Improved **M**ethods for the **A**ssessment of the **G**eneric **I**mpact of **N**oise in the **E**nvironment

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Work Package 6

Measured railway noise source data in the public domain or via the Imagine project

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1. INTRODUCTION

The main objective of the Railway Noise Sources Work Package (WP6) of Imagine is to provide default databases for the source description of railway noise for an exemplary sample of the European rail traffic fleet. In order to do this with precision, advanced techniques for data
gathering will be used where possible, especially by the application of source separation techniques. However, it is important that data already available should be identified and incorporated within the database where this is feasible, to maximise its usefulness for a wide range of situations. The purpose of this report is therefore to provide guidance to the Work Package on the provenance and nature of various sets of European railway noise data that may be of relevance to the project. It is accepted that some data of relevance may not be freely available, and therefore this review is restricted to published data, or data in the ownership of the Imagine partners, or data previously acquired for the European Commission under separate contracts.

2. RAILWAY NOISE PREDICTION MODELS

Several noise prediction models with source term data based on measurements, either directly or with some manipulation, are available for railways within Europe. Table 1 identifies some of the models that come into this category, and which will therefore be a potential source of useful data for the IMAGINE database, especially if the original data used to formulate the algorithms can be made available.

State	Title
Germany	Deutsche Bundesbahn, 1990, "Richtlinie zur Berechnung der Schallimmissionen von Schienenwegen (Schall 03)[1]
Austria	Österreichisches Normungsinstitut, 1995, "Berechnung der Schallimmission durch Schienenverkehr, Zugverkehr, Verschub- und Umschlagbetrieb", Önorm S5011[2]
Nordic	The Nordic Prediction Method - TemaNord 1996:524.[3]
UK	Calculation of Railway Noise 1995[4] (CRN)
Netherlands	Ministerie voor Volkshuisvesting, ruimtelijke ordening en milieubeheer, 1996, "Reken- en Meetvoorschrift Railverkeerslawaai"[5]

Table 1. Examples of railway noise models that are based on measured source terms

The source data contained within these methods is in a variety of forms, with varying levels of complexity, although they tend to be L_{eq}/SEL based and either in overall A-weighted form alone, or with additional spectral information. It tends to be dominated by rolling noise information but other aspects, such as traction noise (UK) and braking noise (Netherlands), are available. Separation of track and vehicle contribution is not normally attempted.

An example of spectral rolling noise data that could be available through this approach comes from the Nordic model, where data was gathered in 1982/3 and 1994. Figure 1 shows octave band rolling noise SEL data for the BM69 suburban Electric Multiple Unit, normalized to a train length of 100m, and a measuring position 10m from the track centre line.

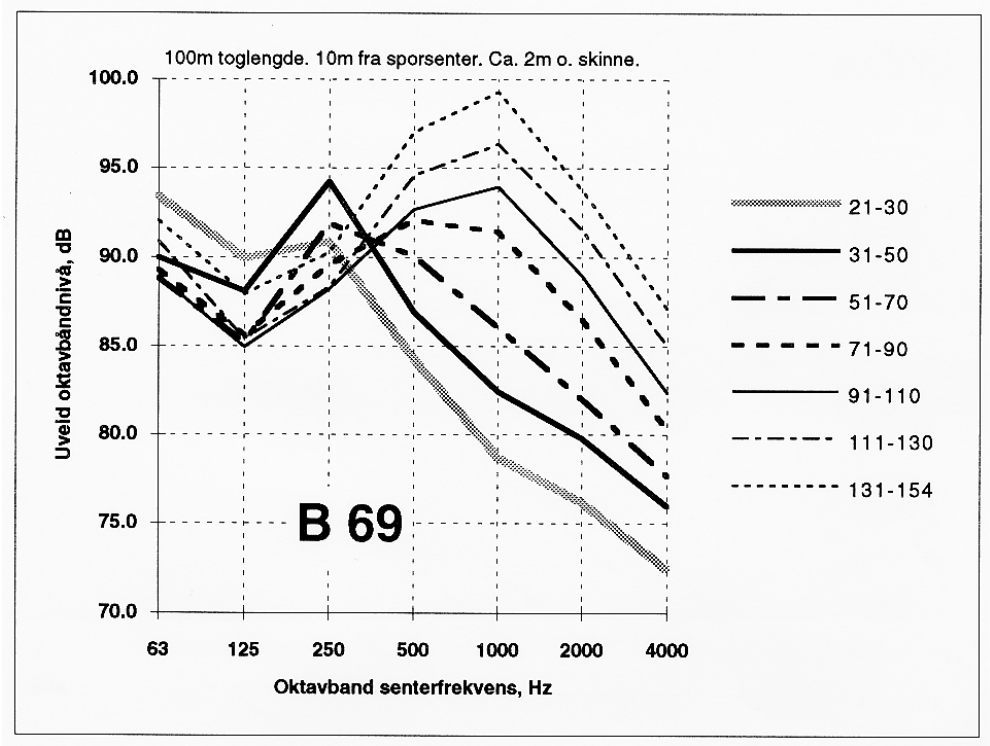

Figure 1. Norwegian B69 EMU octave band SEL data, 10m from track centre line, for speeds ranging from 21 km/h to 154 km/h.

A-weighted SEL data is also available for a range of stock within the Norwegian database, with examples shown in Table 2.

A-weighted SEL normalized to 100m train length and 10m from track centre line							
Speed band +/- 10km/h	**20**	**40**	**60**	**80**	**100**	**120**	**140**
Goods	88.8	91.0	96.0	97.9	99.0		
Long distance passenger			97.2	98.7	100.9	104.0	
B65/68 suburban		86.8	92.5	98.0	96.8	101.4	
B70 Intercity				92.7	97.8	100.5	
B69 EMU	86.8	89.9	91.4	94.8	96.8	99.1	101.7

Table 2. SEL data from the Norwegian database

Further data has been acquired in Norway in 2002, applying the same approach as for the earlier measurements, in connection with a rail grinding programme. This data may also be available via Jernbaneverket.

The UK method "CRN" is similarly SEL-based, and provides a baseline rolling noise SEL value at 25m as a function of speed for individual vehicles. The baseline function is

$$SEL = 31.2 + 20 \log_{10} V_{km/h} \text{ dB(A)},$$

with this function being adjusted by a correction for each vehicle type. These functions were derived either from data already in place at British Railways Research, or from measurements taken at the time of the formulation of the procedure in the early 1990s. Examples of correction factors are given in Table 3.

Vehicle type	Correction dB(A)
Mk II Cast-iron tread-braked coach	+14.8
Mk III/IV Disc-braked coach	+6.0
Class 421/422 Cast-iron tread-braked EMU	+10.8
Class 465 EMU Disc-braked EMU	+8.4
Class 60 Diesel	+16.6
Class 91 Electric locomotive	+14.8

Table 3. UK correction factors for rolling noise in the "CRN" procedure

The UK method also takes into account the additional noise due to diesel locomotives "on power". The baseline function for the additional SEL at 25m is

$$SEL = 112.6 - 10\log_{10} V_{km/h} \text{ dB(A)},$$

with correction factors dependent on the class of vehicle. In the official document this correction factor is 0.0 dB for all classes except for the Class 60, which is known to be quieter and which has a correction factor of –5.0 dB(A).

A supplement[6] to CRN was produced in 1996 to provide source term information for the Eurostar Channel Tunnel trains, to account for the significant levels of fan noise that are produced by this stock.

The UK environment ministry "Defra" recognised in 2004 that CRN did not cater for a significant proportion of the rolling stock on the UK network at that time, and therefore commissioned AEA Technology to either measure or predict source term corrections for more recent stock. The results of this study are presented within a report for Defra[7] which is known to have been made available to interested parties upon request. The report also presents source term information for freight wagons and locomotives measured by AEA Technology for the UK freight operator EWS. 37 new source terms in total are available.

3. DATABASES OF RAILWAY NOISE POTENTIALLY SUITABLE FOR INPUT TO THE IMAGINE MODEL

Core data as a starting point for the Imagine database is that obtained within the 5th Framework STAIRRS project and that already in place in the Harmonoise database, which forms the basis for the Imagine database. The data from STAIRRS and in the Harmonoise

database is based on source-separation and is therefore of appropriate quality for the intended Imagine approach.

The NOEMIE measurement project, coordinated by the joint EC/Industry Association Européenne pour l'Interopérabilité Ferroviaire (AEIF), is designed to establish the true situation regarding pass-by and stationary noise, and also to measure track characteristics so that the practical achievability of the very low roughness, and high vibration decay rate, test tracks for acceptance testing can be assessed. It has been running since 2003 and has acquired pass-by and stationary data on a wide range of high speed stock at several European locations in terms of L_{Aeq} and TEL (transit exposure level = all pass-by energy normalised to pass-by time): TGV-PBKA, TGV-Duplex, ICE 3, ETR 480, ETR 500, AVE, ICE-TD, Taurus and German IC coaches, ZTER and French IC coaches. Although this data is not currently in the public domain, it is in the ownership of the European Commission and therefore is likely to be available to IMAGINE.

Other source data that is available as a result of an EC initiative is found in the ODS study of priorities and strategies for railway noise abatement[8]. Pass-by noise in terms of TEL is available for Variobahn 6NGT-LDE/LDZ Tram, DT4 Underground trainset, DSB 4th Generation S-Train, ICE 1 and 2, Lok 2000, DB-AG Quiet Sgss 703, ÖBB Rkqss/Sgjss. As part of the Union Internationale des Chemins de Fer (UIC) response to this work, a report on noise creation limits was produced[9]. Within this report is a set of TEL pass-by figures for passenger coaches, freight stock, DMU/EMUs and locomotives from Switzerland, Germany, the Netherlands and France.

A workshop was held in Vienna on 2 April 2004 presenting the work of the Low Noise Train consortium (ÖBB, SBB/CFF/RRS, Trenitalia). At that event pass-by information taken at Dürnkrut (Austria) and Kerzers (Switzerland) was presented for a range of freight vehicles with cast-iron tread brakes, and with K-blocks (composite), the latter including the "Low Noise Train". At the same event, round robin test results from the 5th Framework "Metarail" project were presented for a range of freight vehicles including those with disc brakes and sinter block brakes. Similar data for a range of freight vehicles has been acquired by Deutsche Bundesbahn and has been presented to the European Commission and the Article 21 Interoperability Committee in connection with the setting of freight wagon rolling noise TSI levels.

In 2003, within the Harmonoise project, the Spanish consultants Labein carried out measurements following the Harmonoise source separation protocol on a Unidad de Cercanias 446 disc-braked passenger train. Although the transfer function elements of this work are still under review, L_{eq} measurements of sound are available at 1.5m, 7.5m and 25m from the track.

A limited amount of stationary and accelerating ("starting") noise data was gathered for Harmonoise from Sweden (SP), The Netherlands (TNO and AEAT NL) and France (SNCF)[11]. This data is variable in methodology of acquisition and quality, but is useful as an indication of the nature of the spectra and absolute sound power/pressure levels from a variety of traction. AEAT UK hold a certain amount of locomotive and multiple unit starting noise, but it has been acquired for several customers (eg the freight operator "EWS" and the UK Association of Train Operating Companies (ATOC)) and is not able to be released without their permission (usually readily granted). Some of this data was used in deriving traction noise source term corrections for CRN (see above) for newer locomotives such as the General

Motors Class 66 diesel locomotive operated by the freight company "EWS". Data on the Swedish variant of this locomotive is included within the Harmonoise traction noise report[11].

During the formulation of the Conventional Rail Noise Technical Specification for Interoperability, the AEIF Noise Expert Group assembled a large set of data on starting noise from Trenitalia, Bombardier, DB, AEAT UK, the Netherlands and SNCB. This data is summarised graphically in the Report that accompanies that TSI, and also in the noise elements of the revised High Speed Rolling Stock TSI Report. It is reproduced in Figure 2. For details, it is necessary to refer to the Reports in question when they are officially available through the EC.

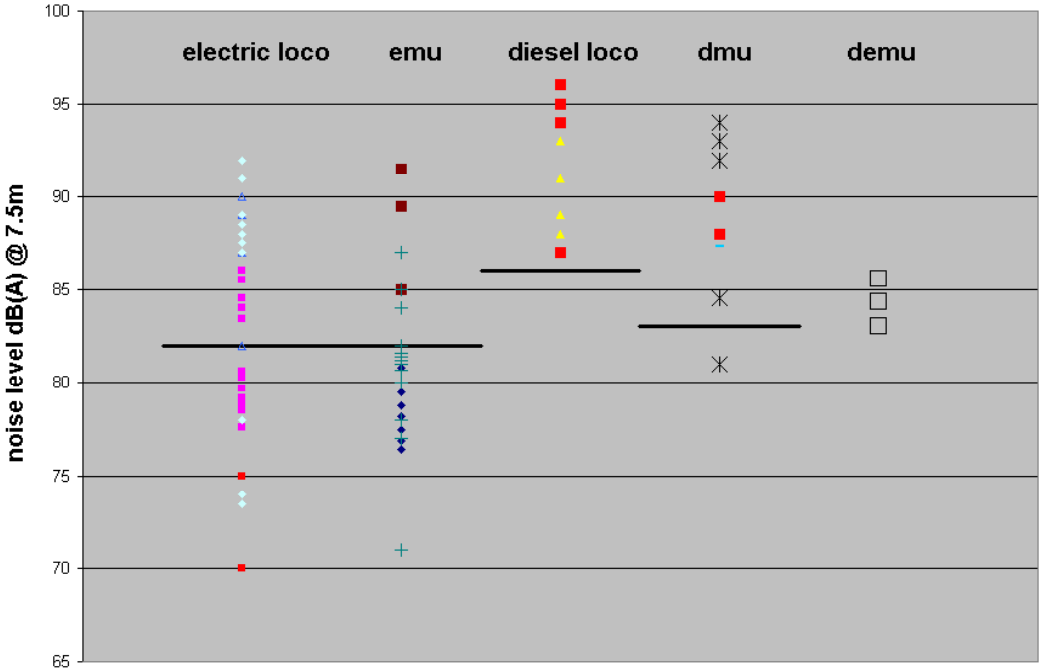

Figure 2. Ranges of starting noise levels measured from stock in Europe.

4. CONCLUSIONS

It is clear from the foregoing that there is, as yet, no coherent set of railway noise source data available for the noise mapping exercises required under Environmental Noise Directive 2002/49/EC. This therefore confirms and reinforces the importance of the Rail Noise Sources Work Package in Imagine. There is, however, a certain amount of data readily available, and also some that may be available if the owners grant permission, that can at least be used as a starting point for rail noise mapping prior to the Harmonoise/Imagine database being available and sufficiently populated. It is also intended that the Imagine database will be flexible enough to accommodate data of varying quality (ie the disparate datasets referred to above) to ensure that it can be of the greatest use possible for noise mapping in a wide range of situations in Europe.

5. REFERENCES

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