

Edinburgh Airport Rail Link



Noise and Vibration Policy Paper 12 January 2007



Issue & Revision Schedule

Author(s)	<i>Paul Maddock, ERM</i>
Checked by:	<i>Steve Mitchell, ERM</i>
Approved by:	<i>Gail Jeffrey, Scott Wilson Railways</i>
Draft/Issue No:	<i>Issue 2 Rev 4</i>
Issue Date:	<i>12/01/2007</i>
Project Manager:	<i>Kevin Murray, Senior Project Manager, tie limited</i>

Date	Issue No.	Revision No.	Comments	Issued by
<i>12/01/2007</i>	<i>2</i>	<i>4</i>	<i>Draft addressing Parliamentary Committee Assessor's comments</i>	<i>JS</i>
<i>21/07/2006</i>	<i>2</i>	<i>3</i>	<i>Draft for Public Issue</i>	<i>JS</i>
<i>17/07/2006</i>	<i>2</i>	<i>2</i>	<i>Draft to address Local Authority and Network Rail Comments</i>	<i>JS</i>
<i>20/06/06</i>	<i>2</i>	<i>1</i>	<i>Draft for Local Authority Comment</i>	<i>JS</i>
<i>13/03/06</i>	<i>1</i>	<i>0</i>	<i>Draft for comment</i>	<i>JS</i>

For enquiries please contact:

tie limited
Verity House
2nd Floor
19 Haymarket Yards
Edinburgh
EH12 5BH

Tel: 0131 622 8300
Fax: 0131 622 8301
www.earlproject.com
barry.cross@tie.ltd.uk

1 EDINBURGH AIRPORT RAIL LINK (EARL) (SCOTLAND) BILL NOISE AND VIBRATION POLICY PAPER

1.1 INTRODUCTION

- 1.1.1 The purpose of this policy document is to set out the Promoter's (the *tie* ltd's) policy for assessing and mitigating noise and vibration effects during the operation of EARL. The policy builds on the commitments made during the Environmental Impact Assessment (EIA) as reported in the Environmental Statement (ES) of March 2006. Effects during construction are covered in the Code of Construction Practice (CoCP) which is included in draft as *Annex L* of the ES. This has since been updated, and there is a separate Policy Paper prepared to support this document.
- 1.1.2 There are no statutory requirements for mitigating noise from railways in Scotland. However, the Promoter takes this issue seriously and proposes a two tier approach to controlling noise and vibration to mitigate their potential impacts. The Promoter will adopt the Noise Insulation Regulations that apply in England and Wales to insulate properties where necessary. The Promoter will also set noise design targets at lower noise 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 detailed below.
- 1.1.3 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).
- 1.1.4 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.
- 1.1.5 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 unacceptable.
- 1.1.6 The Promoter will continue to 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."

- 1.3.2 Where train noise is predicted to be more than 3dB ⁽¹⁾ 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 ($L_{Aeq, 1 \text{ hour}}$) noise level is increased. For an increase of greater than 3 dB, mitigation will be implemented if reasonably practicable and acceptable to affected parties.
- 1.3.3 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, for example:
- 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 sight 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; and
 - 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.
- 1.3.4 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. The residents will be consulted to ensure that where practicable a suitable form of noise mitigation will be agreed during the detailed design process.

Noise insulation to residential properties will be considered if train noise levels exceed the following 'unacceptable' free-field levels which are those used to trigger noise insulation in England and Wales.

Unacceptable impact levels:

<i>Day</i>	$> L_{Aeq, (0600-0000 \text{ hours})}$	66 dB ⁽²⁾
<i>Night</i>	$> L_{Aeq, (0000-0600 \text{ hours})}$	61 dB

(1) 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.

(2) 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.

$$\text{Night} > L_{A\text{max}} 82 \text{ dB}^{(1)}$$

- 1.3.5 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 also routinely exceeded, by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations 1996 that apply in England and Wales.

1.4 TRAIN HORN NOISE

- 1.4.1 Train drivers are required to sound the train's horn to warn of their approach in certain situations.
- 1.4.2 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 1.3* 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.

1.5 TRAIN VIBRATION

- 1.5.1 The movement of operating trains may give rise to perceptible levels of ground vibration in adjacent occupied properties. Vibration Dose Value (VDV)⁽²⁾ is a measure of the accumulated level of ground vibration over a period, and, through the application of BS: 6472⁽³⁾ 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}

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

(1) $L_{A\text{max}}$ is a measure of the peak noise level, A-weighted. This will need to be regularly exceeded more than twice in any night-time operational hour to qualify as "unacceptable".

(2) 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 units $\text{m/s}^{1.75}$.

(3) BS6472: 1992 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz).

1.6 *MONITORING*

- 1.6.1 The Promoter will monitor noise and vibration levels within 6 months of opening of the railway to confirm the effectiveness of the noise mitigation measures.
- 1.6.2 The monitoring sites and procedures will be agreed with the Environmental Health Department of the City of Edinburgh Council or West Lothian Council, as appropriate. The monitoring sites will be at noise sensitive receptors close to the railway including those where noise mitigation has been included and those where predicted noise levels are close to the target levels set in this policy. Approximately 10 noise monitoring sites will be used. Where access is required onto land immediately adjacent to a noise sensitive building, prior consultation will be undertaken with the building occupier and suitable arrangements will be made to carry out the monitoring at a time that suits the building occupier.
- 1.6.3 Monitoring at a selection of the sites, to be agreed in the same way, will be repeated annually for 5 years after opening. The results of the monitoring will be sent to the Environmental Health Departments of the City of Edinburgh Council and West Lothian Council and will be made available to the public through publication in newsletters or on the internet.

1.7 *COMPENSATION*

- 1.7.1 Noise and vibration are 'physical factors' ⁽¹⁾ 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.

(1) 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.

EDINBURGH AIRPORT RAIL LINK
NOISE AND VIBRATION TECHNICAL BRIEFING NOTE

1 INTRODUCTION

Some property owners along the route of the railway have expressed concern that noise and vibration from construction and/or operation of the scheme could affect them. The Edinburgh Airport Rail Link Noise and Vibration Policy ⁽¹⁾ 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. ⁽²⁾

Noise and vibration are technical subjects and can be difficult to understand. This Briefing Note gives detailed explanations of noise and vibration terminology and levels, and should enable interested parties 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.

(1) EARL Noise and Vibration Policy, July 2006

(2) EARL Environmental Statement, March 2006

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 sound, called the 'A'-weighting.

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

However, even though the *energy* levels have doubled, the ear *perceives* only a slight increase in loudness instead of a doubling because human hearing responds to changes in noise logarithmically. This means that 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 possible 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 perceived loudness.

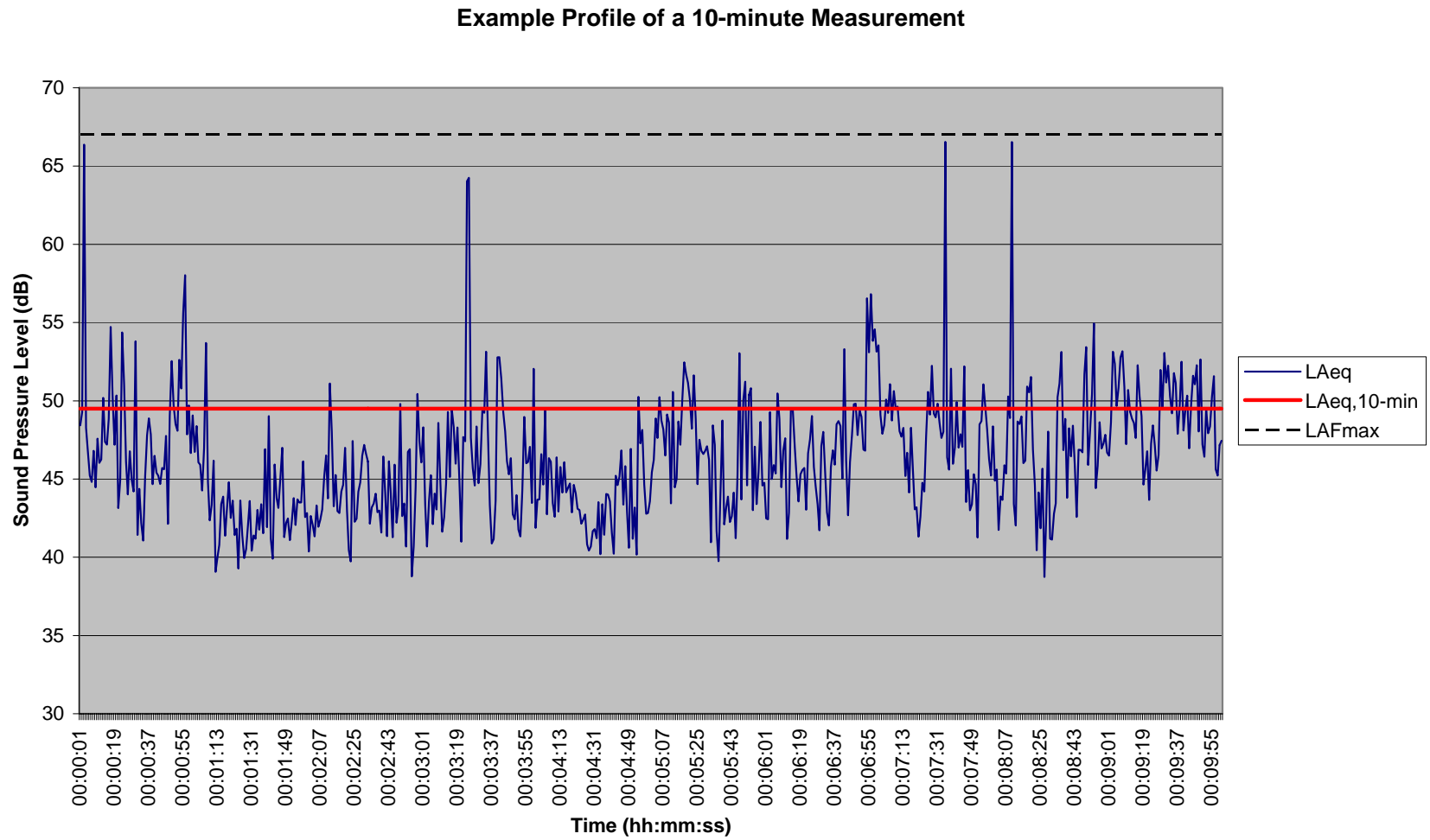
To place this into context, to change a noise level by around 3dB there would need to be a doubling or halving of the noise energy; and a change of 10dB would need a ten-fold change in noise energy.

2.3

HOW IS NOISE MEASURED AND DESCRIBED

Since noise often varies over time, we need to use statistical parameters (or metrics) to measure, and describe noise. *Figure 2.1* below is an example of 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 of a 10-minute Measurement



Box 2.1

Example Noise Measurement

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

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

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 sound level that would have the same sound energy content over the measurement period. The letter 'A' denotes that 'A'-weighting has been used and the 'eq' indicates that an equivalent level has been calculated. Hence $L_{Aeq,T}$ is the A-weighted 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. This can be seen in Figure 2.1.

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 comprise 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 measurement over 10 to 15 minutes is 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 vehicle 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 EFFECTS 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 exposure.

3.3 EFFECTS ON PEOPLE (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 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 comment is low:

- Day (0700-2300) 0.4 m/s^{1.75}; and
- Night (2300 – 0700) 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 to damage levels from groundborne vibration'.

(2) British Standard BS 6472: 1992 'Guide to Evaluation of human exposure to vibration in buildings (1Hz to 80Hz)'

levels. To double the VDV it would be necessary to double the event or acceleration level, or to increase 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