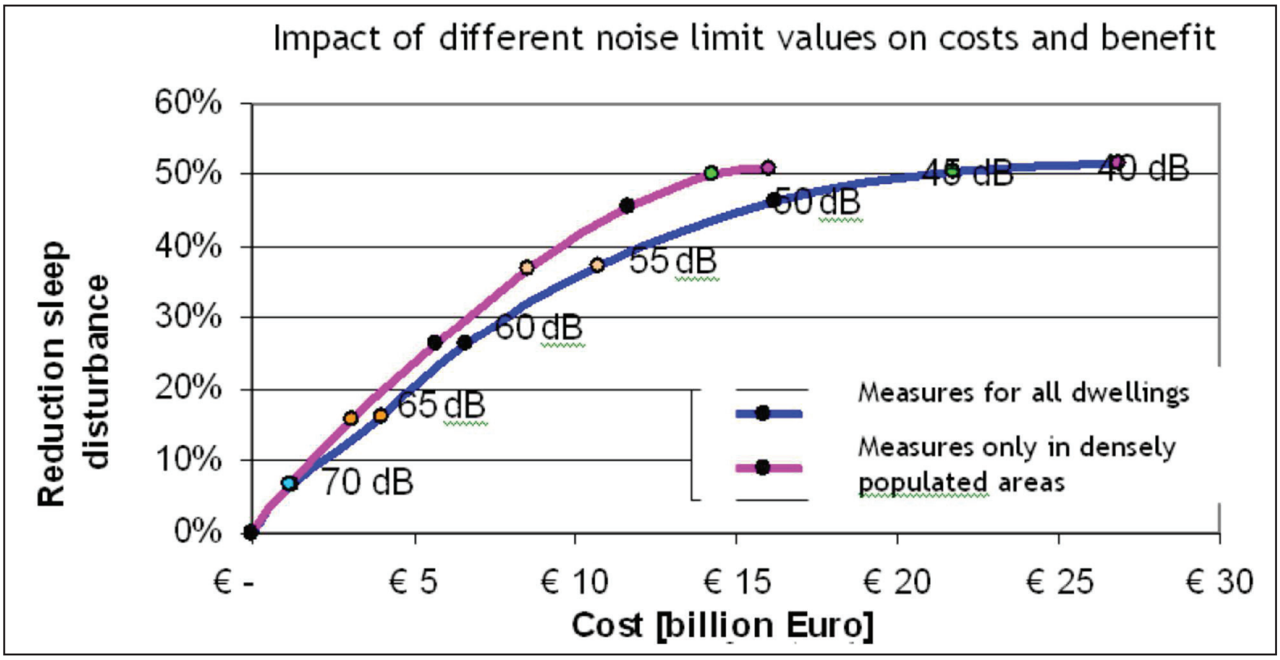

Figure 3. The impact on costs and benefits (reduction of sleep disturbed persons) of different L_{night} limit values for 15 000 km main freight corridors.

Therefore, the NNG should be used as long-term goal. The WHO realizes that implementing the recommended noise targets takes time and money:

- Governments should adopt the health guidelines for community noise as targets to be achieved in the long-term.
- Cost-effectiveness and cost-benefit analyses should be considered as potential instruments when making management decisions.

2. Findings

In this study the focus has been on a 202 km freight railway line. The results are extrapolated to the most relevant part of the UIC European Railway Infrastructure Masterplan (ERIM) network. The ERIM project focuses on a high-level infrastructure of six major international rail (ERMTS) corridors within and between 32 countries. These corridors are mainly used for freight traffic. The ERIM network has a route length of 50 000 km. These ERTMS corridors have a route length of 15 000 km. For this extrapolation corrections are made for cost per km based on different traffic volumes, sleep disturbed persons based on different traffic volumes, route length and average density of buildings per country.

This study proposes that limits for noise reception should be combined with a noise emission monitoring system (see figure 2). This monitoring system follows the noise emission on a periodical (i.e. yearly) basis and compares it to a pre-set ceiling level. The system stimulates the railways to take measures at the source (retrofitting) to avoid that freight traffic noise exceeding the ceiling.

A bearable value of noise reception limits for the night (L_{night}) is not lower than around 55 dB. More stringent limit values are not effective because:

- For lower values than 55 dB, it is more effective to spend money on measures for road traffic noise. This is because if railway noise is lower than 55 dB, it is generally not the dominant source of sleep disturbance in urban areas.
- Below 50 dB, results show a large increase of cost and a small increase of benefits (see figure 3).

Self-reported annoyance studies show that 10% of the persons are sleep disturbed if exposed to L_{night} values of 55 dB for rail [7]. In a European perspective a 55 dB limit on the six main freight corridors with a total length of 15 000 km would cost € 10.8 billion[3]. These freight corridors transport 43% of the total European freight. The € 10.8 billion costs are for noise barriers up to a height of 6 m and for rail dampers. A reduction to € 8.6 billion is possible if noise measures are mainly placed in densely populated areas, where they are more cost-effective. This can be achieved by a decision support method called a CBC method (cost-benefit criterion).

More stringent L_{night} noise reception limits will significantly increase costs. The additional benefit of a 5 dB more stringent noise limit becomes less and less, while additional costs increase (see figure 3). Therefore more stringent noise reception limits become less efficient.

With this CBC method it is possible to avoid noise measures in situations where costs are unacceptably high, relative to the number of dwellings that benefit. With the CBC method the focus on additional noise measures is in urban areas. Figure 3 shows the impact of variations of the limit values.

2.1. Road traffic dominates for L_{night} railway levels below 55 dB

Sleep disturbance is generally dominated by road traffic in situations where the L_{night} for railway noise is 55 dB or less. Therefore, a reduction of railway noise is only effective until a certain limit. In order to benefit from low noise limits for railway noise, additional measures against urban road traffic noise should be taken first. Without measures for urban road traffic noise, a further reduction of railway traffic noise does not contribute to a reduction of sleep disturbed persons.

2.2. Annoyance rail correction factor reduces costs by € 3.3-3.7 billion

Several countries have different noise legislation limits for road and rail traffic noise [8]. If one would include the dose-effect responses of rail noise and road noise, an advantage for rail is found of 8-12 dB for sleep disturbance (L_{night}) and 6-8 dB for annoyance (L_{den}), see figure 4. This difference is sometimes called 'noise annoyance rail correction factor'. If this health-related correction factor is applied, the costs of infrastructure noise measures would be reduced by 14 – 27% for the 40 dB limit value and around 89% for the 70 dB limit value.

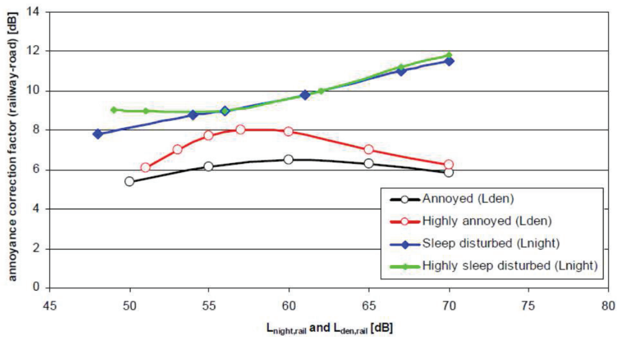

Figure 4. The correction factor (railbonus) derived from the difference between railway and road dose response relationships.

[3] *1 000 000 000 = a billion (one thousand million)*

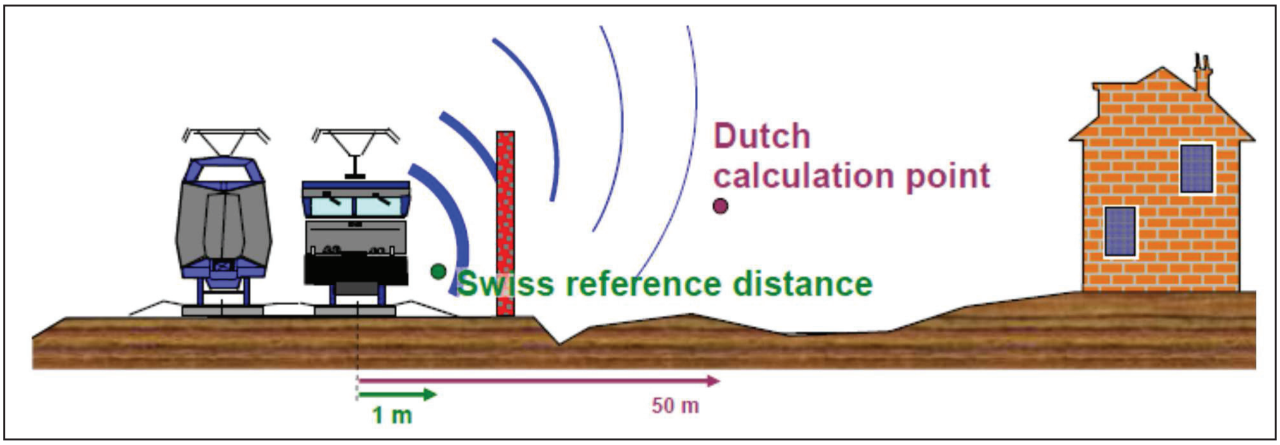

Figure 5. Noise ceilings in Switzerland and the Netherlands.

2.3. 100% retrofitting reduces costs by € 3.3 – 3.7 billion

For a 100% retrofitted freight wagon fleet, the cost of infrastructure noise measures would be reduced by 14 – 27% for the 40 dB limit value and around 89% for the 70 dB limit value. Unlike the local effects for barriers and rail dampers, noise reduction by retrofitting is everywhere along the railway line.

2.4. Use of cost benefit criterion gives possible cost reduction of € 2.2 billion

With almost equal effects on reduction of sleep disturbed persons, the use of a cost benefit criterion (CBC) makes it possible to reduce costs between 7 and 37%. Or, alternatively, it can be calculated that with equal costs a more stringent L_{night} noise limit can be established. For example: With the same budget a limit value of about 56 dB is possible without a cost benefit criterion and a more stringent limit value of 53 dB with a cost benefit criterion. This reduction is obtained due to the fact that the CBC method focuses on urban areas.

The combination of the noise annoyance rail correction factor, 100% retrofitting and cost benefit criterion will reduce costs for infrastructure noise measures by € 7.7 billion.

2.5. Noise emission ceilings can be a helpful instrument to protect against increasing railway noise

Limits for noise emission (or creation) and noise reception can be defined in different ways. The four for basic positions where limits can be defined are:

1. Limit the creation of emission.
2. Limit the reception level at a monitoring point.
3. Limit the reception level at the façade of a building.
4. Limit the reception level inside the building.

Limits on the creation of emission can focus both on the daily average level but also on the single vehicle levels. Limits on the three reception levels are more suitable for monitoring the daily average level.

Most countries have defined a set of noise reception limits at the façade (position 3) which are meant to protect residents from high noise exposure levels. Generally only new situations (new or renewed railway lines, new buildings) are governed by these limits, while the severe noise impact of existing lines is reduced on a long-term basis by noise abatement programmes. Apart from some exceptions, interior noise limits (position IV) are only considered in case window insulation is involved.

Emission monitoring should be based on calculated levels because measured levels are less accurate, only valid locally and not suitable for traffic planning. If the instrument of monitoring is implemented in combination with feasible regulations about how to continue when exceeding the noise ceiling, viable railway operations that respect the need for a quiet environment are possible. The noise emission ceiling notifies against increasing noise, but action is only taken in combination with targets for noise reception levels and noise abatement programmes. Then it provides a better protection against unacceptable noise exposure than legislation that solely relies on reception limits.

Switzerland and the Netherlands have developed quite similar systems of emission ceilings [9]. The main difference lies in the definition of the source: whether or not to include barriers in the noise emission level (Figure 5). The Swiss and Dutch ceilings have in common that they are backed up by a legal framework of noise reception limits, which existed already in these countries long before the ceilings were established. In both countries, different ceilings apply to different railway lines.

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