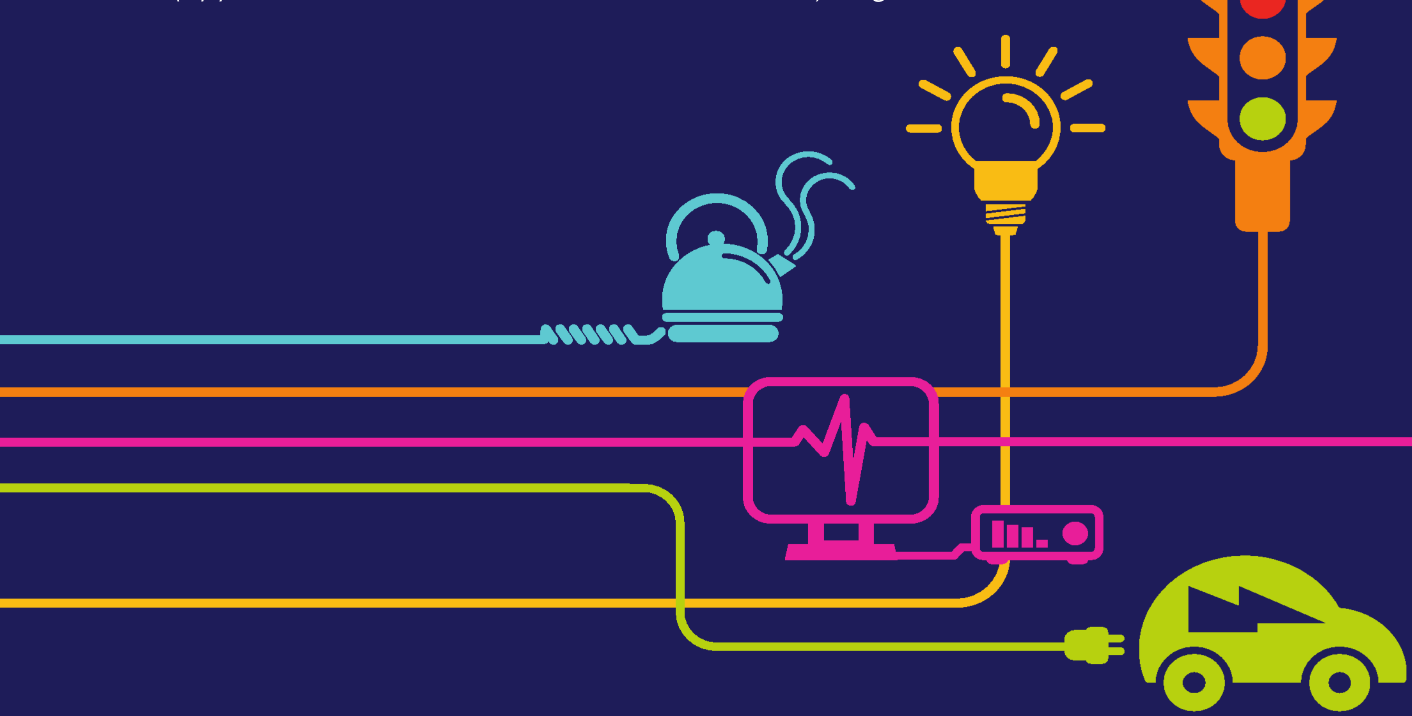
DOCUMENT 5.16.2.3

OHL Conductor Assessment Methodology Summary

Chapter 16 – Appendix 3

National Grid (North Wales Connection Project)

Regulation 5(2)(a) including (l) and (m) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009



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North Wales Connection Project

Environmental Statement

Document 5.16.2.3 Appendix 16.2.3 OHL Conductor Assessment Methodology Summary

National Grid
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

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Approved by	Richard Morris		
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1 Introduction

1.1.1 The majority of overhead line (OHL) conductors operate quietly during normal operating conditions. However, in reality, conductors can produce noise under a variety of conditions. The factors that can influence this include operating voltage, conductor surface electrical stress, meteorological conditions and the potential for build-up of surface contaminants. Thus, although clean and dry conductors are considered 'practically quiet', contamination, such as surface damage, dirt or rain droplets, can alter the electrical stress distribution and cause audible noise due to a phenomenon known as corona discharge.

1.1.2 Noise levels and characteristics can differ significantly during dry conditions compared to wet conditions. In dry noise conditions, when there is a build-up of surface contamination, conductors typically produce a broadband 'crackle' at a fairly constant, albeit low, level. In wet conditions, a higher level of noise is produced. Unlike dry noise (which is fairly constant, when it is occurring) wet noise can vary according to the intensity of the rainfall and at rain rates above approximately 1 mm/h hum inception can occur due to water droplets on the conductor surface oscillating. Accordingly, whereas a BS 4142:2014 (Ref 1) methodology comparing the specific noise against the background sound level would suffice for dry noise, the assessment for wet noise must take into account the higher background sound levels resulting from rainfall (which can also vary depending upon the rainfall rates, and are defined in a series of 'Miller Curves' (Ref 2) as well as the character and variable level of noise produced by the conductors.

1.1.3 The National Grid document TR(T)94 (Ref 3) provides a methodology for predicting line noise in both wet and dry conditions. However, the wet noise prediction method calculates a normal distribution curve weighted annual average change in noise level, taking into account typical rainfall rates and durations. The outputs from this model are not, therefore, able to be used directly in a BS 4142 assessment which is based on the difference between the rating level and background sound (as opposed to an annual weighted mean increase in noise). Furthermore, the method is based on the now superseded BS 4142:1990 (Ref 4) and it has therefore been necessary to update the dry noise assessment method in order to take into account changes to the standard.

1.1.4 It has therefore been necessary to adopt a combined approach utilising aspects of both TR(T)94 and BS 4142:2014 in order to undertake the assessment. This technical memorandum describes the methodology that has been used to carry out the prediction and assessment of OHL noise due to the Proposed Development.

1.1.5 In this report all sound pressure levels are referenced to 20 µPa and all sound power levels are referenced to 1 pW.

2 Methodology

2.1 GENERAL APPROACH

2.1.1 The methodology used for predicting and assessing both wet and dry noise from OHL conductors is shown in Image 16.2.3.1 and described in the following sections. (In the figure SPL = sound pressure level and LW = sound power level).

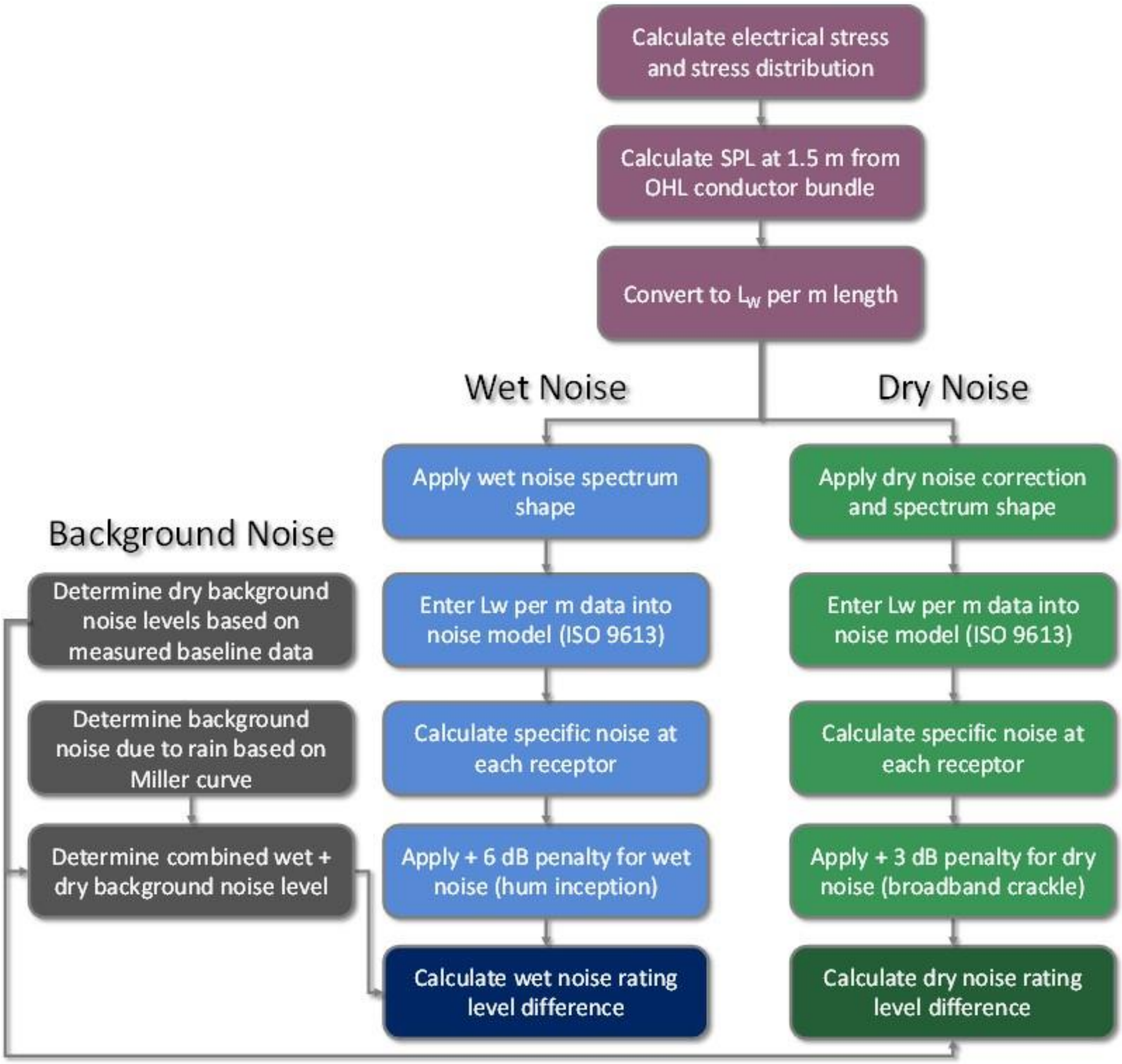

Image 16.2.3.1 Overview of OHL noise prediction and assessment methodology

2.2 OHL CONDUCTOR NOISE PREDICTION

2.2.1 The level of noise emitted by OHL conductors is directly related to the magnitude and distribution of electrical stress on the surface of the conductor, which itself is a function of operating voltage and the geometry and design of the conductor system. The TR(T)94 method is based on empirical electrical stress and measured noise data from in-service twin aluminium steel reinforced conductor (ACSR) (28.6 mm diameter) and twin all aluminium alloy conductor (AAAC) (31.5 mm diameter) systems on a range of lattice pylon types operated at 400,000 volts (400 kV). This data is then extrapolated to calculate noise levels for other conductor sizes.

2.2.2 The first stage of the model is to calculate the electrical stress on the surface of each conductor from the line design geometry and phase voltages. The maximum electric stress, stress distribution factor and conductor diameter are then used as inputs in order to calculate the sound pressure level at 1.5 m from each twin conductor bundle for wet and dry weather conditions. This is then used to calculate the sound power level per unit length of the conductor bundle.

2.2.3 Third octave band spectrum shapes are then applied to the resulting sound power level per metre length of wet and dry noise (for wet noise the prediction is based on a rainfall rate of 1 mm/h). The spectrum shapes are based on measured data for wet noise (with tone inception present) and dry noise (crackle) and are shown in Image 16.2.3.2. These third octave band sound power levels are then used as inputs to the noise model.

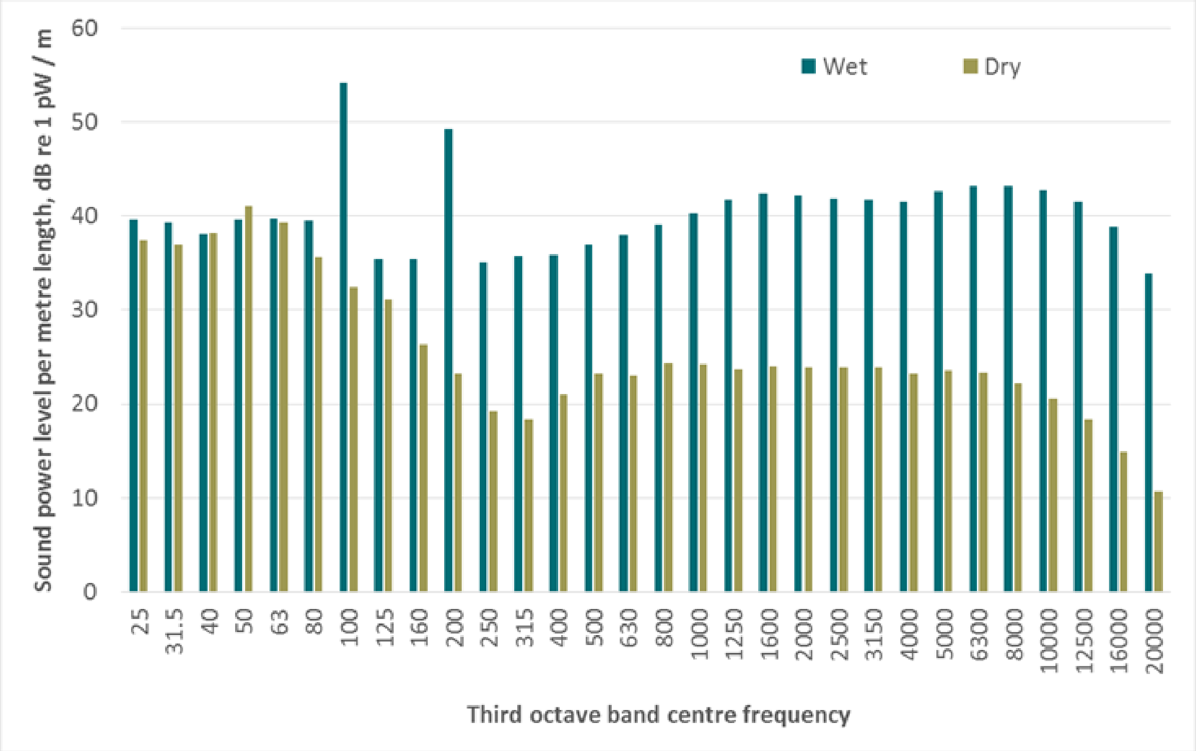

Image 16.2.3.2 Third octave band spectrum shapes for wet and dry noise

2.2.4 The noise emissions have been modelled using SoundPlan environmental noise prediction software. This model calculates the contribution from each noise source input as a specified source type (e.g. point, line, area) octave or third-octave band sound power levels at selected locations. It predicts noise levels under light down-wind conditions based on geometric divergence, atmospheric absorption, ground effects, screening and directivity based on the procedure detailed in ISO 9613-2 (Ref 5).

2.2.5 The ground between the OHL conductors and the receiver locations has been assumed to be soft and terrain contour data has also been entered in the model based on OS land contours. In order to present a worst case assessment, buildings have not been included within the model. Screening effects by buildings have therefore not been accounted for, which represents a worst case assessment.

2.2.6 OHL conductors have been modelled as line sources. The sound levels for the proposed DCO design pylon with twin 41.04 mm diameter conductors that have been used in the model are presented in Table 16.2.3.1. The outputs of this model are based on a predicted maximum conductor surface electrical stress of 13.9 kV/cm.

Table 16.2.3.1 Conductor Noise Source Model Assumptions				
Pylon and Conductor Type	Condition	Position	Distance from Centreline, m	Sound Power Level per m length, dB L_{WA}/m
L12 Twin	Dry	Bottom	7.12	36.3
L12 Twin	Dry	Middle	9.12	36.4
L12 Twin	Dry	Top	6.3	34.2
L12 Twin	Wet	Bottom	7.12	51.9
L12 Twin	Wet	Middle	9.12	52.0
L12 Twin	Wet	Top	6.3	49.8

2.3 APPLICATION OF RATING LEVEL PENALTIES

2.3.1 In general, the noise produced during wet conditions increases with rain rate and tone inception occurs when the rain rate reaches 1 mm/h. In order to undertake a worst-case assessment of wet noise from the overhead line, a rating level penalty of +6 dB has been applied for wet noise in accordance with BS 4142:2014. This is the maximum penalty allowed for tonal noise under the standard.

2.3.2 The dominant characteristic for dry noise can be described as a broadband ‘crackle’ and is therefore not as ‘noticeable’ as wet noise which can sometimes include a tone. In order to provide a worst case assessment for dry noise a +3 dB penalty has been applied for ‘other characteristics’ under BS 4142:2014. This is considered to provide an overly pessimistic assessment because dry noise levels are typically much lower than wet noise and the sound produced is not tonal and more easily masked by the prevailing background noise in the area.

2.4 ASSESSMENT METHODOLOGY AND CRITERIA

2.4.1 The BS 4142:2014 methodology is based on a comparison between the rating level of a sound (i.e. the specific noise level with any penalties added to it to account for character) and the prevailing background sound level. For dry noise, this is a relatively straightforward assessment process and in order to ensure that the predicted impact is robust, the BS 4142:2014 dry noise assessment is carried out relative to measured night-time (i.e. lowest typical) background sound levels.

2.4.2 For wet noise, the background sound level also increases as the rainfall rate increases (due to the sound of rain falling on the ground), meaning that the difference between rating level and background level varies under different rates of rainfall. In order to provide a robust assessment, the wet noise assessment assumes a rate of rainfall sufficient to induce ‘hum’ on the overhead line and also a ground terrain that produces minimal masking due to the sound of rainfall on the ground. The wet background sound is calculated by logarithmically adding the sound produced by rainfall to the dry background sound level.

2.4.3 Miller (1978) conducted a study of rain induced noise, from which he produced five empirical curves (r-1 to r-5) for sound levels due to rainfall on various types of ground cover, ranging from bare, porous ground to fully-leafed trees. The rainfall sound levels used in this assessment are based on the Miller Curve r-2 (see Image 16.2.3.3) which is for: ’*Non-porous, hard, bare ground or pavement; falling raindrops splash on thin layers or puddles of collected water; or in or beside wooded area of deciduous trees without leaves or with only small leaves; or in or beside wooded area of coniferous trees or evergreens having needles rather than leaves; or thin-leafed ground cover or crop, such as hay, clover or grain’.* This is considered to be a robust assessment representing typical rainfall sound levels in the garden of a residential property. It should be noted that rainfall sound levels near more wooded areas (such as forests) will be significantly higher than represented by the r-2 curve, meaning that the assessment will be overly pessimistic.

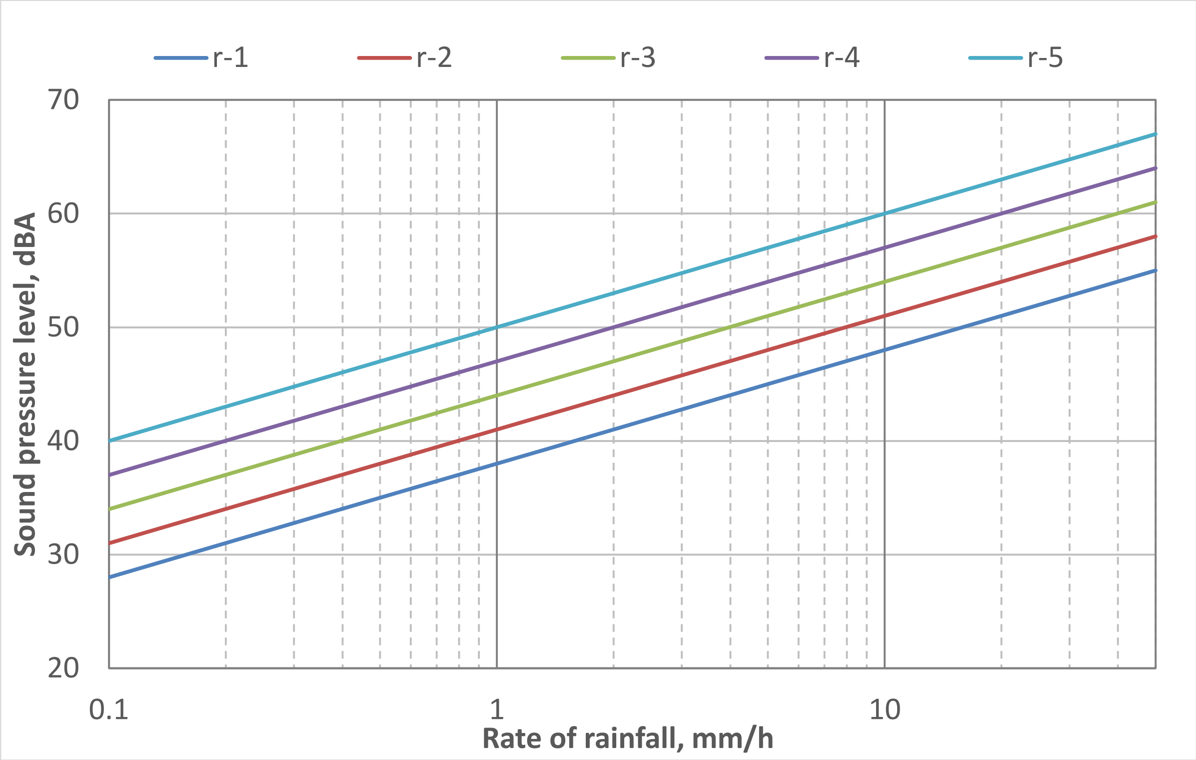

Image 16.2.3.3 Curves for estimating sound levels from rainfall (Miller 1978)

2.4.4 The rating level of the OHL conductor noise and the rating level difference are then assessed in accordance with the criteria outlined in Table 16.2.3.2. It should be noted that the assessment criteria are based on a combination of both the absolute rating level and the rating level difference, both of which include the rating penalties applied for either wet or dry noise. Thus, for example, a high magnitude effect would occur if the rating level was 5 dB or more above the background sound level AND if the rating level was greater than or equal to 35 dB (equating to an absolute sound level of 29 dB(A) for wet noise or 32 dB(A) for dry noise once the rating penalties are taken into account). Conversely, if the rating level difference is more than 5 dB and the rating level is 35 dB or less, then a medium magnitude effect would be deemed to occur.

2.4.5 The assessment criteria adopted for the project are therefore considered to be significantly more stringent than if BS 4142:2014 had been applied rigidly and are based on National Grid’s extensive experience of assessing noise from OHL conductors.

Table 16.2.3.2 OHL Conductor Noise Assessment Criteria	
Magnitude of Impact	Operational Noise
High	Predicted rating levels are 5 dB or more above the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall) and rating levels are greater than or equal to 35 dB
Medium	Predicted rating levels are between 4.9 dB and 0 dB above the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall); or Predicted rating levels are 5 dB or more above the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall) and rating levels are less than 35 dB
Low	Predicted rating levels are between 0.1 dB and 5 dB below the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall)
Very Low	Predicted rating levels are between 5.1 dB and 10 dB below the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall)
No Effect	Predicted rating noise levels are 10.1 dB or more below the existing background sound level (background sound levels for wet noise assessment include sound due to rainfall)

2.4.6 Once the magnitude of impact has been determined, based on the methodology defined in this document, the assessment of significance is then assessed following the methodology defined in section 4 of ES Chapter 16 Operational Noise (**Document 5.16**).

References to Appendix 5.16.2.3

1 British Standards Institution. British Standard 4142:2014. Methods for rating and assessing industrial and commercial sound.

2 Miller, L.N., 1978. Sound Levels of Rain and of Wind in the Trees. Noise Control Engineering, 11(3), pp.101-109.

3 Technical Report TR(T)94, Issue 1, October 1993. A Method for Assessing the Community Response to Overhead Line Noise, National Grid.

4 British Standards Institution. British Standard 4142:1997. Method for Rating industrial noise affecting mixed residential and industrial areas.

5 ISO. International Standard ISO 9613-2:1996. Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation.