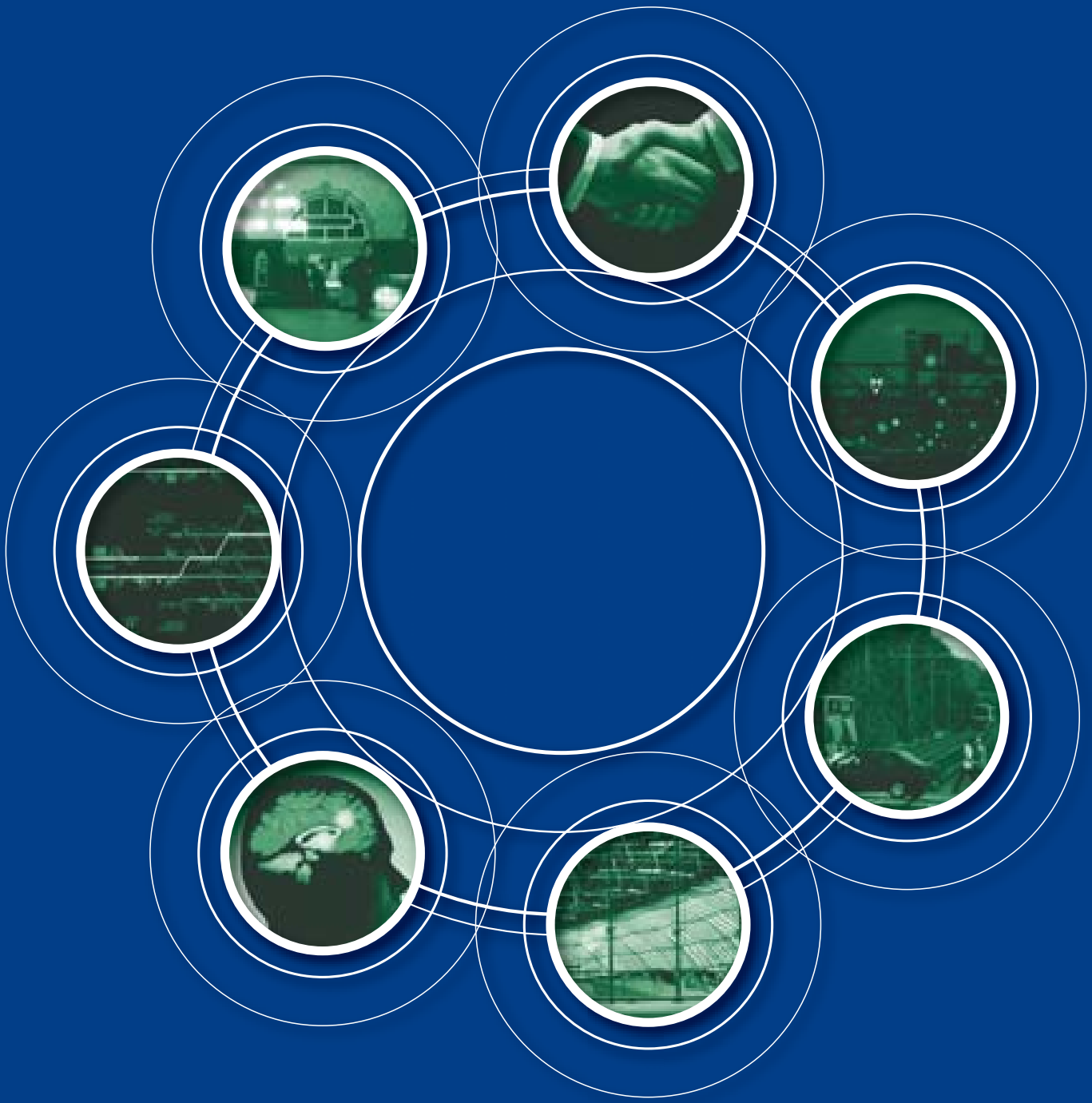
Rail Safety & Standards Board

Research Programme

Operations

T680 Mapping the extent of the train horn noise problem - Canterbury



Spectrum
ACOUSTIC CONSULTANTS

T680 - Train Horn Noise Mapping - Canterbury

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1. SUMMARY

The Rail Safety and Standards Board (RSSB) has received complaints regarding noise disturbance, from residents living near to whistle boards in the Canterbury area.

The RSSB has instructed Spectrum Acoustic Consultants Ltd to develop an acoustic model showing noise propagating from each of six whistle board locations (serving three crossings).

Noise levels of train horns have been measured, and open site noise maps produced in accordance with the following standards:

- ISO 9613-1:1993 Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere

- ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation

The purpose of the acoustic modelling exercise is to map the extent of noise propagation from the train horns, rather than to attempt to predict precise noise levels at specific locations.

2. INTRODUCTION

The Rail Safety and Standards Board (RSSB) is investigating the extent of propagation of noise from train horns, sounded at whistle boards near rail crossings.

Spectrum has been appointed by the RSSB to produce noise maps for three crossing sites in Canterbury. Following a survey to establish the typical noise level of the train horns, these noise maps have been produced.

The purpose of the acoustic modelling exercise is to map the extent of noise propagation from the train horns, rather than to attempt to predict precise noise levels at specific locations. Acoustic modelling is always subject to limitations, and these are discussed elsewhere in this report.

3. SITE DESCRIPTION

Canterbury is in Kent, and the whistle boards are all near to crossings, as follows:

- Tonford (TR126569) – to the south west of Canterbury, with up and down whistle boards 365 m each side of the crossing;
- Folly Farm (TR157595) – to the north east of Canterbury, with one whistle board on the up line 402 m east of the crossing and one whistle board on the down line, 362 m west of the crossing
- Park Alley (TQ393441) – to the north east of Canterbury approximately 400 m south-west of Folly Farm Crossing), with up and down whistle boards 400 m each side of the crossing;
- Westbere (TR196610) – to the north east of Canterbury, with one whistle board on the up line 422 m east of the crossing and one whistle board on the down line, 442 m west of the crossing

The Tonford Crossing has a residential development (Thanington) to the south, on the side of a steep upwards slope away from the crossing. The A2 runs north east of the housing and the crossing.

The Folly Farm and Park Farm crossings have housing in most directions, apart from the immediate south, where land use is largely industrial.

The Westbere crossing is relatively rural, with Westbere marshes to the immediate south. Westbere is a small residential development to the west of the crossing, though there is some housing immediately to the north of the crossing. The Westbere crossing is in a steeply sided valley.

The site location plans are shown in Appendices A, B and C.

4. ACOUSTIC MODEL PRINCIPLES

The acoustic model follows the procedures set out in ISO 9613 to determine noise levels around the local area. The procedure for generating the model is as follows:

Source noise levels (the noise level of a train horn) were measured at positions 1 and 2. The model then positions a noise source at each whistle board, and noise levels in the surrounding area are calculated at regular intervals on a grid covering the extent shown. The model takes account of the following features:

Noise levels in the surrounding area then are calculated taking account of the following features:

- Distance from noise source (due to geometric divergence)
- Atmospheric absorption
- Ground effects (which includes the height of ground relative to the noise source)

Noise contours are then generated showing zones corresponding to the predicted noise levels from the train horn.

As an acoustic model, there are limitations as to the degree of precision of such an assessment. In particular, the following assumptions are made during the modelling process:

- The noise source (the train horn) is assumed to be omnidirectional – that is, it radiates noise equally in all directions. There are anecdotal comments that this may not be the case, but in the absence of precise directivity patterns for the horn, omnidirectional propagation has been assumed;
- The source height is assumed to be 0.5 m above the ground – correlating approximately with the height of the underside of the train, where the horn is fitted;
- The noise level of the train horn is assumed to be consistent. Train horn noise levels are in reality variable – depending on how the driver operates the horn. The loudest measured case has been used as the source model, though noise levels may occasionally be higher, or lower;
- The acoustic model is an "open site" model. Therefore, screening and reflection effects from buildings, barriers etc have been disregarded. The extent of housing/built up areas will create both screening (reducing noise levels where the whistle boards cannot be seen) and reflected sound (increasing noise levels where sound is reflected off buildings);
- Neutral meteorological conditions (eg no wind, no temperature inversion etc) have been assumed, and so no meteorological corrections have been made to the model;
- The noise contours produced by the model are generated at a height of 1.5m above the ground level;
- The noise contours are calculated every 50m for the full size model, and every 10m for the larger scale (central zone) model;
- In addition, ISO9613 suggests that for distances up to 1km, the accuracy of any model will be ± 3dB. The standard does not give accuracy estimates for greater distances.

5. MEASUREMENTS

5.1 MEASUREMENT PROCEDURE

Noise levels were measured in two locations for each crossing on 8th August 2006.

The monitoring was undertaken during the day under neutral weather conditions. Measurements were focussed on the maximum noise levels that occurred (corresponding to train horn soundings) and measurements were made in one-third octave bands. All data has been stored and is available to the RSSB on request – this report details the necessary measurement data used to produce the models.

The following equipment was used during the survey:

- Bruel & Kjaer Type 2260 Sound Level Meter serial number 1772229
- Bruel & Kjaer Type 4189 Microphone serial number 2199530
- Bruel & Kjaer Type 4231 Acoustic Calibrator serial number 2229957
- Bruel & Kjaer Type 2260 Sound Level Meter serial number 2311704
- Bruel & Kjaer Type 4189 Microphone serial number 2523534
- Bruel & Kjaer Type 4231 Acoustic Calibrator serial number 2389076

The noise measurement system instrumentation is calibrated biannually using equipment referenced to the British Calibration Service, and the National Physical Laboratory. It was also field checked before and after the survey and sensitivity drift was negligible.

5.2 MEASUREMENT LOCATIONS

Measurement and crossing locations are shown in Appendices A, B and C.

5.2.1 Tonford

Position 1: Grid ref TR126569 - At crossing itself. The up whistle board was approximately 365 m north-east, and the down board 365 m south-west of the measurement position.

Position 2: Grid ref TR129570 – Beside the up whistle board (365 m to the east of the crossing), on the south side of the railway approximately 15m from the board.

5.2.2 Folly Farm and Park Alley

Position 1: Grid ref TR157595 - At Folly Farm crossing itself. The down whistle board was approximately 362 m west, and the up board 402 m east of the measurement position.

Position 2: Grid ref TR154593 – At the Park Alley crossing. The down whistle board was approximately 382 m west, and the up board 362 m east of the measurement position.

5.2.3 Westbere

Position 1: Grid ref TR194609 – Beside the down whistle board. The railway is elevated (about 5 m above the measurement position). The down whistle board was approximately 40 m away, and screened from the measurement position.

Position 2: Grid ref TR196610 - At crossing itself. The up whistle board was approximately 422 m east, and the down board 442 m west of the measurement position.

5.3 RESULTS AND OBSERVATIONS

Ideally, measured noise levels would be used to verify the acoustic model – they should correspond reasonably with the noise levels predicted by the acoustic model. It is significant though that there are a large range of noise levels measured on the sites, and the calculation of the train horn sound power is based only on a few events. Therefore, there may be a high degree of variability between predicted and measured levels as well as between the model and noise levels regularly experienced by residents.

(Sound power level is a measure of how loud the horn is, independent of where the noise level was measured. It can be used to calculate the sound pressure level at a specific distance.)

5.3.1 Tonford

Generally, the train horns were not always sounded at this location, and when they were sounded, it was often significantly after the whistle board location. In addition, the volume of the soundings were highly variable. Horn soundings from other train lines were faintly audible at this location.

At measurement position 1, (beside the level crossing) noise levels from soundings at the down whistle board were significantly lower than those from the up board which would not be expected, as the crossing is equidistant between the boards. This then is likely due to the way the horn was sounded, rather than specific acoustic effects.

At measurement position 2, soundings at the down board (approximately 700 m away) were not audible or measurable, but measurements of soundings at the up board have been recorded.

There were 6 train events per hour (three trains on the up line, and three trains on the down line). All trains observed on this line were Class 375 and Class 465.

Key noise measurements are set out below:

- Train horn noise levels correspond to a maximum sound power level of L_{WA} = 113dB. (This is based on the only clear sounding of the train horn at the down board, and this corresponds to an A weighted sound pressure level of approximately 91 dB at 5 m.) This is significantly lower than measured elsewhere in Canterbury, and at other sites in the south-east.
- For the purposes of verifying the model, noise levels measured at the crossing were as follows:

Whistle Board	L_{AFmax} dB measured from horn sounding
Up	76-85dB
Down	57-59dB

Table 1: Noise levels measured at position 1

5.3.2 Folly Farm and Park Alley

Train horn soundings at these boards were generally not clearly audible or measurable.

At position 2, (on the Park Alley crossing) a single sounding of L_{AFmax} 74 dB was measured from a horn sounding at the up board. This correlates to a sound power level of L_{WA} 134 dB.

There were 4 train events per hour (two trains on the up line, and two trains on the down line). All trains observed on this line were Class 375. However, horns were not regularly sounded at any of the whistle boards in this area.

5.3.3 Westbere

At these locations, again, horns were sounded significantly away from the whistle board locations.

At measurement position 1, (beside the down whistle board) noise levels from two soundings were clearly measurable. A sounding at the up whistle board gave a level of L_{AFmax} = 65 dB, and a sounding near (though before) the down board gave an L_{AFmax} = 76 dB.

At measurement position 2 beside the crossing), soundings were generally clearly audible, unless masked by a particular event (such as a car engine). A sounding at the up whistle board gave a level of L_{AFmax} = 68 dB, and soundings at the down board gave L_{AFmax} = 53-55 dB.

There were 4 train events per hour (two trains on the up line, and two trains on the down line). All trains observed on this line were Class 375.

Train horn noise levels correspond to an estimated maximum sound power level of L_{WA} = 126dB. (This is based on the only clear sounding of the train horn at the down board, and assumes a screening correction. This corresponds to an A weighted sound pressure level of approximately 104 dB at 5 m.)

6. ACOUSTIC MODEL RESULTS

Noise models are attached in the Appendices.

The acoustic models are a propagation model of the maximum noise level from any whistle board. As horn soundings will not occur at each board simultaneously, the model shows the highest noise level that could occur at any time a horn is sounded.

As discussed in Section 4, the acoustic model is inevitably limited in its precision. However, to attempt to verify the model and get an indication of the precision of the model, noise levels measured can be compared to the model's predicted levels.

6.1 TONFORD VERIFICATION

Whistle board	Measured noise level at Position 1 (L_{AFmax}, dB)	Model predicted noise level at Position 1 (L_{AFmax}, dB)
Up	65-73	43
Down	58-72	48

Table 2: Verification of measured levels with model predicted levels

The model does not correlate well with the actual measured noise levels at Tonford. This is expected to be primarily due to the variability in train horn sounding location, as well as volume and directivity (as discussed above).

6.2 FOLLY FARM AND PARK ALLEY VERIFICATION

The Folly Farm and Park Alley noise model is based on the single L_{WA} 134 dB described above. As this is based on a single sounding, no verification measurements are possible, as this was not clearly audible at measurement position 1.

6.3 WESTBERE VERIFICATION

Whistle board	Measured noise level at Position 2 (L_{AFmax}, dB)	Model predicted noise level at Position 2 (L_{AFmax}, dB)
Up	68	58
Down	53-55	59

Table 3: Verification of measured levels with model predicted levels

The model predicts lower levels than those measured from soundings at the up board, but higher levels than those measured at the down board. Again, this is expected to be primarily due to the variability in train horn sounding location, directivity and volume (as discussed above).

7. CONCLUSIONS

Open site acoustic models have been produced, showing the extent of noise propagation from train horn soundings at whistle boards around Canterbury. The models are based on train horn noise levels measured during surveys at the crossing sites, and are based on a series of assumptions as set out in the report. Any acoustic model is always subject to limitations, and these limitations are also discussed elsewhere in this report.

Despite all trains on these lines being Class 375, a variation in sound power level of the train horn of 21 dB was observed between different sites. In particular therefore, a more precise method of characterising the train horn noise level and directivity pattern could be completed by measuring levels in a controlled setting. Such soundings could then be used in determining the noise models to ensure that such models are a clear worst case.

However, taking account of the assumptions and limitations discussed, these noise model maps represent the extent of noise propagation from horn soundings at the whistle boards and other locations detailed.

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