WAVERLEY RAILWAY (SCOTLAND) BILL

CONSIDERATION STAGE

WRITTEN EVIDENCE GIVEN TO THE WAVERLEY RAILWAY (SCOTLAND) BILL COMMITTEE ("COMMITTEE")

POLICY PAPER ON BEHALF OF THE PROMOTER IN RESPECT OF NOISE AND VIBRATION

Introduction

1. The purpose of this policy document is to set out the Promoter's policy for mitigating noise and vibration effects during operation of the railway. The policy builds on the commitments made during the environmental impact assessment as reported in the Environmental Statement. Effects during construction are covered in the Code of Construction Practice Policy Paper.

2. There are no statutory requirements for mitigating noise from railways in Scotland. However, the Promoter takes this issue seriously and proposes to implement the noise insulation regulations that apply in England and Wales and also to set noise design targets at considerably lower levels, to be achieved wherever reasonably practicable by mitigation measures taken at source (i.e. within railway land). There are practical limitations as to what mitigation can be achieved in any particular case and this document helps to explain these. The Promoter's overall approach is as follows: -

a. through the design of the track and track bed the Promoter will use the Best Practicable Means[1] to design the railway so as to avoid significant noise and vibration impacts at existing sensitive receptors (e.g. residential properties, educational buildings and places of worship);

b. where these measures are not sufficient to mitigate significant impacts the Promoter will, if effective and reasonably practicable, provide noise barriers to mitigate noise between the track and sensitive receptors;

c. after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, the Promoter will offer noise insulation where impacts on sensitive receptors are severe;

d. the Promoter will consult with those parties who may be affected by noise and vibration explaining the mitigation measures that are proposed.

[1] Best Practical Means are defined in Section 72 of the Control of Pollution Act 1974 as those measures which are "reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to financial implications".

3. The Promoter will reassess the impacts of noise and vibration during the detailed design of the Scheme to ensure the design incorporates mitigation measures in accordance with this policy.

4. Describing noise and vibration requires technical nomenclature. To assist the interested reader's understanding, the Promoter has prepared a Noise and Vibration Public Briefing Note which further explains noise and vibration units.

Assessment of Noise and Vibration Effects

5. The Promoter's environmental consultants, Environmental Resources Management ("ERM") have, in accordance with accepted practice, undertaken an assessment of the impacts of noise and vibration as reported in the Environmental Statement[2]. This has been undertaken by identifying various representative noise sensitive receptors (primarily residential properties) along the entire railway route, comparing predicted levels against impact assessment criteria, and outlining mitigation measures where necessary to achieve these criteria. The mitigation measures were refined in the Promoter's Supplementary Memorandum Responding to the Peer Review, August 2004. These measures will be further refined as the detailed design and consultation progress, in accordance with this policy.

6. The assessment has been based on an assumed service frequency of two trains per hour each way during the daytime (0700 – 2300) and two trains per hour each way at night between 2300 and 0030 and also between 0555 and 0700. This assumed level of service is, given current circumstances and knowledge, a reasonable worst case scenario.

Noise Mitigation

7. The requirements for noise mitigation relate to two sets of absolute noise levels termed 'Threshold' levels and 'Unacceptable' levels, as follows. In all cases these are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field[3] noise levels.

   Noise Impact Threshold levels: Day - $L_{Aeq, (0700\text{-}2300\ hours)}$ 55 dB[4]
   Night – $L_{Aeq, (2300\text{-}0700\ hours)}$ 45 dB

[2] See chapter five of the Environmental Statement which accompanies the Bill.
[3] Free-field means away from reflective surfaces, except the ground.
[4] $L_{Aeq,\ T}$ is the A-weighted equivalent sound level over the period T. A-weighting is a frequency weighting that replicates the frequency response of the ear. $L_{Aeq,\ T}$ is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. It is the recommended parameter for train noise.

8. Where train noise is predicted to be more than 3dB [5] above either of the threshold levels (i.e. day or night) mitigation measures at source will be considered to reduce the adverse impact of noise according to the extent to which the pre-existing ambient ($L_{Aeq,\ 1\ hour}$) noise level is increased, as follows:

   - Increase of 3-5 dB - mitigation considered on a case by case basis, and implemented if reasonably practicable and acceptable to affected parties.

   - Increase of greater than 5 dB – mitigation implemented if reasonably practicable and acceptable to affected parties.

9. Impacts of 3 dB above the thresholds are considered sufficiently significant to warrant the consideration of noise barriers. That is not to say that noise barriers will always be appropriate as there are other considerations including noise e.g.

Track Safety:	There are HMRI requirements to limit structures close to railway tracks so as to allow room for escape. This means that generally a noise barrier can be located no closer than approximately three metres from the track.
Sight lines:	On curves, noise barriers could compromise line of site ahead and so may be impracticable.
Visual Impact:	In highly visible locations noise barriers may not be desirable.
Creation of Crime Havens:	In built-up areas, such as near stations noise barriers could create areas where criminal activity could be hidden from view and thus be facilitated.
Construction and maintenance difficulties:	Noise barriers may require deep foundations or be unstable on sloped land. They may interfere with access or maintenance and they can attract graffiti in unfavourable locations.

10. Whilst it is anticipated that noise barriers will offer a solution in many of the locations identified there may be certain locations where local conditions do not permit noise barriers. Consultation with the residents will be undertaken to ensure that where practicable a suitable form of noise mitigation will be agreed during the detailed design process.

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[5] Exceedences of up to 3 dB are considered to be of marginal significance. In line with current guidance, 3 dB is taken as the limit of perception of change in environmental noise.

Unacceptable impact levels: Day > $L_{Aeq, (0600\text{-}0000\ hours)}$ 66 dB[6]
Night > $L_{Aeq, (0000\text{-}0600\ hours)}$ 61 dB
Night > L_{Amax} 82 dB [7]

11. If, after consideration of measures at source, any of the relevant unacceptable levels is exceeded then noise insulation will be offered, provided the corresponding ambient noise level is routinely exceeded by at least 1dB. Noise insulation would be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations 1996 that apply in England and Wales.

Train Horn Noise

12. Train drivers are required to sound the train's horn to warn of their approach in certain situations. There are two tunnels where this may occur; Torwoodlee Tunnel (just North of Galashiels) and Bowshank Tunnel (approximately 5km North of Galashiels).

13. Given the vital safety requirement of train horns it is not considered viable to mitigate this noise source except through the use of noise insulation if the unacceptable levels given in section 3 are routinely exceeded. Train drivers will also be made aware of the residential areas that may be affected and will be instructed not to sound the horn unnecessarily.

Train Vibration

14. The movement of operating trains may give rise to perceptible levels of ground vibration in adjacent occupied properties. Vibration Dose Value (VDV) [8] is a measure of the accumulated level of ground vibration over a period, and, through the application of BS6472 [9], is a standard metric for predicting the likelihood of adverse comments from building occupants. The standard gives the following VDV levels at or below which the probability of adverse comment is low.

- Day (0700 – 2300 hours) - 0.4 $m/s^{1.75}$
- Night (2300 – 0700 hours) - 0.13 $m/s^{1.75}$

15. Trackforms will be designed adjacent to sensitive receptor buildings using Best Practicable Means to keep within the guideline levels.

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[6] Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations 1996 that apply in England and Wales, where it is defined as 0600 hours to midnight.
[7] L_{AMax} is a measure of the peak noise level, A-weighted.
[8] Vibration Dose Value, VDV, is the vibration metric recommended in BS6472, 1992 for the assessment of annoyance from railway vibration. It is a measure of the overall vibration dose throughout a day or night period. It is highly weighted towards peaks and has the units $m/s^{1.75}$.
[9] BS6472: 1992 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz).

Monitoring and Maintenance

16. The railway, and in particular the wheel and rail surfaces, will be maintained so as to minimise noise and vibration at sensitive receivers. A noise and vibration monitoring scheme will be implemented and the results will be used to inform wheel and track maintenance programmes in order to minimise unnecessary increases in noise or vibration. The monitoring scheme will include initial surveys within 6 months of opening of the railway to confirm the effectiveness of the noise mitigation measures.

17. The operator will establish appropriate sound levels for station Public Address systems and will seek to address complaints, if they are received from occupiers of noise sensitive premises, as far as is practicable within railway safety requirements.

Compensation

18. Noise and vibration are 'physical factors' [10] which may give rise to compensation if they result in the value of a property being reduced. The Promoter has produced a separate policy on compensation.

[10] Under the Land Compensations Act, 1973 noise and vibration are included as Physical Factors for which compensation may be payable as a result of a public works such as a new railway.

WAVERLEY RAILWAY
NOISE AND VIBRATION PUBLIC BRIEFING NOTE

November 2005

1 INTRODUCTION

1.1 PURPOSE

Some property owners along the route of the railway have expressed concern that noise and vibration could affect them. The Waverley Railway Noise and Vibration Policy sets out the commitments that the Promoter has made to control noise and vibration through a range of mitigation measures. The policy builds on the results of the noise and vibration assessment reported in the Environmental Statement.

Noise and vibration are technical subjects and can be difficult to understand. This Briefing Note gives detailed explanations of noise and vibration levels and should enable interested objectors to better understand the technical information that has been prepared and hence what to expect from the project.

Section 2 of this document discusses noise and *Section* 3 discusses vibration.

2 WHAT IS NOISE ?

2.1 OVERVIEW

The terms 'sound' and 'noise' tend to be used interchangeably, but noise can be defined as unwanted sound. Sound is a normal and desirable part of life. However, when noise is imposed on people (such as from industry, construction or transportation) it can lead to disturbance, annoyance and other undesirable effects.

It is relatively straightforward to physically measure sound with a sound level meter. However, it is more difficult to measure perceived loudness and the effects it may cause.

For this reason we draw on various standards and guidelines that relate a measured noise level to the effect it is likely to have. These guidelines are generally based on large scale social surveys that have produced accepted, albeit approximate, relationships between noise level and effect.

2.2 AN EXPLANATION OF NOISE LEVELS AND PERCEPTION OF NOISE

Noise is measured and quantified using decibels (dB). Examples of noise levels in common situations are shown in *Table 2.1*.

Table 2.1 Example of Noise Levels on a Decibel Scale

Noise Level, dB(A)*	Typical noise source / example
0	Threshold of hearing – lowest sound an average person could hear
30	Quiet bedroom at night
40	Whispered conversation at 2 metres
50	Conversational speech at 1 metre
60	Busy general office
70	Loud radio indoors
80	Lorry at 30kph at 7 metres
90	Lawnmower at 1m

*The dB(A) scale is a particular way of measuring the different frequencies in sound designed to match how the human ear perceives noise, called the 'A'-weighting.

The Decibel scale is logarithmic, which means that noise levels do not add up according to simple linear arithmetic. For example, adding two equal noise sources results in a combined noise level that is 3dB higher than the individual levels. For example 60dB + 60 dB = 63 dB (not 120 dB).

The ear perceives only a slight increase in loudness instead of a doubling.

Since human hearing responds to changes in noise logarithmically, a relatively large change in sound energy is needed before it is *perceived* to be louder or quieter. For example, it is generally accepted that:

- an increase or decrease of 1dB cannot usually be heard in everyday conditions (although possibly in ‘laboratory’ conditions);

- an increase or decrease of 3dB is generally accepted as the smallest change that is noticeable in ordinary conditions;

- an increase or decrease of 5dB is a clearly perceptible change in noise; and

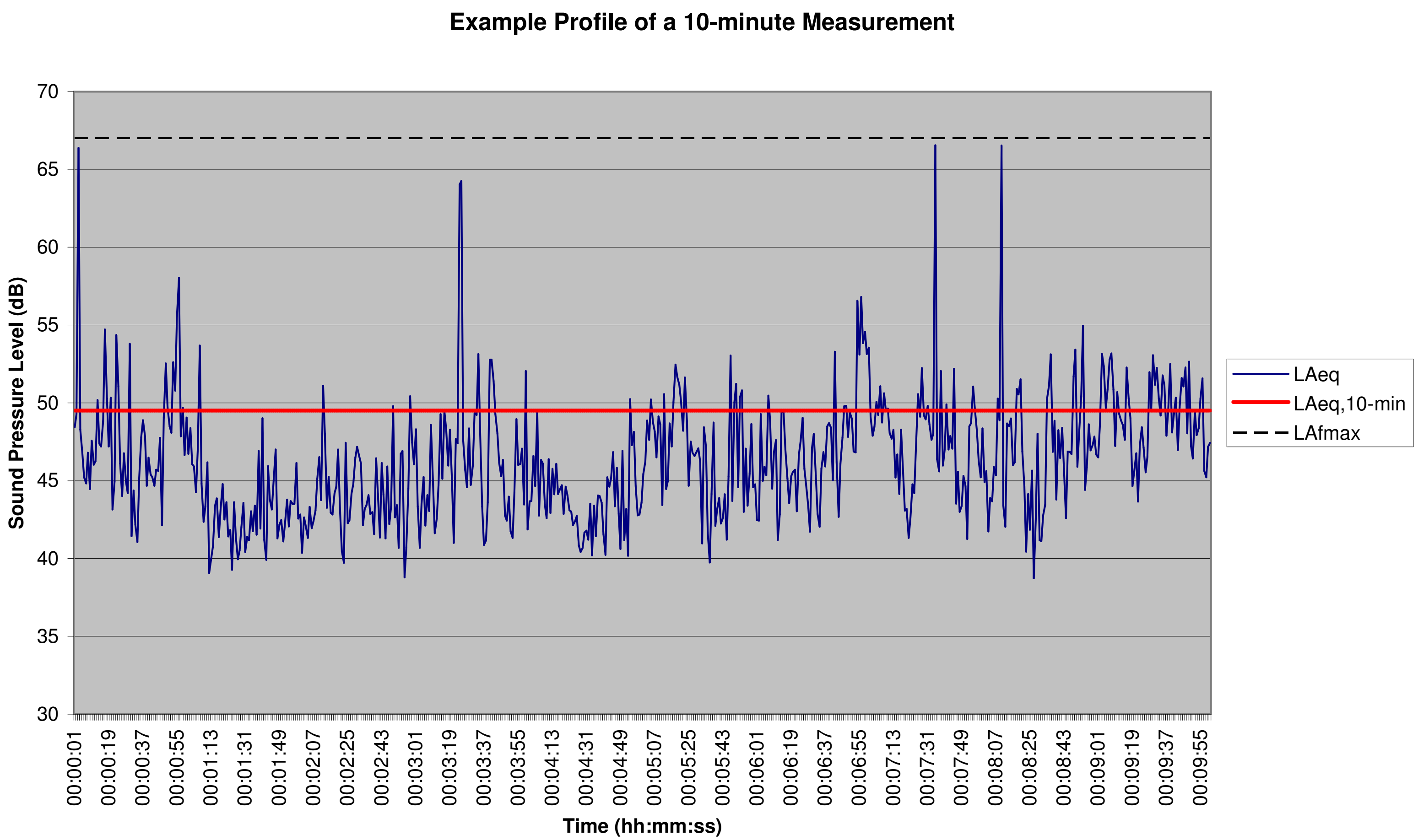
- an increase or decrease of 10dB is perceived to be a doubling or halving of noise.

To place this into context, to change a noise level by around 3dB there would need to be a doubling or halving of the noise energy; and a change of 10dB would need a ten-fold change in noise energy.

2.3 *HOW IS NOISE MEASURED AND DESCRIBED*

Since noise sometimes varies over time, we need to use statistical parameters (or metrics) to measure it. *Figure 2.1* below is an example of a noise varying over a 10 minute period. It also shows how a noise measurement can describe this noise signal with two commonly used noise metrics (‘L_{Aeq}’ and ‘L_{Amax}’) which are defined below.

Figure 2.1 Example Noise Profile Over 10 minutes



Box 2.1 Example Noise Measurement

A Sound Level Meter measuring this noise signal would record the following values:

The Equivalent Noise Level: $L_{Aeq,10\ minutes}$ 50 dB; and
The Maximum Noise Level: L_{Amax} 67 dB.

These measurement parameters and what they represent are described in more detail below.

$L_{Aeq,T}$

This metric is called the 'continuous equivalent sound level'. It represents a varying noise level by calculating the constant noise level that would have the same sound energy content over the measurement period. The letter 'A' denotes that 'A'-weighting has been used and 'eq' indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous sound level, measured over period 'T'.

L_{Aeq} is a logarithmic average noise level over a period (instead of an arithmetic average) which gives a high weighting to high noise levels even if they are relatively short lived or infrequent events.

The difference between arithmetic and logarithmic (L_{Aeq}) averaging can be further illustrated by considering the average age of a class of 30 children and their teacher. Suppose the children are 5 years old and the teacher is 40 years old. The arithmetic average age is just 6, whereas the logarithmic (L_{eq}) average is 16. This partly explains why L_{eq} has been found to be a good indicator of the effects of noise that comprises a series of varying signals over a period, such as railway noise.

L_{Aeq} can be calculated over different periods, T, depending on the characteristics of the noise and when people are exposed to it. If the noise is steady, a relatively short measurement period will be sufficient to characterise it. If it fluctuates randomly or has cyclical elements, then a longer measurement period will be required to obtain a representative sample. Some standards specify a measurement period, but for many environmental noise climates that are dominated by road traffic 10 to 15 minutes are adequate to obtain repeatable results.

L_{AMax}

This is a measure of the maximum A-weighted noise level. For railway noise, it is the highest level experienced when the vehicles passes, usually occurring as it is directly in front of the receptor location.

The L_{Amax} is a useful metric when considering sleep disturbance, so it is used in conjunction with the L_{Aeq} to assess the impact from railway noise.

3 VIBRATION

3.1 OVERVIEW

Vibration may occur as a result of the construction and operation of a railway. It is necessary to consider the potential for effects on people and structures. These two effects are quite different and are described below.

3.2 EFFECT OF VIBRATION ON STRUCTURES

Where building damage is of key concern it is usual to measure in terms of Peak Particle Velocity (PPV). British Standard BS 7385 (1) gives guidance on the PPV vibration levels above which damage may potentially occur, as follows:

- reinforced or framed buildings 50 mm/s PPV; and
- un-reinforced or light framed buildings 15 mm/s PPV.

The threshold of perception (see below) is many times lower than these levels which can result in the misconception that, if vibration is perceptible, it will damage a building. There are numerous buildings and structures in close proximity to sources of vibration, such as railways, that have not been damaged by vibration even after many years of exposure.

3.3 ANNOYANCE

Human sensitivity to vibration varies between people and circumstances, but the threshold of perception is usually taken to be in the PPV range 0.15 and 0.3 mm/s.

British Standard BS 6472 (2) provides a method of predicting the likelihood of 'adverse comment' from occupiers of buildings due to vibration. This is assessed in terms of the Vibration Dose Value (VDV), and is a measure of the frequency weighted acceleration accumulated over a period. BS 6472 gives the following VDV levels at or below which the probability of adverse comments is low:

- day (0700-2300 hours) 0.4 $m/s^{1.75}$; and
- night (2300-0700 hours) 0.13 $m/s^{1.75}$.

Vibration from railways takes the form of a series of 'vibration events' as trains pass, interspersed with periods with no vibration. The VDV depends on both the magnitude of train vibration 'events' and their number during the day or night-time period. VDV is highly biased towards higher vibration

(1) BS 7385-2: 1993 'Evaluation and measurement for vibration in buildings - Part 2: Guide for damage levels from groundborne vibration'
(2) BS 6472: 1992 'Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)'

levels. To double the VDV it would be necessary to double the event acceleration level, or to increase in the number of events by a factor of 16.

The research that lead to British Standard 6472 and the use of VDV included social surveys of the response of individuals to railway vibration, and it is the method recommended in Planning Advice Note 56 [1] for assessing acceptable magnitudes of vibration from new railways.

(1) PAN 56 Planning and Noise, 1999, the Scottish Executive.