

NOISE AND VIBRATION MITIGATION POLICY



**THE CHILTERN RAILWAYS (BICESTER TO OXFORD IMPROVEMENTS)
ORDER**

TRANSPORT AND WORKS ACT 1992



Chiltern Railways

JANUARY 2011

SUMMARY OF THE NOISE AND VIBRATION POLICY

The Noise and Vibration Policy has been adopted by Chiltern Railways to ensure that mitigation of noise and vibration from trains using the railway authorised by the Chiltern Railways (Bicester to Oxford Improvements) Order is provided on a fair basis for all occupiers and landowners along the route between Bicester and Oxford.

The Policy has been based on extensive research and modelling and offers a high standard of mitigation, comparable with other similar railway schemes in Britain.

The Policy will ensure that the following are achieved:

- (i) Noise will be reduced at source where it is reasonably practicable to do so.
- (ii) Where this is not reasonably practicable, noise barriers or noise insulation to properties will be provided, where necessary, in accordance with relevant standards.
- (iii) Where predicted noise levels exceed relevant levels set out in the Noise Insulation (Railways and Other Guided Systems) Regulations, noise insulation will be offered to the occupiers of eligible buildings to the standards required by those Regulations and provided at their request.
- (iv) At other locations, where statutory noise levels are not exceeded but where significant noise impacts are predicted, noise will be mitigated wherever reasonably practicable. Significant noise impacts include a significant increase in noise in an already noisy area, or the significant exceedance of stringent thresholds in an area where the ambient noise is currently low. Chiltern Railways has chosen to offer this high standard of mitigation. It is not a statutory requirement.
- (v) Vibration from trains will not cause damage to structures, and even without mitigation, will be likely only to give rise to 'adverse comments from occupiers being possible' at a few properties that are located very close to the railway. At these locations, appropriate mitigation measures will be provided.

These commitments and the ways in which the Policy will be implemented are set out in the remainder of this Policy.

The Policy, which has been agreed with Network Rail, applies to any works authorised by the Transport and Works Act Order.

1. *HOW WILL THE POLICY BE APPLIED?*

INTRODUCTION

- 1.1. Chiltern Railway has applied for the Chiltern Railways (Bicester to Oxford Improvements) Order. The Order, if made, would allow for the railway works to be carried out in phases. Phase 1 consists of those works required to allow the operation of Chiltern Railways' proposed London Marylebone to Oxford passenger services together with the freight services that currently operate on the Bletchley to Oxford line between Bicester and Oxford. Phase 2A, which is the lowering of the trackbed of the Wolvercot Tunnel, will be undertaken at the same time as the Phase 1 works.
- 1.2. The Phase 1 and 2A works will be carried out as soon as the Order is approved, so that their passenger services can start no later than May 2013. Further works, in Phase 2B, will take place at a later date and be undertaken either by the East West Rail (EWR) consortium or others on behalf of Network Rail (NR). The Phase 2B works are mainly those to provide double track between the MoD depot at Bicester and Islip and through the Wolvercot Tunnel.
- 1.3. The Noise and Vibration Mitigation Policy has been prepared by Chiltern Railways and agreed by Network Rail. It will be applied, in the first instance, by Chiltern Railways when designing in detail, building and operating the works in Phase 1 and 2A. EWR, or others on behalf of NR, when they undertake the Phase 2B works, will also apply this policy. Hereafter, in this policy, the organisation which builds the relevant works is called the 'Promoter'.
- 1.4. The purpose of this policy is to set out the Promoter's commitments to mitigating noise and vibration effects arising from operation of the railway. These are based on the commitments made in the Environmental Statement ⁽¹⁾.
- 1.5. The mitigation of noise and vibration effects during construction will be the responsibility of the Contractor, who will have to work within and abide by an approved Code of Construction Practice.
- 1.6. Chiltern Railways' consultants, Environmental Resources Management, have carried out an assessment of the likely effects of noise and vibration which is reported in the Environmental Statement ⁽²⁾. This has been undertaken by:
 - identifying representative noise sensitive receptors (primarily residential properties) along the entire railway route;
 - measuring current actual noise levels at these locations;

(1) Chiltern Railways (Bicester to Oxford Improvements) Order, Environmental Statement, ERM, 2009

(2) See chapter six (of volume 2) of the Environmental Statement which accompanies the Transport and Works Act Order Application.

- predicting likely future noise levels, based on noise measurements relating to the actual types of passenger and freight trains that will be used on the railway;
 - comparing these predicted levels against noise impact assessment criteria and outlining, where necessary, appropriate mitigation measures.
- 1.7. The detailed design of the Phase 1 and 2A works will be developed by Chiltern Railways' appointed contractor. This will involve refinement of the mitigation following the principles set out in this policy. This will ensure that the residual noise effects at any location are no worse than those reported in the Environmental Statement.
- 1.8. The assessment of noise and vibration has been based on two operational patterns of new train services:
- After the implementation of the works in Phases 1 and 2A, operational services will consist of up to two Chiltern Railways passenger trains per hour each way. The passenger trains will replace the existing passenger service operated by First Great Western between Bicester Town and Oxford stations.
 - After the implementation of the East West Rail (EWR) link including works in Phase 2B, there are likely to be an additional two passenger trains per hour each way.

Neither Chiltern Railways or EWR will be running passenger trains throughout the night, and services in late evening and early morning will be at a reduced frequency. A small number of passenger trains may arrive in Oxford after midnight or depart from Oxford before 0600.

- 1.9. In the operation of Phase 1 and 2A, there are likely to be no more freight trains than operate at present, as there will be no new freight destinations that can be served. When the East-West Rail (EWR) link is in operation, there may be more freight trains. For this reason, additional freight services were included in the noise assessment in the Environmental Statement, so that this reflects a reasonable planning scenario. The actual number of freight services will reflect national freight demand, but will be limited to the maximum number of available freight 'paths' (1 per hour in each direction). Experience shows that about half of the available freight train paths are likely to be used on a given day, which would suggest a reasonable planning scenario of 8 freight train movements between 11pm and 7am. Freight trains will not use the 'new' railway line between Oxford North Junction (where the Bicester to Oxford Line meets the Oxford-Banbury main line) and Oxford, but instead will use the existing main line, as at present.
- 1.10. The noise and vibration mitigation will be designed based on the assumptions in paragraph 1.8 and 1.9 regarding the numbers and timing of train movements.

INSTALLATION OF NOISE MITIGATION MEASURES

- 1.11. Noise mitigation measures in accordance with this policy will be installed during the Phase 1 and 2A works, to be completed before the commencement of Chiltern Railways passenger services. Before the Phase 2B works take place, any additional noise mitigation measures made necessary by those works and the services in the reasonable planning scenario for Phase 2B will be designed. The assessment of noise and vibration for Phase 2B will cover all parts of the route, where service frequencies are expected to increase in Phase 2B. The mitigation measures will be installed before the Phase 2B works are brought into use. After each Phase of works, the effectiveness of the noise insulation measures installed will be monitored, as detailed in para 2.11.

2. ***HOW IS NOISE ASSESSED TO DETERMINE APPROPRIATE MITIGATION?***

PRINCIPLES

2.1. The Noise and Vibration Policy is intended to ensure that noise and vibration mitigation is provided on a fair basis for all landowners and occupiers affected by the Order Scheme.

2.2. The Promoter is committed to using 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). The first preference will be to apply necessary noise control measures at source where this is reasonably practicable. These may include rail damping or other infrastructure measures to reduce noise at source. Where this is not reasonably practicable or sufficient to mitigate significant noise impacts, the Promoter will:

- where they are effective and reasonably practicable to install, provide noise barriers to mitigate noise between the track and sensitive receptors; and
- after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, offer noise insulation to properties where residual noise impacts on sensitive receptors remain high.

(1) Best Practicable 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, financial considerations and compatibility with safety and safe working conditions”

2.3. The Promoter will consult with landowners and occupiers who may be affected by noise and vibration to explain the mitigation measures that are proposed.

The assessment of noise uses technical terms, which are described in Annex A. The provision for noise mitigation will be based on two sets of absolute noise levels ⁽¹⁾. The first are 'Noise Impact Threshold' levels, below which noise impacts are never significant. The second set of levels are the 'Noise Insulation Trigger' levels. These are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field ⁽²⁾ noise levels.

Noise Impact Threshold levels: *Day* - $L_{Aeq, (0700-2300 \text{ hours})}$ 55 dB ⁽³⁾
 Night - $L_{Aeq, (2300-0700 \text{ hours})}$ 45 dB

2.4. Where train noise is predicted to be above either of these threshold levels, but where the level is still less than that set out in the Noise Insulation Regulations requiring noise insulation to be provided, the Promoter will provide mitigation measures to reduce the adverse impact of noise. These will vary according to the extent to which the train noise level exceeds the threshold levels and the extent to which overall noise is increased above the existing or ambient noise level, as follows:

- exceedances of 3 dB or greater and increases of 3 dB or greater – mitigation at source through rail infrastructure solutions will be implemented where reasonably practicable;
- exceedances of greater than 5 and up to 7 dB and increases of greater than 5 dB and up to 7 dB -- at source and/or in the form of noise barriers if reasonably practicable and have no other negative effects;
- exceedances of greater than 7dB and increases of greater than 7dB – at source through rail infrastructure solutions and where these cannot be reasonably practicably achieved, noise barriers will be provided, where reasonably practicable.

These standards are consistent with those applied in the Environmental Statement, where noise mitigation is considered at source for impacts that are greater than 3 dB and in the form of noise barriers for impacts above a minimum of 5 dB. (Noise impacts in the ES are calculated by considering both the exceedance of the threshold criteria and the increase in overall noise, and taking the lower of the two.) The noise benefits of noise barriers are more likely to outweigh any dis-benefits, where the noise increase is above 7 dB. There are certain locations where because of the topography of the railway

(1) The standards relate to disturbance of building occupants, and do not relate to specific effects such as speech interference.

(2) Free-field means away from reflective surfaces, except the ground.

(3) $L_{Aeq, T}$ 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 recommended parameter for train noise.

and adjacent properties, safety or visual impact, barriers cannot be installed or will not be effective.

- 2.5. Noise barriers or other noise attenuating infrastructure solutions will achieve noise reductions in most areas, to near to the existing noise levels. However residual noise impacts may still occur at particular locations. If, after consideration of the effects of noise mitigation measures at source, any of the Noise Insulation Trigger levels is still exceeded, then noise insulation to relevant properties will be offered, provided the corresponding existing or ambient noise level is routinely exceeded by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations. The noise level thresholds at which this will be offered are shown below in terms of free-field noise levels that are equivalent to the façade levels provided for in the Regulations.

Noise Insulation Trigger Levels

<i>Day</i>	$> L_{Aeq, (0600-0000 \text{ hours})}$	66 dB ⁽¹⁾
<i>Night</i>	$> L_{Aeq, (0000-0600 \text{ hours})}$	61 dB

- 2.6. Even with the mitigation in paragraph 2.5, some of the properties close to the railway may still experience residual noise impacts that may be classed as 'high'. A 'high' impact is the equivalent of a noise impact of greater than +10 dB. If these properties are not already to be provided with insulation under the Noise Insulation Regulations, they will be offered additional mitigation, which is likely to be in the form of noise insulation.
- 2.7. If maximum pass-by free-field noise (L_{Amax} , the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance, except where ambient maximum noise levels are already above the predicted train noise level. One or two events per night would not be interpreted as regular, but the 8 assumed freight movements each night in Phase 2B are considered to be regular. In those very few locations likely to have such noise effects, additional noise attenuation measures will be taken to include the offer of noise insulation to affected properties. This form of mitigation is particularly effective in addressing night-time noise impacts when noise levels inside buildings are the key factor as regards sleep disturbance. The following additional criterion for noise insulation is therefore being applied.

Significant impact, need for further mitigation likely to be noise insulation:

	<i>Night</i>	$> L_{Amax}$	82 dB ⁽²⁾
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(1) Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations, where it is defined as 0600 hours to midnight. These noise levels are free-field values that are equivalent to the values defined in the Noise Insulation Regulations

(2) L_{Amax} is a measure of the peak noise level, A-weighted

MITIGATION OF VIBRATION

- 2.8. The levels of vibration resulting from passenger and freight trains operating on the new railway will be far below the levels that might cause structural damage to buildings. However, the additional trains may give rise to perceptible levels of ground vibration in adjacent occupied properties. Vibration Dose Value (VDV) ⁽¹⁾ is a measure of the accumulated level of ground vibration over a period, and, through the application of BS6472 ⁽²⁾, is a standard metric for predicting the likelihood of adverse comments from building occupants. The standard gives the following threshold 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) - 0.2 m/s^{1.75}
- 2.9. By comparison, the measured levels from the types of passenger and freight trains that will be used on the new railway, running on standard ballasted track, suggest that even at 8 m from the track the levels will be 0.14 m/s^{1.75} during the day and 0.12 m/s^{1.75} at night which are very much less than the “adverse comment” thresholds set out above. Trackforms will be designed and installed adjacent to occupied vibration sensitive receptor buildings using Best Practicable Means to keep within the thresholds.
- 2.10. Where existing vibration levels are already above either of the thresholds set out above, mitigation will be considered where the change in VDV is 50% or more as a result of the Phase 1, 2A and 2B works.

MONITORING AND MAINTENANCE

Monitoring

- 2.11. A noise and vibration monitoring scheme for the Phase 1 and 2A works will be implemented to ensure that the performance of the mitigation measures that are installed achieve the levels of noise mitigation predicted by the design contractor, whose design instructions will include the requirement to achieve the residual noise levels set out in the Environmental Statement. The monitoring scheme will include the carrying out of surveys, the first being undertaken at around 6 months after the opening of the railway for Chiltern Railways passenger services, at locations agreed with the local planning authorities. A second survey will be undertaken 18 months after opening. If defects in construction or performance are identified in the first survey, these will be corrected in a timely manner by the contractor. If any defects in construction or performance are found in the second survey, these will also be corrected in a timely manner by the contractor. The same procedure for post construction monitoring surveys and the remedy of defects or performance

(1) Vibration Dose Value, VDV, is the vibration metric recommended in BS6472 -1, 2008 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}

(2) BS6472: 2008 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) Part 1 Vibration Sources Other than Blasting.

will be undertaken after the Phase 2B works have been completed and EWR services introduced.

- 2.12. The results of the Phase 1 and 2A monitoring will be published in an easily accessible format on the Chiltern Railways website and in the project newsletter and will be made available, either in hard copy or in electronic format, to any person requesting the information. Arrangements for publishing the surveys after Phase 2B will be agreed with the local planning authorities.

Maintenance

- 2.13. The railway, and in particular the wheel and rail surfaces, will be maintained so as to minimise noise and vibration at sensitive receivers.

OTHER NOISE MITIGATION

Station Announcements

- 2.14. Directional public address systems will be used that minimise the impact on nearby properties whilst maintaining audibility on platforms. The station 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 reasonably practicable within railway safety requirements.

Train Stabling and Servicing

- 2.15. Chiltern Railways trains will not be stabled or serviced in the carriage sidings at the north end of Oxford station. Drivers will be instructed to shut down engines if the train is not to be moved within 5 minutes of arrival at Oxford station, and all Chiltern trains are equipped with automatic systems to shut down the engines if the train has been standing for more than 15 minutes.

Train Horns

- 2.16. Safety regulations require train drivers to sound the train's horn to warn of their approach in certain situations, for example, at certain level crossings or where there is risk of collision. This is essential, but after the Phase 1 works are completed, all of the present level crossings, except London Road, Bicester will be permanently closed and the situations where horns need to be sounded will be much reduced. There will be audible alarms on the crossing at London Road, Bicester and horns will not be used except in emergency. Although it is an inherent feature of the scheme rather than a specific mitigation measure, the reduction in horn noise will reduce noise impacts from this distinctive noise source, and so it has been noted in this section.

ANNEX A NOISE TERMINOLOGY

WHAT IS 'NOISE'?

- A.1 The terms “sound” and “noise” tend to be used interchangeably, but noise can be defined as unwanted sound. Your neighbour may enjoy the sound of his music at 2am but you would be disturbed by the noise.
- A.2 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.
- A.3 It is relatively straightforward to physically measure sound with a sound level meter, but it is a different matter to quantify the sound in terms of how noisy it is perceived to be and the effects it may cause.
- A.4 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, all be it approximate, relationships between noise level and effect.

AN EXPLANATION OF NOISE LEVELS

- A.5 Noise is measured and quantified using decibels (dB). This scale is logarithmic, which means that noise levels do not add up or change according to simple linear arithmetic. For example, any two equal noise sources added together give only an increase of 3dB higher than the individual levels (e.g. 60 dB + 60 dB = 63 dB, not 120 dB). This represents what happens in practice when two equal sounds coincide; the ear perceives only a slight increase in noise and not a doubling.

The following table provides examples typical of noise levels.

Examples of Noise Levels on the 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
70 – 75	Existing trains at Lakeside
80	Lorry at 30 kph at 7 metres
90	Lawnmower at 1 metre

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

A.6 The way human hearing works is conveniently similar to the logarithmic changes in noise.

- An increase of 1 dB in noise levels cannot usually be heard (except possibly in 'laboratory' conditions).
- An increase of 3 dB is generally accepted as the smallest change that is noticeable in ordinary conditions.
- An increase of 5dB is clearly perceptible.
- An increase of 10dB seems to be twice as loud.

HOW IS NOISE MEASURED?

A.7 There is a little more to the measurement of noise than pointing a sound level meter and taking a reading. Because noise tends to vary over time, we need to find a way of measuring it in a manner which represents the variation in noise level that also reflects people's perception of how noisy it is. Over the years a number of different ways to measure noise (metrics or parameters) have been developed as the best ways of representing different types of noise sources (single events, industry, road traffic, railway, aircraft etc). Those relevant to the Chiltern Railways are introduced below.

NOISE MEASUREMENT PARAMETERS

A.8 The parameter or metric $L_{Aeq,T}$ is called the continuous equivalent sound level. It 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. 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 time period 'T'.

A.9 Detailed surveys have been carried out into people's responses to different sources of noise and these have been used to define which noise metrics provide good relationships with perceived noisiness. PPG 24 which deals with the assessment of environmental noise from sources for example, advocates $L_{Aeq, Period}$ for all types of transportation noise.

A.10 It is important to appreciate that whilst L_{Aeq} does give a measure of the accumulated noise over a period of time it is not like a conventional (arithmetic) average. It is in fact a logarithmic average. The effect of this is to give a high weighting to high noise levels even if they are relatively short lived or infrequent peaks.

A.11 The difference between arithmetic and logarithmic (L_{Aeq}) averaging can be 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 of time, such as railway noise.

A.12

An L_{Aeq} level can be calculated over different time periods depending on the characteristics of the noise and how 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 10 to 15 minutes is often adequate to obtain repeatable results. In terms of train noise for Chiltern Railways, the approach that has been taken is to identify the noise levels from individual trains and to use these to calculate the noise levels over suitable day and night periods.

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