# Supplementary Rail Noise Measurements for the Stirling-Alloa-Kincardine Rail Link

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Rail Noise Assessment

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**Appendices**

# Supplementary Rail Noise Measurements for the Stirling-Alloa-Kincardine Rail Link

# 1 Introduction

1.1 AECOM was instructed by Clackmannanshire Council to undertake additional noise measurements to those which were undertaken in January 2009 (detailed in **AECOM Report Job No: 60051518 Reference: M001.001)** to determine whether any of the eligible[1] existing residential properties along the length of the newly constructed section of railway track between Causewayhead, Stirling and Kincardine would qualify in terms of the provisions set out within the Stirling-Alloa-Kincardine (S-A-K) Environmental Statement, 2003[2], in respect of noise insulation. The measurements also served to indicate whether or not any of the properties should have been provided with mitigation against railway noise; the criteria for mitigation was clearly set within the Environmental Statement.

1.2 Additional noise monitoring was requested as engineering works had been undertaken at locations along the railway and it is likely that these works would have affected the noise level measurements that had been undertaken previously.

1.3 Further to a request from Mr A McIver of East Neuk Cottage. Night-time noise levels were predicted in accordance with the World Health Organisation (WHO) Night-Time Noise Guidance (NNG).

1.4 A brief description of the S-A-K works relevant to this assessment is offered in Section 2. The requirements for assessment of both insulation and mitigation in respect of railway noise identified within the Environmental Statement are reproduced in Section 3. The rail noise assessment methodology is presented in Section 4, and the assessment for rail noise is presented in Section 5. Finally a summary and conclusions can be found in Section 6.

1.5 Rail noise measurements were undertaken between Tuesday 16th and Friday 19th February 2010, for a minimum period of 48 hours continuous monitoring. The rail noise measurements were undertaken at 2 residential properties along the rail track. These were: East Neuk Cottage, Causewayhead and 16 Ochil View, Kincardine

1.6 A glossary of acoustical terminology is included as Appendix 1.

1.7 A list of the instrumentation used during the measurement period is included as Appendix 2.

1.8 The detailed site notes taken throughout the measurement period are presented as Appendix 3.

[1] Eligible – (meaning were constructed prior to the passing of the S-A-K Parliamentary Bill
[2] Stirling – Alloa – Kincardine Railway (Route Re-opening) and linked Improvements (Scotland) Bill – Environmental Statement Volumes 1, 2 & 3. – February 2003.

1.9 As detailed in paragraph 1.43 further analysis of night-time noise levels is included as Appendix 4.

# 2 A Brief Description of the Site

2.1 The (S-A-K) rail line comprises of approximately 21km of track between Stirling Station and Longannet Power Station in Kincardine. It provides passenger services from Alloa to Stirling and freight services to Longannet Power Station.

2.2 The re-opening of the rail line involved reconstructing the line between Stirling and Kincardine along its former route and upgrading the existing railway route between Kincardine and Longannet Power Station. The section of the route from Stirling to Alloa has been re-opened to passenger and freight trains, with a new railway station located at Alloa and a freight only connection through to Kincardine and on to Longannet Power Station.

2.3 The rail line passes within the Stirling Council, Clackmannanshire Council and Fife Council areas.

# 3 Criteria for Assessment

3.1 The criteria for assessment are twofold, i.e. in respect of mitigation and insulation. The criterion for mitigation is described in sections 3.2 – 3.3 and the criteria for insulation in section 3.4.

**Mitigation Criteria for Assessment as Identified in the Environmental Statement**

3.2 *"... all properties subject to a facade noise level (due to railway noise) equal to or greater than 55 dB $L_{Aeq,18h}$ (approximately 52 dB $L_{Aeq,18h}$ free-field) and subject to an increase in free-field noise level equal to or greater than 5 dB(A) were considered in need of mitigation"*[3]

*3.3* *"Additionally, the occurrence of $L_{Amax,fast}$ values above 60dB at the facades of residential properties during night-time (23:00 – 07:00) is appropriate for assessing the impact of the railway movements specific to sleep disturbance"*[4].

**Insulation Criteria for Assessment as Identified in the Environmental Statement**

3.4 *"Under certain circumstances, occupiers of dwellings affected by rail traffic noise from a new or additional railway may be entitled to noise insulation treatment (acoustic glazing and acoustic ventilation to habitable rooms) under the Railway Noise Insulation Regulations (Reference 8). These regulations apply in England and Wales but have no equivalent in Scotland. However, legal advice is that the criteria and standards embodied in the regulations can be applied in cases such as this, where no equivalent or alternative is available. The circumstances for entitlement are defined by three conditions which have to be met:*

- *The combined expected maximum rail traffic noise level (i.e. the relevant noise levels from the new or altered railway) must not be less than the specified noise levels (68 dB $L_{Aeq,18h}$ daytime (06:00-24:00) and 63 dB $L_{Aeq,6h}$ night-time (24:00 – 06:00).*
- *The relevant noise level is at least 1.0 dB(A) more than the prevailing noise level.*
- *The contribution to the increase in the relevant noise level from the new or altered railway must be at least 1.0 dB(A).*

3.5 *Noise from the railway shall be assessed at a reception point located 1 metre outward of the external side of a qualifying window. The railway flows to be used in the calculation shall be the noisiest expected traffic flows occurring during the specified day and night-time periods within a period of 15 years after opening the system"* [5].

[3] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 2 – Topic Specific Report, February 2003. P 195

[4] Stirling - Alloa - Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill - Environmental Statement Volume 2 – Topic Specific Report, February 2003. p189

[5] Stirling - Alloa - Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill - Environmental Statement Volume 3 – Supporting Information, February 2003. p138

# 4 Rail Noise Assessment Methodology

4.1 The railway noise was measured and predicted in accordance with the requirements of the Department of Transport *Calculation of Rail Noise (CRN)*[6] publication. These methodologies are used to determine the $L_{Aeq,18hr}$ dB rail noise level for the daytime period (06:00 – 00:00 hours) and the night-time period (00:00 – 06:00 hours).

4.2 The predicted daytime and night-time $L_{Aeq,T}$ noise levels were assessed in accordance with the criteria for assessment identified within the Environmental Statement, as detailed within Section 3.

4.3 Further analysis and calculations of night-time noise levels carried out in accordance with the World Health Organisation (WHO) Night Time Noise Guidance (NNG), i.e $L_{night,outside}$. The methodology used is as set out in the WHO NNG (see Appendix 4).

4.4 The properties selected as monitoring locations were taken to be representative of other properties along the length of the reopened section of the track with a similar relationship to the track in terms of both horizontal and vertical displacement.

[6] The Department of Transport (1995) Cal*culation of Railway Noise (CRN).* HMSO

# 5 Rail Noise Assessment

5.1 A prediction of the rail noise level, at the selected two existing residential properties, identified along the route, has been undertaken in accordance with the methodology detailed in Calculation of Railway Noise, (CRN)[7] using on-site noise level measurement data. During the measurement period the daily numbers of trains passing along the S-A-K line are presented in Table 1.

**Table 1: Train Numbers Passing Existing Properties along S-A-K Line**

| Train Company | Direction | Day 1 | Day 2 | Night 1 | Night 2 |
|---|---|---|---|---|---|
| **Stirling – Alloa (Passenger)** | Eastbound | 20 | 20 | 1 | 2 |
| | Westbound | 21 | 21 | 1 | 1 |
| **Stirling – Kincardine (Freight)** | Eastbound | 5 | 6 | 2 | - |
| | Westbound | 4 | 5 | 1 | 1 |

5.2 Attended on-site train noise level measurements were undertaken between Tuesday 16th February and Friday 19th February 2010 at two selected existing residential properties along the route. Noise level measurements of D.B. Schenker (formerly E.W.S) freight train movements and SPT passenger train movements, where applicable, using sound level meters left in situ at the identified properties. The measurement period was for a minimum of 48 hours. The results of the individual measurement periods are contained within the detailed site notes, presented as Appendix 3. Details of the instrumentation used during the measurement are provided in Appendix 2.

5.3 Furthermore, satellite on-site noise level measurements were undertaken at each of the two properties at varying times throughout the overall measurement period with a sound level meter equipped with an audio recording facility. The purpose of these satellite measurements was to compare with the unattended measurement data results. The results of the additional measurement periods are contained within the detailed site notes, presented as Appendix 3.

5.4 The microphones were positioned at a height of 1.5m above the ground (equivalent to ground floor window height). The sound level meters were placed within 'all weather kit[8]' casings and secured within the rear garden areas of each of the properties being assessed. All measurements were undertaken with the microphone positioned 1m from the facade. Table 2

[7] The Department of Transport (1995) *Calculation of Railway Noise (CRN).* HMSO

[8] 'All weather kit' encompasses a sound level meter with pre-amp secured within a weather-tight plastic case with the microphone on an extension cable attached to a pole and fitted with a windshield

presents information regarding the type and model of each sound level meter and the height of the microphone at each measurement location.

**Table 2: Type and Model of Sound Level Meter and Height of Microphone at Each Monitoring Location**

| Measurement Location | Sound Level Meter Type and Model | Height of Microphone from Ground (m) |
|---|---|---|
| **East Neuk Cottage, Causewayhead** | Rion: NL-32 | 1.5 |
| **16 Ochil View, Kincardine** | Rion: NL-32 | 1.5 |

*NL-32 Class 1 integrated sound level meter with audio recording facility

5.5 At each location the microphone was positioned outside the window of interest, i.e., ground floor living room areas/bedroom area windows, where practicable. At each location the measurement position had direct line of sight of the S-A-K rail track.

5.6 The noise monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards, at each measurement location. There was no shift in the observed calibration on any of the sound level meters.

5.7 The weather conditions, throughout the measurement period were dry with no wind. A breakdown of the environmental conditions recorded at intervals throughout the measurement period, are presented within the detailed site notes within Appendix 3.

5.8 Whilst on site up to 111 train pass-bys were measured at each measurement location, over a 48 hour period, dependent upon the location of the measurement site along the track, Tables 3 and 4 detail the measured noise level associated with the trains using the S-A-K line, at each monitoring location, during the 18 hour daytime period (06:00 – 00:00 hours) and six hour night-time period (00:00 – 06:00 hours), respectively.

5.9 The overall $L_{Aeq(T)}$ train noise level during each of the relevant time periods were calculated using the measured train data, using individual measured SELs. To assess the noise level associated with the total train pass-bys at each location, the individual measured SELs were summed using Equation (1), as detailed below in CRN:

$$L_{Aeq(T)} = 10 \times \log\left[\frac{10^{\left(SEL_1/10\right)} + 10^{\left(SEL_2/10\right)} + \ldots 10^{\left(SEL_n/10\right)}}{T_t}\right] \quad (1)$$

(where: the $SEL_n$ is the $n^{th}$ measured single event level for a given train type and $T_t$ is the total time in seconds of the $L_{Aeq(T)}$ to be determined)

5.10 Furthermore, the remaining measured noise levels during the measurement period, with the train pass-bys extracted, is deemed to be representative of the background noise level ($L_{Aeq,T}$)

within the area. The predicted ambient noise level is the total measured train noise level combined with the measured background noise level, with the train line in operation, see Tables 3 and 4.

**Table 3: Measured Daytime Noise Levels at Existing Residential Properties along the S-A-K Route, with Rail Line in Operation**

| Measurement Period on 17/02/10 between 06:00 – 00:00 hours (18 hour Daytime Period) | | | | | |
|---|---|---|---|---|---|
| **Property** | **Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Background Noise Level $L_{Aeq,18hr}$ (dB)** | **Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)** |
| **East Neuk Cottage, Causewayhead** | 61.3 | 57.6 | 58.8 | 63.8 | 65.7 |
| **16 Ochil View, Kincardine** | 53.8 | 53.8 | - | 50.7 | 55.5 |
| **Measurement Period on 18/02/10 between 06:00 – 00:00 hours (18 hour Daytime Period)** | | | | | |
| **Property** | **Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)** | **Measured Background Noise Level $L_{Aeq,18hr}$ (dB)** | **Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)** |
| **East Neuk Cottage, Causewayhead** | 60.9 | 58.2 | 57.5 | 62.6 | 64.8 |
| **16 Ochil View, Kincardine** | 55.3 | 55.3 | - | 50.7 | 56.6 |

**Table 4: Measured Night-time Noise Levels at Existing Residential Properties along the S-A-K Route, with Rail Line in Operation**

| Measurement Period on 17/02/10 Between 00:00 – 06:00 Hours (6 Hour Night-time Period) | | | | | |
|---|---|---|---|---|---|
| **Property** | **Total Measured Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Freight Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Passenger Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Background Noise Level $L_{Aeq,6hr}$ (dB)** | **Predicted Ambient Noise Level $L_{Aeq,6hr}$ (dB)** |
| **East Neuk Cottage, Causewayhead** | 57.3 | 56.9 | 47.5 | 54.6 | 59.2 |
| **16 Ochil View, Kincardine** | 54.6 | 54.6 | - | 44.9 | 55.1 |
| **Measurement Period on 18/02/10 Between 00:00 – 06:00 Hours (6 Hour Night-time Period)** | | | | | |
| **Property** | **Total Measured Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Freight Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Passenger Train Noise Level $L_{Aeq,6hr}$ (dB)** | **Measured Background Noise Level $L_{Aeq,6hr}$ (dB)** | **Predicted Ambient Noise Level $L_{Aeq,6hr}$ (dB)** |
| **East Neuk Cottage, Causewayhead** | 54.9 | 52.3 | 51.4 | 54.1 | 57.5 |
| **16 Ochil View, Kincardine** | 49.4 | 49.4 | - | 42.5 | 50.2 |

5.11 The threshold for mitigation as outlined within the ES[9] states that "*These results were used to assess the need for mitigation in the form of lineside barriers. Applying the methodology discussed previously, all properties subject to a facade noise level (due to railway noise) equal to or greater than 55 dB $L_{Aeq,18h}$ (approximately 52 dB $L_{Aeq,18h}$ free-field) and subject to an*

[9] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 2 – Topic Specific Report February 2003. P 195

*increase in free-field noise level equal to or greater than 5 dB(A) were considered in need of mitigation*". It is therefore assumed that the threshold for mitigation is simply a predicted railway facade level of 55dB or more and an increase of 5dB or more in the ambient noise level. It should be noted that this criteria is for daytime noise levels only, as at the time of publication of the ES it was stated "*Indication is that there would be no timetabled railway movements at all in the period 24.00-06.00*"[10].

5.12 At **16 Ochil View, Kincardine** the predicted daytime ambient noise levels, with the S-A-K line in operation were $L_{Aeq,18hr}$ 55.5 and $L_{Aeq,18hr}$ 56.6, on the 17th and 18th February, respectively. Consequently these ambient noise levels are 4.8dB(A) and 5.9dB(A) above the measured background noise level of $L_{Aeq,18hr}$ 50.7 on both the 17th and 18th February. Therefore, taking the average of the two daytime railway noise levels as being representative of a typical $L_{Aeq,18hr}$ train pass-by noise level at this property, **16 Ochil View, falls within the criteria for rail noise mitigation for daytime noise levels**, as defined within the ES.

5.13 As for **East Neuk Cottage, Causewayhead**, although the $L_{Aeq,18hr}$ 55dB train noise level is exceeded, the existing background noise level is such that there is not a 5dB difference between the train noise level and the background noise level. Hence, in accordance with the ES mitigation criteria, **this property is not eligible for mitigation in respect of daytime noise.**

5.14 The criterion for eligibility in terms of noise insulation was set out in section 3.4 of this report.

5.15 Although, throughout the ES, it is stated that there is to be no timetabled night-time railway movements, i.e., between the hours of 24:00 and 06:00 hours, it is also stated in Volume 2, p189 "*Additionally, the occurrence of $L_{Amax,fast}$ values above 60dB at the facades of residential properties during night-time (23:00-07:00) is appropriate for assessing the impact of the railway movements specific to sleep disturbance*"[11]. However, no information in relation to the qualifying number of occurrences of this maximum level was provided within the ES. To assess the significance of impact for the night-time period it is essential that the number of events which exceed the suggested trigger level of 60 dB $L_{Amax,fast}$ is also included within this criteria. The level of 60 dB $L_{Amax,fast}$ is derived from World Health Organisation (WHO) Guidelines for Community Noise precautionary guideline value of 45dB $L_{Amax,fast}$ inside a bedroom with the windows open. In respect of this precautionary guideline value the WHO advises that indoor sound pressure levels in bedrooms should not exceed approximately 45 dB $L_{Amax,fast}$ more than 10 – 15 times per night. To avoid the situation whereby all 10-15 events occur within the same hour and being deemed acceptable because they do not occur throughout the night-time period, it is advisable to assume not more than 2 events in any one hour period throughout the night-time duration to avoid sleep disturbance.

5.16 The basis of the assessment of potential night-time noise disturbance referred in the ES is the absolute maximum levels referred to within the World Health Organisation (WHO) document

[10] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 3 – Supporting Information, February 2003 p 167

[11] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 2 – Topic Specific Report, February 2003. P 189

entitled Guidelines for Community Noise. However, it has been explained that the WHO guidelines can be interpreted as providing a conservative and precautionary approach to noise impact assessment. This is because they represent noise levels at which it is possible to start detecting effects and below which effects can be assumed to be negligible, and values exceeding the recommended noise levels are not necessarily indicative of significant adverse impacts. Furthermore, there is no evidence that anything other than a small minority of the population exposed to noise at the WHO guideline noise levels find them to be particularly onerous in the context of their daily lives.

5.17 The internal levels of 45 dB $L_{Amax,fast}$ is based on an external level of 60 dB $L_{Amax,fast}$ and a reduction of 15 dB(A) for a partially open window. Whether the assessment should be made with the window open or closed is also an issue for consideration.

5.18 However, laudable this precautionary approach may be the appropriate night time maximum noise levels and the provision of mitigation has previously been addressed by the Scottish Parliament in respect of the following schemes: Edinburgh Tram Lines, Glasgow Airport Rail Link (GARL) and Edinburgh Airport Rail Link (EARL). Both the Edinburgh Tram Line and EARL noise and vibration policies clearly state that the maximum level which should not be exceeded more than twice in any one hour is in fact 82 dB $L_{Amax,fast}$.

5.19 The justification for the use of 82 dB $L_{Amax,fast}$ previously adopted by the Scottish Parliament in relation to maximum level of noise from train pass-bys is based on the fact that sleep disturbance from noise is a complex subject and one over which there is some debate. The subject has been reviewed by various authorities. The most relevant review was carried out at the request of the UK government by a Committee led by Dr. CGB Mitchell in 1990-1991. The Committee's remit was to provide the then Secretary of State for Transport with recommendations for national noise standards for noise insulation for new railways which equitably relate to the standard set by regulations for new highways. The Committee comprised 8 leading experts in transportation noise. Over the course of a year the Committee reviewed scientific evidence on transportation noise from the UK and abroad, considering contributions from 52 local authorities and 30 consultants, operators and professional bodies, and produced its report "Railway Noise and the Insulation of Dwellings", ("Mitchell Report"). The Mitchell Reports concludes that 'Noise from railways causes less disturbance to sleep than does noise from roads. The noise differential in favour of rail for equal sleep disturbance is at least 5 dB(A). Studies have tentatively suggested to avoid sleep disturbance the facade noise level from railways should be no more than 60 dB(A) $L_{Aeq,T}$ and the maximum noise level should be no more than 85 dB(A) $L_{Amax}$, with the additional proviso that there should be no more than 20 'noise events' per night.

5.20 The Department for Transport did not include an $L_{Amax}$ limit in the 1996 Insulation Regulations, but the $L_{Amax}$ limit recommended in the Mitchell Report to avoid sleep disturbance remains (i.e. 85dB at facade level, which is 82dB away from the facade in the free-field – at least 3.5m away from hard reflecting surfaces apart from the ground).

5.21 However, the criterion adopted by GARL was different in that it was 70dB $L_{Amax}$ (Paisley to Airport). The lower level was adopted on the basis that the trains were moving at slow speed as a consequence of track alignment.

5.22 In view of the above it would appear appropriate to adopt a level of 82 dB $L_{Amax,fast\ (free\ field)}$ not being exceeded more than twice in any one hour period during night-time hours as a threshold for consideration of mitigation measures. It should also be noted that in considering the appropriateness of mitigation measures cognisance must be taken of acceptable standards in terms of traffic, safety, environmental and economic issues.

5.23 Taking the measured $L_{Amax,slow}$ dB values of each individual train pass-by, measured at 1m from the facade at each location, and calculating the percentage of train pass-bys resulting in a noise level greater than $L_{Amax,slow}$ 60dB it can be seen in Table 5 that 100% of the measured train pass-bys exceed this value at both sample receptors. Accordingly the associated $L_{Amax,fast}$ noise level of each train pass-by will also exceed the $L_{Amax,fast}$ 60dB criterion quoted within the ES at all measured properties. It is important to restate that the ES did not qualify the $L_{Amax}$ criteria in terms of the number of occurrences that may occur in a given time period and even if an absolute level of 60 dB $L_{Amax,fast}$ was considered an appropriate threshold it is also vital to take account of the number of occurrences when considering possible sleep disturbance (see section 2 5.17-5.24).

**Table 5: Adjusted* Night-time $L_{Amax}$, Noise Levels**

| Train Passes | East Neuk Cottage | 16 Ochil View |
|---|---|---|
| **1** | 83.9 (P) | 79.8 (F) |
| **2** | 82.6 (P) | 84.1 (F) |
| **3** | 88.2 (F) | 77.7 (F) |
| **4** | 84.6 (F) | 80.1 (F) |
| **5** | 91.0 (F) | **Freight Trains Only** |
| **6** | 87.5 (P) | |
| **7** | 86.4 (P) | |
| **8** | 84.2(F) | |
| **9** | 84.7 (P) | |
| **Average (Measured) $L_{Amax.slow}$ (dB)** | **82.9** | **77.4** |
| **Calculated $L_{Amax,fast}$ (dB)** | **85.7** | **80.2** |

5.24 The average calculated $L_{Amax,fast}$ values, as shown in Table 5, indicate that the 82 dB $\boldsymbol{L_{Amax,fast}}$ threshold is likely to be exceeded at East Neuk Cottage.

5.25 In the ES forty-eight properties are identified as requiring possible mitigation in respect of daytime operations, with the S-A-K line operational. Of the 2 additional properties for which measurements have been undertaken, as stated within Section 5.12 – 5.14 of this report, only 1 property has been identified as requiring possible mitigation in respect of daytime operations,

with the S-A-K line operational. Details of the 48 properties stated in the ES as requiring possible mitigation are not given in the ES, so it is not possible to correlate the ES properties with the properties identified in both this supplementary report and the earlier noise monitoring report (**AECOM Report Job No: 60051518 Reference: M001.001)** as meeting the mitigation criteria.

5.26 However, Tables 6.61 – 6.64, Volume 3 (supporting Information) of the ES[12] presents the predicted ($L_{Aeq,18hr}$ dB) facade noise levels, for operation of the railway with no mitigation. The one representative property within these tables that corresponds with properties in this supplementary noise monitoring report is 16 Ochil View, Kincardine. For comparison purposes only, Table 6 presents the difference between the predicted daytime noise levels (Scott Wilson) and the measured daytime noise levels (AECOM) at existing properties.

**Table 6: The Difference Between the Predicted Daytime Noise Levels (Scott Wilson) and the Measured Daytime Noise Levels (AECOM)**

| Location | Predicted Daytime $L_{Aeq,18hr}$ dB (facade) 06:00 – 24:00 | | Measured Ambient Daytime $L_{Aeq,18hr}$ dB (facade) 06:00 – 24:00 | | Difference Between Predicted and Measured Ambient Noise Levels (dB) | |
|---|---|---|---|---|---|---|
| | Floor Level | | Floor Level | | Floor Level | |
| | Ground | First | Ground | First | Ground | First |
| 16 Ochil View, Kincardine | 59.6 | 59.4 | 56.6 | - | 3.0 | - |

5.27 From Table 6 it can be seen that there is a 3.0dB difference between the predicted daytime noise levels and measured daytime noise levels at the existing properties.

5.28 From the initial results of the measured noise levels, with the S-A-K line in operation, it would appear that the predicted results of the ES erred on the side of caution in respect of the noise levels at existing properties and therefore an overestimation of the number of properties that may qualify for mitigation in relation to the re-opening of the S-A-K rail line is likely to have occurred.

[12] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 3 – Supporting Information, February 2003. P 172 - 174

# 6 Conclusions

6.1 AECOM was instructed by Clackmannanshire Council to undertake additional noise measurements to those which were undertaken in January 2009 and detailed in **AECOM Report Job No: 60051518 Reference: M001.001** to determine whether any of the eligible[13] existing residential properties along the length of the newly construction section of railway track between Causewayhead, Stirling and Kincardine would qualify in terms of the provisions set out within the S-A-K Environmental Statement, 2003[14], in respect of noise insulation.

6.2 The criteria for assessment are twofold, i.e. in respect of mitigation and insulation. The criterion for mitigation is described in Sections 3.2 – 3.3 and the criteria for insulation 3.4.

6.3 The two additional properties where noise monitoring has occurred are East Neuk Cottage, Causewayhead and 16 Ochil View, Kincardine.

6.4 Attended on-site train noise level measurements were undertaken between Tuesday 17th February and Friday 19th February 2010 at two selected existing residential properties along the route. At each location the microphone was positioned outside the window of interest, ground floor living room areas/bedroom area windows, where practicable.

6.5 From the measured results presented within Table 3 it can be clearly seen that of the two additional monitoring locations only the property at 16 Ochil View, Kincardine meets with the ES daytime criterion for possible rail noise mitigation. At this existing residence the predicted ambient noise levels, at a distance of 1m from the facade of the property is greater than $L_{Aeq,18hr}$ 55.0 dB and also subject to an increase in free-field noise level of 5 dB or more.

6.6 From Tables 3 and 4 it is evident that none of the existing properties qualify for sound insulation treatment in accordance with the adopted criteria[15].

6.7 From Table 6 it can be seen that there is a difference between the predicted daytime noise levels in the ES and actual measured daytime noise levels at the existing properties. The ES predicted that forty-eight of the existing properties may qualify for mitigation in the form of barriers, and that four properties may qualify for insulation as per the criteria set out within the ES.

6.8 From the results of the measured noise levels, with the S-A-K line in operation, it would appear that the predicted results of the ES erred on the side of caution in respect of the noise levels at existing properties and therefore an overestimation of the number of properties that may qualify

[13] Eligible – (meaning were constructed prior to the passing of the S-A-K Parliamentary Bill)
[14] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volumes 1,2 & 3. – February 2003.
[15] Stirling – Alloa Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 3 – Supporting Information, February 2003. P 138

for mitigation and/or insulation in relation to the re-opening of the S-A-K rail line is likely to have occurred.

6.9 The appropriate criteria for the assessment of night-time noise is considered in Section 5. The measured night-time noise levels in terms of $L_{Amax,slow}$ dB of each individual train pass-by, was measured at 1m from the facade at each location. The percentage of train pass-bys resulting in a noise level greater than $L_{Amax,slow}$ 60 dB was then calculated and it can be seen in Table 5 that 100% of the measured train pass-bys exceed this value at all sample receptors. Accordingly the associated $L_{Amax,fast}$ noise level of each train pass-by will also exceed the $L_{Amax,fast}$ 60 dB criterion quoted within the ES at all properties. It is important to note that the ES did not qualify the $L_{Amax}$ criteria in terms of the number of occurrences. It is vital to take account of the number of occurrences when considering sleep disturbance.

6.10 If the assessment of night-time noise and the provision of mitigation is considered on the same basis as has previously been addressed by the Scottish Parliament in respect of the: Edinburgh Tram Lines Glasgow Airport Rail Link (GARL) and Edinburgh Airport Rail Link (EARL) i.e. both that the maximum level which should not be exceeded more than twice in one hour is in fact 82 dB $L_{Amax,fast}$. On this basis the night-time threshold value is likely to be exceeded at **East Neuk Cottage only** but, at present, we are advised that there is no evidence to suggest that the number of occurrences are being exceeded, **therefore it does not qualify for mitigation.**

# Appendix 1 – Glossary of Acoustical Terminology

**Ambient Noise**

Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

**"A" Weighting (dB(A))**

The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear. It is used in the assessment of risk of damage of hearing due to noise.

**Decibel (dB)**

The range of audible sound pressures is approximately $2 \times 10^{-5}$ Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0dB to 140dB.
Mathematically:

Sound Pressure Level (dB) = $20 \log \{p(t)/P_o\}$
Where $P_o = 2 \times 10^{-5}$ Pa

**Frequency (Hz)**

The number of cycles per second, for sound this is subjectively perceived as pitch

**Frequency Spectrum**

Analysis of the relative contributions of different frequencies that make up a noise.

$L_{A10,T}$

The A-weighted sound pressure level of the residual noise in decibels exceeded for 10% for a given time interval. This is the parameter defined by the government to describe road traffic noise.

$L_{Aeq,T}$

Equivalent Continuous A-weighted Sound Pressure Level. The value of the A-weighted sound pressure level in decibels of continuous steady sound within a specified time interval, T, has the same mean-square sound pressure as a sound that varies with time. It is quoted to the nearest whole number of decibels.

**Noise**

Unwanted sound

$L_{Amax,fast}$

The maximum RMS A-weighted sound pressure level occurring within a specified time period. Fast time weighting indicates sound pressure level measurements undertaken using a 125-millisecond moving average time weighting period.

$L_{Amax,slow}$

The maximum RMS A-weighted sound pressure level occurring within a specified time period. Slow time weighting indicates sound pressure level measurements undertaken using a 1.0 second moving average time weighting period.

# Appendix 2 – Instrumentation Used

Bruel & Kjaer Hand Held Analyser Type 2250
Serial Number 2507254

Bruel & Kjaer Microphone Type 4189
Serial Number 2542984

Bruel & Kjaer Sound Analysis Software BZ 5503

Bruel & Kjaer Sound Level Calibrator Type 4231
Serial Number 2545421

**Rion NL-32 Class 1 Sound Level Meter**

| | |
|---|---|
| Sound Level Meter: Serial No: | 00282521 |
| Microphone Model UC-53A: | 313883 |
| Pre-Amp NH-21 | 267720 |
| | |
| Sound Level Meter: Serial No: | 00682724 |
| Microphone Model UC-53A: | 314631 |
| Pre-Amp NH-21 | 28032 |

**Rion NC-74 Class 1 Acoustic Calibrator**

| | |
|---|---|
| NC-74 Calibrator: | 35051996 |

# Appendix 3 – Detailed Site Notes

**Location 1: East Neuk Cottage, Ladysneuk Road, Causewayhead**

The measurement position was located 1m from the northern facing facade, within the rear garden area of the property. This position in turn was approximately 7m south of the nearside edge of the rail link as shown in Figure 1.2. The Rion NI-32 sound level meter was secured within a weatherproof box with the microphone positioned 1.5m above the ground at ground floor window height, see Figure 1.1. The monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards. There was no shift in the observed calibration level. This sound level meter was secured at the property and left continuously logging, with an audio recording event trigger set, throughout the measurement period.

The dominant noise of this location, at the time of measurement, was continuous road traffic noise associated with the A907. Also present was occasional birdsong and intermittent dog barking.

The Bruel & Kjaer 2250 sound level meter was secured to a tripod with the microphone 1.5m above the ground, adjacent to the Rion NL-32 sound level meter. The monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards. There was no shift in the observed calibration level. Continuous noise level measurements were undertaken with the Bruel & Kjaer 2250 at East Neuk, Causewayhead.

**Measured Results: East Neuk Cottage, Ladysneuk Road, Causewayhead**

| Period | Date | Start Time (hh:mm) | Duration (hh:mm) | Noise Level (dB) | | | Weather | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $L_{Aeq,T}$ | $L_{A10}$ | $L_{A90}$ | Wind Speed ($ms^{-1}$) & Direction | Conditions | |
| **Rion NL-32 Sound Level Meter** | | | | | | | | | |
| **Weekday 18hr (position 1)** | 17/02/10 | 06:00 | 18:00 | 65.7 | - | - | Calm | Dry, clear skies 2°C | Constant road traffic noise from A907, birdsong |
| **Weekday 18hr (position 1)** | 18/02/10 | 06:00 | 18:00 | 64.8 | - | - | Calm | Dry, clear skies 3°C | Constant road traffic noise from A907, birdsong |
| **Brüel & Kjær 2250 Sound Level Meter** | | | | | | | | | |
| **Weekday DAY** | 17/02/10 | 10:35 | 1:41 | 63.3 | 65.9 | 53.5 | Calm | Dry, clear skies 2°C | Constant road traffic noise from A907, birdsong |
| **Weekday DAY** | 17/02/10 | 12:17 | 00:55 | 65.5 | 65.9 | 52.6 | Calm | Dry, clear skies 2°C | Constant road traffic noise from A907, birdsong |
| **Weekday DAY** | 18/02/10 | 14:19 | 1:30 | 64.2 | 65.8 | 52.4 | Calm | Dry, clear skies 3°C | Constant road traffic noise from A907, birdsong |
| **Weekday DAY** | 18/02/10 | 15:51 | 1:23 | 63.9 | 66.2 | 54.8 | Calm | Dry, clear skies 3°C | Constant road traffic noise from A907, birdsong |
| **Weekday EVE** | 18/02/10 | 17:18 | 1:20 | 64.5 | 66.9 | 54.5 | Calm | Dry, clear skies 3°C | Constant road traffic noise from A907, birdsong |

*- Not measured

**Further Breakdown of Rion Measurements**

| Period | Date | Train Noise | | Background Noise | Number of Trains | |
|---|---|---|---|---|---|---|
| | | Passenger | Freight | | Passenger | Freight |
| **Weekday 18hr** | **17/02/10** | 58.8 | 57.6 | 63.8 | 41 | 9 |
| **Weekday 18hr** | **18/02/10** | 57.5 | 58.2 | 62.6 | 41 | 12 |

**Figure 1.1: Rion NL-32 Sound Level Meter at Measurement Position, East Neuk Cottage, Ladysneuk Road, Causewayhead.**

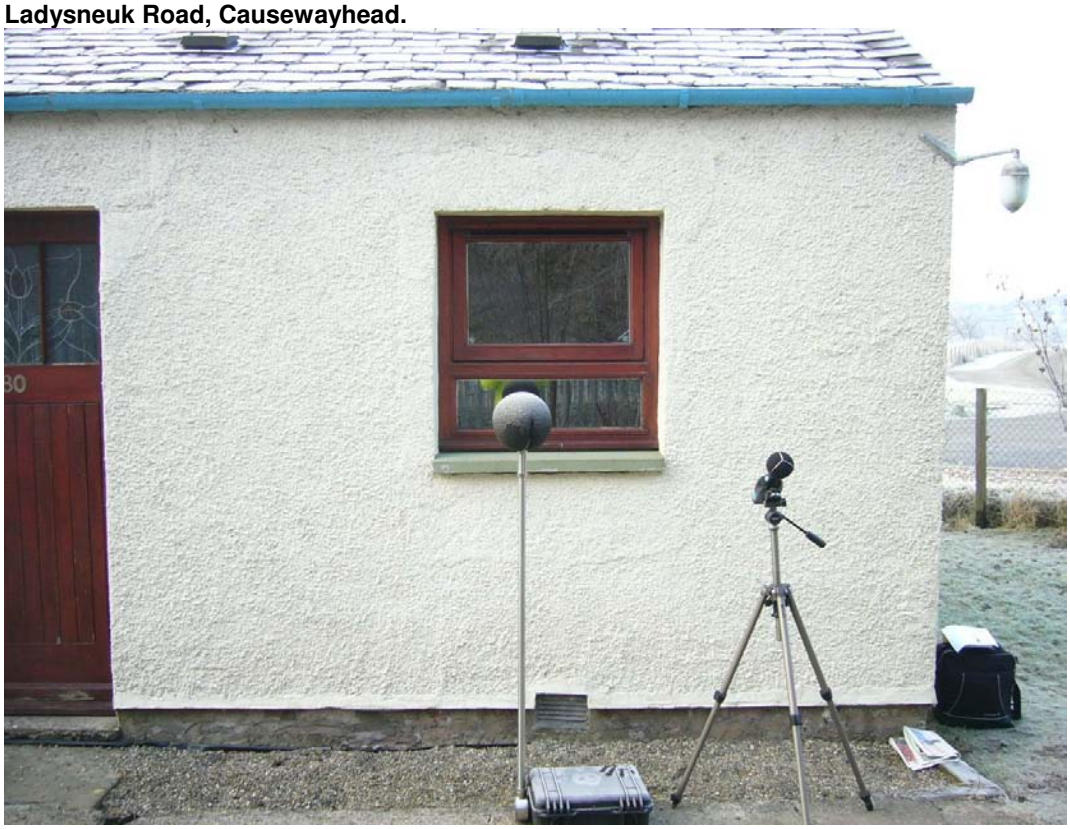
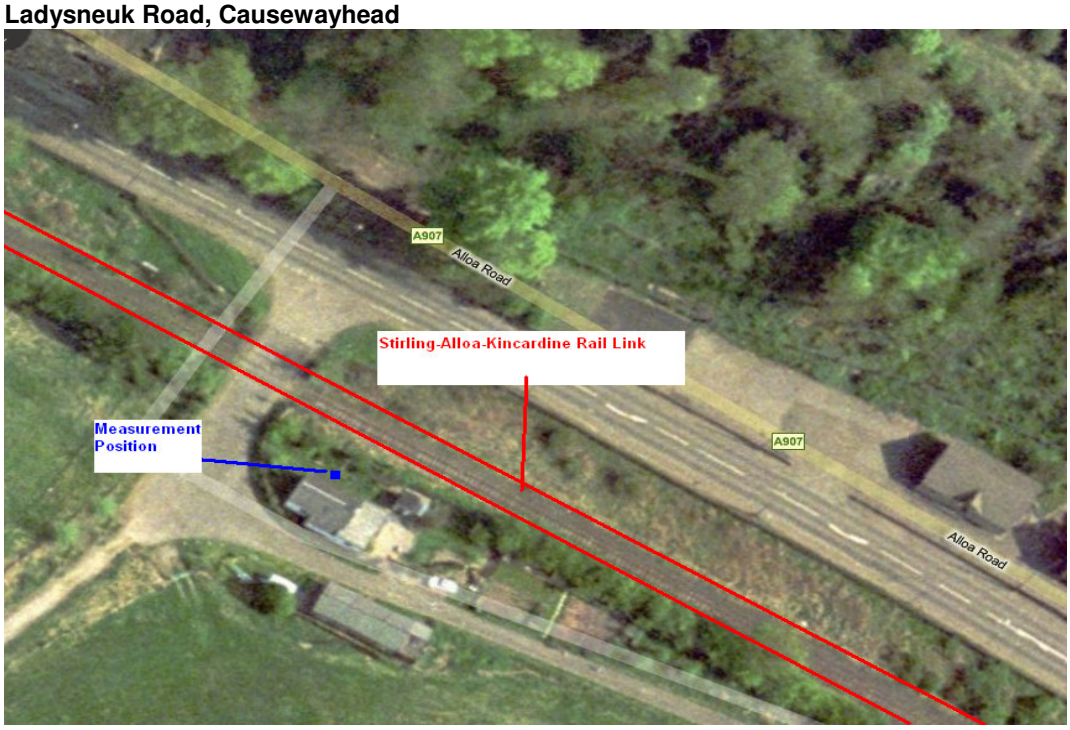


**Figure 1.2: Site Location and Approximate Measurement Positions, East Neuk Cottage, Ladysneuk Road, Causewayhead**



**Location 2: 16 Ochil View, Kincardine**

The measurement position was located 1m from the southern facing facade, within the rear garden area of the property. This position was approximately 7m from the east of the nearside edge of the rail link as shown in Figure 2.2. The Rion Nl-32 sound level meter was secured within a weatherproof box with the microphone positioned 1.5m above the ground at ground floor window height, see Figure 2.1. The monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards. There was no shift in the observed calibration level. This sound level meter was secured at the property and left continuously logging, with an audio recording event trigger set, throughout the measurement period.

The dominant noise of this location, at the time of measurement, was distant road traffic noise associated with the A876 Kincardine Bridge to the South of the property and the Clackmannan Bridge, passing to the west of the property. Also present was birdsong and occasional noise from pedestrians using the level crossing.

The monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards. There was no shift in the observed calibration level. Noise level measurements of train pass-bys were undertaken with the B&K 2250 at 16 Ochil View, throughout the measurement procedure.

**Measured Results: 16 Ochil View, Kincardine**

| Period | Date | Start Time (hh:mm) | Duration (hh:mm) | Noise Level (dB) | | | Weather | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $L_{Aeq,T}$ | $L_{A10}$ | $L_{A90}$ | Wind Speed ($ms^{-1}$) & Direction | Conditions | |
| **Rion NL-32 Sound Level Meter** | | | | | | | | | |
| **Weekday 18hr (position 1)** | 17/02/10 | 06:00 | 18:00 | 55.5 | - | - | Calm | Dry, clear skies 2°C | V. distant road traffic (Kincardine Bridge), birdsong, occasional pedestrian at level crossing |
| **Weekday 18hr (position 1)** | 18/02/10 | 06:00 | 18:00 | 56.6 | - | - | Calm | Dry, clear skies 3°C | V. distant road traffic (Kincardine Bridge), birdsong, occasional pedestrian at level crossing |
| **Brüel & Kjær 2250 Sound Level Meter** | | | | | | | | | |
| **Weekday DAY** | 17/02/10 | 14:41 | 00:01 | 71.1 | 75.1 | 49.7 | Calm | Dry, clear skies 2°C | 19 Carriage Freightliner Westbound |
| **Weekday DAY** | 17/02/10 | 16:44 | 00:01 | 74.3 | 77.1 | 50.3 | Calm | Dry, clear skies 2°C | 23 Carriage EWS Westbound |
| **Weekday DAY** | 18/02/10 | 11:20 | 00:01 | 71.2 | 47.9 | 52.0 | Calm | Dry, clear skies 3°C | 21 Carriage Freightliner Eastbound |
| **Weekday DAY** | 18/02/10 | 11:34 | 00:01 | 75.8 | 78.5 | 49.2 | Calm | Dry, clear skies 3°C | 23 Carriage EWS Westbound |
| **Weekday DAY** | 18/02/10 | 13:13 | 00:01 | 75.5 | 78.5 | 49.9 | Calm | Dry, clear skies 3°C | 23 Carriage EWS Eastbound |

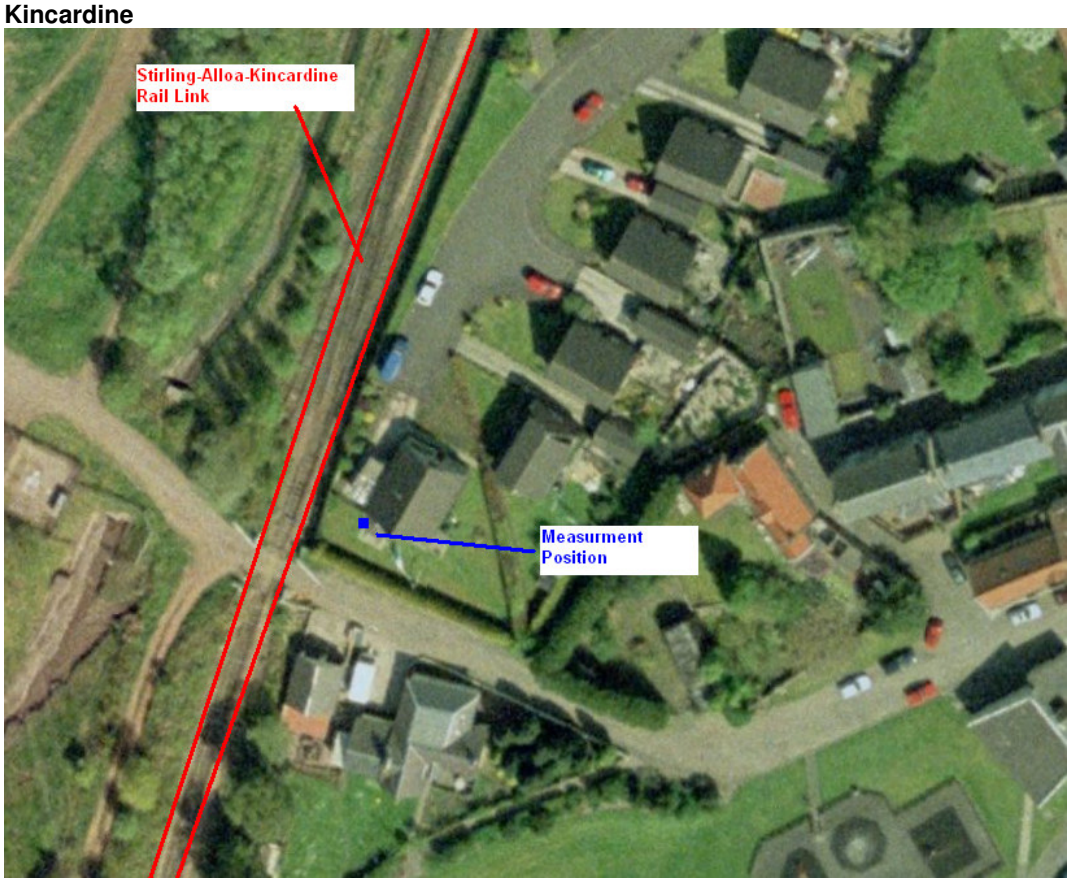
*- Not measured

**Further Breakdown of Rion Measurements**

| Period | Date | Train Noise | | Background Noise | Number of Trains | |
|---|---|---|---|---|---|---|
| | | Passenger | Freight | | Passenger | Freight |
| **Weekday 18hr** | **17/02/10** | **-** | 53.8 | 50.7 | **-** | 9 |
| **Weekday 18hr** | **18/02/10** | **-** | 55.3 | 50.7 | **-** | 11 |

**Figure 2.1: Rion NL-32 Sound Level Meter at Measurement Position, 16 Ochil View, Kincardine**

**Figure 2.2: Site Location and Approximate Measurement Position, 16 Ochil View, Kincardine**



# Appendix 4 – Further Analysis of Night-time Noise Levels

Following requests for further analysis of night-time noise levels and with specific reference to the recently published World Health Organisation (WHO) Night Time Noise Guidance (NNG) AECOM can advise as follows.

First of all it is important to view the WHO NNG in perspective. The foreword of the document states that "*the European Union tackled the problem of environmental noise with an international law on the assessment and management of environmental noise. The WHO Regional Office for Europe developed the Night Noise Guidelines for Europe to provide expertise and scientific advice to the Member States in developing future legislations in the area of night noise exposure control and surveillance, with the support of the European Commission. This guideline document reviews the health effects of night time noise exposure, examines exposure-effects relations, and presents guideline values of night noise exposure to prevent harmful effects of night noise in Europe. Although these guidelines are neither standards nor legally binding criteria, they are designed to offer guidance in reducing the health impacts of night noise based on expert evaluation of scientific evidence in Europe*."

It is important to appreciate that the guideline values aim to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly. In protecting such groups the NNG refers to an external night-time noise target of $L_{night,outside}$ of 40dB, which is a free field noise level, determined 1m from the nosiest facade of the noise sensitive property. However, in recognising the precautionary nature of such a target a $L_{night,outside}$ value of 55dB is recommended as an interim target for the countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers chose to adopt a stepwise approach.

It is understandable that some may find the actual noise metrics confusing. The original Stirling-Alloa-Kincardine (SAK) Environmental Statement (ES) and, indeed, the subsequent Environmental Noise Assessment report dated 26th May 2009 considered the night-time threshold for possible mitigation in terms of the maximum noise levels ($L_{Amax}$). This was because the $L_{Amax}$ is/was the standard noise metric used in the UK for assessing the potential for sleep disturbance at night. Moreover, it should be appreciated that the aforementioned noise assessments were undertaken prior to the publication of the NNG. However, the NNG does provide guidance on converting between noise metrics.

The metrics used in the WHO NNG we can advise that the $L_{night}$ is defined as the 1 year $L_{Aeq}$ (exposure to noise) covering an 8 hour period outside the most exposed facade. For the purpose of strategic noise mapping and reporting the height is fixed at 4 metres. As $L_{night}$ is a relatively new definition and because the studies rarely cover such a long period, the research data are rarely expressed in $L_{night}$. The most frequently used noise descriptor in sleep research is the $L_{Amax}$ or SEL (Sound Exposure Level) near the sleeper. This means that a considerable amount of conversion work needs to be done if relations are to be expressed in $L_{night}$. There are four issues to be considered in relating the levels in the aforementioned SAK reports to the WHO NNG levels, and these are as follows:

- Conversion between SEL and $L_{Amax}$
- Conversion from instantaneous to long- term
- Conversion from inside to outside
- Conversion from (outside) bedroom level to most exposed facade.

According to the WHO NNG the $L_{Amax}$ can be converted to a SEL using Equation 2 below

$$SEL \approx L_{Amax} + 10 \times \log_{10}(t) \qquad \text{Equation (2)}$$

where t (in seconds) is the duration of the noise event, i.e., individual pass by. In accordance with the NNG, this formula can be used "*for a long freight train that passes at a short distance*" from a noise sensitive receiver.

Then, assuming that there are N events all with approximately the same SEL level, the $L_{night}$ value can be predicted using the following formula:

$$L_{night} = SEL + 10 \times \log_{10}(N) - 70.2 \qquad \text{Equation (3)}$$

in which:
N = the number of events occurring in period T;
T = time during which the events occur in seconds. For a (night) year 10lg(T) is 70.2

It can be seen from Table 1 that during the measurement periods of Tuesday 16th February and Wednesday 17th February 2010 the maximum number of train pass-bys at East Neuk Cottage during the night time period was 5 (3 freight and 2 passenger) on Tuesday 16th February. As passenger trains do not pass-by 16 Ochil View, Kincardine the maximum freight train pass-bys was 3.

By using Equations 2 and 3 and the maximum measured night-time train pass-bys it is possible to calculate the maximum $L_{night}$ noise levels at both East Neuk Cottage and 16 Ochil View during the measurement period. Tables 7 and 8 below detail the predicted $L_{night}$ noise levels.

**Table 7: Predicted $L_{night}$ Noise Level at East Neuk Cottage Using Maximum Measured Train Pass-bys**

| Train Number | Train Pass-by Duration (s) | $L_{Amax}$ (dB) | Calculated SEL (dB) | Predicted $L_{night}$ (dB) |
|---|---|---|---|---|
| **1 (P)** | 18 | 83.9 | 96.5 | |
| **2 (P)** | 20 | 82.6 | 95.6 | |
| **3 (P)** | 9 | 87.5 | 97.0 | |
| **4 (P)** | 10 | 86.4 | 96.4 | |
| **5 (P)** | 12 | 84.7 | 95.5 | |
| **Average Passenger Train Noise Level** | **13.8** | **84.8** | **96.2** | **29.0** |
| **1** | 52 | 88.2 | 105.4 | |
| **2** | 40 | 84.6 | 100.6 | |
| **3** | 52 | 91.0 | 108.2 | |
| **4** | 32 | 84.2 | 99.3 | |
| **Average Freight Train Noise Level** | **44** | **86.8** | **103.2** | **37.8** |
| **Combined $L_{night}$ Noise Level** | | | | **38.3** |

**Table 8: Predicted $L_{night}$ Noise Level at 16 Ochil View Using Maximum Measured Train Pass-bys**

| Train Number | Train Pass-by Duration (s) | $L_{Amax}$ (dB) | Calculated SEL (dB) | Calculated $L_{night}$ (dB) |
|---|---|---|---|---|
| **1** | 51 | 79.8 | 96.9 | |
| **2** | 56 | 84.1 | 101.6 | |
| **3** | 74 | 77.7 | 96.4 | |
| **4** | 53 | 80.1 | 97.3 | |
| **Average Freight Train Noise Level** | **58.5** | **80.2** | **97.9** | **32.5** |

As can be seen from Tables 7 and 8 the predicted $L_{night}$ noise levels at both properties during the measurement period are both below the precautionary WHO Night-time Noise Guideline value, and well within the recommended interim target values.

Although during the measurement period the predicted $L_{night}$ noise levels are within the WHO NNG value it is possible that there will be a greater number of train pass-bys than that recorded during the measurement period. Therefore, by using the timetabled train movements along the S-A-K line it is possible to calculate the worst case scenario $L_{night}$ noise levels. Table 9 below indicates the timetabled train movements on the S-A-K line.

**Table 9: Timetabled Train Movements on S-A-K Line**

| Route | Direction | Day | Night |
|---|---|---|---|
| **Stirling – Alloa (Passenger)** | Eastbound | 18 | 1 |
| | Westbound | 21 | 0* |
| **Stirling – Kincardine (Freight)** | Eastbound | 8 | 4 |
| | Westbound | 9 | 3 |

*It should be noted that although there is no timetabled trains for passenger trains travelling west during the night-time period, the last train to enter Alloa Train Station at 00:11 returns towards Stirling after this and has therefore been included in the calculations

Tables 10 and 11 below detail the predicted the worst case scenario $L_{night}$ noise levels at both East Neuk Cottage and 16 Ochil View using the timetabled train information provided in Table 9 and Equations 2 and 3.

**Table 10: Predicted $L_{night}$ Noise Level at East Neuk Cottage Using Maximum Timetabled Train Pass-bys**

| Train Number | Train Pass-by Duration (s) | $L_{Amax}$ (dB) | Calculated SEL (dB) | Calculated $L_{night}$ (dB) |
|---|---|---|---|---|
| **1** | 18 | 83.9 | 96.5 | |
| **2** | 20 | 82.6 | 95.6 | |
| **3** | 9 | 87.5 | 97.0 | |
| **4** | 10 | 86.4 | 96.4 | |
| **5** | 12 | 84.7 | 95.5 | |
| **Average Passenger Train Noise Level** | **13.8** | **84.8** | **96.2** | **29.0** |
| **1** | 52 | 88.2 | 105.4 | |
| **2** | 40 | 84.6 | 100.6 | |
| **3** | 52 | 91.0 | 108.2 | |
| **4** | 32 | 84.2 | 99.3 | |
| **Average Freight Train Noise Level** | **44** | **86.8** | **103.2** | **41.5** |
| **Combined $L_{night}$ Noise Level** | | | | **41.7** |

**Table 11: Predicted $L_{night}$ Noise Level at 16 Ochil View Using Maximum Timetabled Train Pass-bys**

| Train Number | Train Pass-by Duration (s) | $L_{Amax}$ (dB) | Calculated SEL (dB) | Calculated $L_{night}$ (dB) |
|---|---|---|---|---|
| **1** | 51 | 79.8 | 96.9 | |
| **2** | 56 | 84.1 | 101.6 | |
| **3** | 74 | 77.7 | 96.4 | |
| **4** | 53 | 80.1 | 97.3 | |
| **Average Freight Train Noise Level** | **58.5** | **80.2** | **97.9** | **36.1** |

As can be seen from Tables 10 and 11 the predicted $L_{night}$ noise levels using the maximum train pass-bys at 16 Ochil View is below the precautionary WHO Night-time Noise Guideline value, and well within the recommended interim target values. The predicted $L_{night}$ noise level at East Neuk Cottage is +1.7dB above the very precautionary WHO NNG value but well within the recommended interim target values.