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# THE CHANNEL TUNNEL RAIL LINK: PREDICTING NOISE AND ITS EFFECT ON DEVELOPMENT

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## 1. INTRODUCTION

This paper outlines a project carried out in 1999, investigating the predicted effect of noise from the channel tunnel rail link on the development for mixed residential and commercial use of a brownfield site in Ashford. Construction of the channel tunnel rail link (CTRL) is currently underway and will pass through the former Ashford barracks, a site of 57 hectares to the north-west of Ashford town centre. The site is bounded by the M20/A20 interchange to the north, new barracks link road to the east and housing areas to the south and west. The project involved a baseline noise survey of the site and the prediction of noise levels when the CTRL is operational, using an adapted form of the Calculation of Railway Noise (CRN) and CRN Supplement 1. Noise Exposure Categories using Planning Policy Guidance 24 were applied to the site and comparisons made between present NEC's and predicted NEC's. The effect on the development of the site in relation to the predicted NEC's was discussed.

## 2. METHODS

### 2.1 SELECTION OF MEASUREMENT/PREDICTION POSITIONS

Ashford Barracks is a relatively flat site and for the purpose of prediction it has been assumed that the site is flat. A plan of the site was obtained and this was divided into a grid of 150m squares to give 21 measurement and prediction positions. The positioning and sizing of the grid was selected to give a reasonable number of positions representative of the whole site. A smaller grid would have given too many positions to be sampled in the time available.

### 2.2 NOISE EXPOSURE CATEGORIES (PPG24)

Planning Policy Guidance 24 (PPG 24) - Planning and Noise (Department of the Environment (DoE), 1994) gives advice to Local Authorities on how to use their planning powers to minimise the adverse impact of noise. It outlines factors to be taken into account in determining planning applications for noise-sensitive developments and introduces the concept of Noise Exposure Categories (NEC's) for residential development. It is the fundamental document used in determining such planning applications and as such, this study has applied PPG 24 principles and NEC's in the assessment of the effect of the noise from the CTRL on the potential re-development of the former Ashford Barracks.

### 2.3 BASELINE NOISE SURVEY

Baseline noise measurements were carried out on 23$^{rd}$ June 1999. A B&K 2236 Sound Level Meter (Serial No. 187393) was used. This was calibrated using a B&K Calibrator (Serial No. 1914413) before and after each measurement. No significant drift was recorded. The weather on the day was warm (24°C), sunny and still with an occasional light breeze. 10-minute measurements were carried out at each of 17 positions. It was not possible to sample 4 positions due to access restrictions or construction in the south of the site making it difficult. For one of these positions (A2), data was obtained from a previous noise survey carried out by Walker-Beak Consultants. At two points (A4 and B4) a concrete crusher on the construction site was operating intermittently and was audible. To obtain a baseline noise level a measurement was taken of the crusher operating and this was subtracted from the original measurement.

A-Weighted (Fast Response) parameters recorded over 10 minutes were $L_{eq}$, $L_{10}$, $L_{90}$, and $L_{max}$. For the purpose of applying PPG 24 NEC's it was assumed that the noise levels remain constant through the day. This is probably not the case due to changes in traffic flows but time constraints prevented sampling at every point at different times of the day. It was also the case that 18 hr $L_{eq}$ levels were used to apply NEC's to save further calculations as CRN (1995) produces 18 hr $L_{eq}$ results. A note was made of the dominant noise source and the microphone was orientated towards that source for the purpose of applying NEC's.

## 2.4 PREDICTED NOISE LEVELS FROM THE CTRL

The predicted noise level for each position was obtained using the method described in "Calculation of Railway Noise (CRN)" (Department of Transport (DoT) 1995), and Supplement 1 to that document, "Procedure for the Calculation of Noise from Eurostar Trains Class 373" (DoT, 1995). However, due to the fact that railway lines such as the CTRL have not been experienced in Britain before, some adjustments were made to the methods. The method followed to obtain the predicted levels is detailed below. It should be noted that where predicted levels and baseline levels fell within 10 dB of each other, these were summed to obtain an overall predicted $L_{eq}$ with the CTRL operating (i.e. predicted noise + existing background).

**STAGE 1** - The section of CTRL across the Barracks was divided into four segments according to noise mitigation features such as barriers or cuttings.

**STAGE 2** (for each segment) – Richard Greer of Rail Link Engineering supplied SEL's for the five train types that will run on the CTRL across the barracks site. The SEL's supplied were converted to reference SEL's for the purpose of the calculations using the formulae in Table 3. CRN Supplement 1 suggests treating Eurostar trains as two train types to take account of noise from rolling stock and brake cooling fans. However, the SEL's supplied were derived from actual measurements by Ashdown Environmental Limited of the TGV (Train Grand Vitesse) in France, so Eurostar trains can be treated as one train type in this study.

## TABLE 2.1 - TRAIN TYPES AND REFERENCE SEL'S

| Train Type | Formula | V | $SEL_{ref}$ |
|---|---|---|---|
| 1. Eurostar @ 270 km/h | 51.2+20log(V) | 270 km/h | 100 dB(A) |
| 2. Eurostar @ 160 km/h | 51.2+20log(V) | 160 km/h | 95 dB(A) |
| 3. 8 Car Networker @ 160 km/h | 41.4+22.4log(V)+10log(N/8) | 160 km/h | 91dB(A) |
| 4. 12 Car Networker @ 160 km/h | 41.4+22.4log(V)+10log(N/8) | 160 km/h | 91dB(A) |
| 5. Class 92 (Freight) @ 140 km/h | 43.6+22.4log(V) | 140 km/h | 92dB(A) |

The data on speeds were obtained from Union Railways Operational Noise Review Group – Operational Input Assumption for the Noise and Vibration Assessment Work (as Reported in the Environmental Statement, November 1994) This document also provided data on train flows (STAGE 5).

**STAGE 3** - (for each Segment and Train Type) – Corrections to the $SEL_{ref}$ for propagation conditions were as follows:
**Distance** – The straight-line distance was measured off plan and slant distance calculated according to the depth of the cutting. The correction was established using Chart 3 of CRN 1995.
**Air Absorption** – This was applied using the formula 0.2 – (0.008 x d) where d is the slant distance.
**Ground Correction** – Not applied as all propagation in this study is obstructed.
**Partially Obstructed Propagation** – Not applied as all propagation in this study is obstructed.
**Obstructed Propagation** – Path difference was calculated according to distance and height of barrier or cutting. Detailed Plans of the CTRL construction were used to obtain this information. The correction was applied using Charts 6a and 6c of CRN 1995, taking account of reflective barriers where appropriate.
**Building Effects** – For the purpose of this study, it was assumed that the site is flat and has no buildings for the simple reason that too much complexity would have been introduced into the calculations. Therefore no correction was applied.
**Angle of View** – This correction was applied according to the angle of view of the receptor to each segment. Chart 7 of CRN 1995 was used.

**STAGE 4** - Relates to reflection effects from facades and buildings. This study has assumed a flat site with no buildings so this stage was not carried out.

**STAGE 5** – The corrected SEL's for each train type on each segment were converted to $L_{eq}$ values using the following formulae:
$L_{Aeq}$ (6hr) = SEL – 43.3 + 10 log($Q_{night}$)
$L_{Aeq}$ (18hr) = SEL – 48.1 + 10 log($Q_{day}$)
$Q_{day}$ = Number of each train type passing receptor point 06.00 to 00.00 hours.
$Q_{night}$ = Number of each train type passing receptor point 00.00 to 06.00 hours.
Train flow information for the CTRL section across the Barracks is shown in Table 2.2.

## TABLE 2.2 - ANTICIPATED TRAIN FLOWS ON CTRL

| Train Type | Q day | Q night |
|---|---|---|
| Eurostar Class 373 | 144 | 4 |
| 8 Car Networker | 53 | 4 |
| 12 Car Networker | 24 | 0 |
| Class 92 (Freight) | 0 | 4 |

**STAGE 6** – The total $L_{eq}$ for the railway at the specific receptor point is arrived at by summing the $L_{eq}$ values for each train type on every track segment. This is carried out for the 18 hour and 6 hour values.

A spreadsheet was designed on "Microsoft Excel." This enabled the corrections for distance, air absorption, obstructed propagation and angle of view to be measured and calculated using the charts in CRN 1995 and then entered into the spreadsheet. The spreadsheet was set up to calculate the Leq (18hr) and Leq (6hr) using this information and pre-programmed reference SEL's, speeds, flows and corrections.

## 2.5 EXAMPLE CALCULATION FOR RECEPTOR POINT F4

| Track Segment | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Distance Correction | -4 | -3.5 | -1 | 0 |
| Air Absorption Correction | -0.33 | -0.22 | -0.04 | 0.04 |
| Obstructed Propagation Correction | -10 | -10 | -16.5 | -17 |
| Angle of View Correction | -15 | -15 | -6 | -8 |
| Total Correction | -29 | -29 | -24 | -25 |

| Segment | 1 | | | | | 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Train Type | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| SEL ref (*1) | 100 | 95 | 91 | 91 | 92 | 100 | 95 | 91 | 91 | 92 |
| Correction | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 |
| SEL (*2) | 71 | 66 | 62 | 62 | 63 | 71 | 66 | 62 | 62 | 63 |
| Segment | 3 | | | | | 4 | | | | |
| Train Type | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| SEL ref (*1) | 100 | 95 | 91 | 91 | 92 | 100 | 95 | 91 | 91 | 92 |
| Correction | -24 | -24 | -24 | -24 | -24 | -25 | -25 | -25 | -25 | -25 |
| SEL (*2) | 76 | 71 | 67 | 67 | 68 | 75 | 70 | 66 | 66 | 67 |

| Segment | 1 | | | | | 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Train Type | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Leq 18 hr (*3) | 44 | 39 | 31 | 27 | 0 | 45 | 40 | 31 | 28 | 0 |
| Leq 6 hr (*4) | 33 | 28 | 0 | 24 | 25 | 34 | 29 | 0 | 25 | 26 |
| Segment | 3 | | | | | 4 | | | | |
| Train Type | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Leq 18 hr (*3) | 50 | 45 | 37 | 33 | 0 | 49 | 44 | 35 | 32 | 0 |
| Leq 6 hr (*4) | 39 | 34 | 0 | 30 | 31 | 38 | 33 | 0 | 29 | 30 |

Total Leq (18 hr) = **55 dB (A)** (*5)
Total Leq (6 hr) = **45 dB (A)** (*6)

*1 – STAGE 2
*2 – SEL ref – Total Correction
*3 – SEL – 48.1 + 10log(Q day)
*4 – SEL – 43.3 + 10log(Q night)
*5 – Sum of all $L_{eq}$ (18 hr) values
*6 – Sum of all $L_{eq}$ (6 hr) values

**Distance Correction Applied (Chart 3 – CRN, 1995)**
Segment 1 – Straight Line = 66.0m, Height = 0.7m, Slant Distance = 66.0m Correction = **-4 dB**
Segment 2 – Straight Line = 52.5m, Height = 0.7m, Slant Distance = 52.5m Correction = **-3.5dB**
Segment 3 – Straight Line = 30.6m, Height = 1.8m, Slant Distance = 30.7m Correction = **-1 dB**
Segment 4 – Straight Line = 24.6m, Height = 1.8m, Slant Distance = 24.7m Correction = **0dB**
Distances were measured off plan at the bisecting line of the angle of view. This was considered to be an average or median distance.

**Air Absorption Correction Applied**
Air Absorption = 0.2 – (0.008d), where d is the slant distance calculated in Distance Correction
Segment 1 = 0.2 – (0.008 x 66) = **-0.33 dB**
Segment 2 = 0.2 – (0.008 x 52.5) = **-0.22 dB**
Segment 3 = 0.2 – (0.008 x 30.6) = **-0.04 dB**
Segment 4 = 0.2 – (0.008 x 24.6) = **+0.04 dB**

**Obstructed Propagation Correction Applied (Chart 6a and 6c - CRN, 1995)**
Path Difference = a + b – c
Segment 1 = 3.7m + 62.4m – 66m = 0.1. Correction = **-10 dB** (Chart 6a – CRN 1995)
Segment 2 = 2.5m + 50.1m –25.5m = 0.1. Correction = **-10 dB**
Segment 3 = 5.8m + 27.8m – 30.6m = 3. Correction = -21 dB + 4.5 dB* = **-16.5 dB**
* - Correction for reflective barrier (Chart 6c – CRN 1995)
Segment 4 = 2.8m + 22.5m – 24.6m = 0.7. Correction = **-17 dB**

**Angle of View Correction Applied (Chart 7 – CRN 1995)**
Segment 1 - $\theta = 6^\circ$, $\propto = 20^\circ$. Correction = **-15 dB**
Segment 2 - $\theta = 10^\circ$, $\propto = 30^\circ$. Correction = **-15 dB**
Segment 3 - $\theta = 60^\circ$, $\propto = 55^\circ$. Correction = **-6 dB**
Segment 4 - $\theta = 15^\circ$, $\propto = 77^\circ$. Correction = **-8 dB**

# 3. RESULTS

## TABLE 3.1 - EXISTING & PREDICTED NOISE LEVELS AND NEC'S

| Position | Existing $L_{eq}$ (18 hr) | NEC | Predicted $L_{eq}$ (18 hr) | Predicted LEQ (6 hr) | NEC |
|---|---|---|---|---|---|
| A2 | 42 | A | 58 | 48 | B |
| A4 | 44 | A | 58 | 48 | B |
| B1 | 46 | A | 60 | 50 | B |
| B2 | 46 | A | 60 | 50 | B |
| B3 | 47 | A | 63 | 53 | B |
| B4 | 48 | A | 63 | 53 | B |
| B5 | \ | \ | 57 | 46 | B |
| C2 | 44 | A | 64 | 54 | B |
| C3 | 44 | A | 64 | 53 | B |
| C4 | 49 | A | 60 | 50 | B |
| C5 | \ | \ | 60 | 50 | B |
| D2 | 50 | A | 60 | 49 | B |
| D3 | 49 | A | 63 | 53 | B |
| D4 | 50 | A | 64 | 54 | B |
| E2 | 50 | A | 60 | 49 | B |
| E3 | 50 | A | 60 | 50 | B |
| E4 | 50 | A | 61 | 51 | B |
| F2 | 59 | B | 61 | 46 | B |
| F3 | 56 | B | 60 | 47 | B |
| F4 | 55 | B | 58 | 45 | B |
| F5 | \ | \ | 57 | 47 | B |

## 3.1 BASELINE NOISE SURVEY

The results from the baseline noise survey carried out on 23rd June 1999 are shown in Table 3.1. The higher NEC B at the eastern edge of the site (F2, F3 and F4) is caused by noise from the barracks link road, town traffic and the A20/M20 Junction.

## 3.2 CALCULATION OF RAILWAY NOISE (1995) PREDICTIONS

The results of the calculations for the predicted noise levels with the CTRL operating are shown in Table 3.1. The 6 Hour $L_{eq}$ values reflect night-time noise levels and are merely for comparison with daytime levels, as the baseline noise survey did not include night-time measurements. The NEC's applied to night-time levels were actually the same as those for the daytime levels

## 3.3 PPG 24 NOISE EXPOSURE CATEGORIES

Table 3.1 also shows the NEC applied to existing and predicted $L_{eq}$'s. The predicted $L_{eq}$ value in this table is an indication of the sum of existing noise levels and those expected from the CTRL. The change over most of the site from NEC A to NEC B with the CTRL operational is evident from this table. At the eastern edge of the site (F2, F3 and F4), there is no change in the NEC, this is because the distance from the CTRL is such that it has less effect on the noise levels in an area that was already in NEC B due to the road traffic noise.

# 4. DISCUSSION

## 4.1 NOISE EXPOSURE CATEGORIES

The results of the baseline noise survey show that the majority of the site falls within NEC A at present. Subjectively, considering its urban location, Ashford Barracks is a "quiet" area. The eastern side of the site falls within NEC B, at the lower end of this category. Noise from the A20/M20 and Barracks Link Road is dominant in this area. However, no mitigation in the form of barriers etc. had been provided along the Link Road at the time of the survey and the recent provision of these would probably have reduced the noise levels to within NEC A. If the site were developed without the CTRL proposed to pass through it, "noise need not be considered as a determining factor in granting planning permission." (PPG 24, DoE 1994). At the Eastern side of the site, "noise should be taken into account," but it is likely that barriers along the route of the Barracks Link Road would reduce this need.

However, the CTRL is to be constructed through the site and Table 3.1 shows the expected noise levels when it is operational. It can be seen that the entire site will fall within NEC B. This is testament to the high level of mitigation provided along the line to protect the potential development of this area. A previous report predicted NEC C in an area 50m either side of the CTRL. This is what would be expected close to a busy, high-speed railway. However, it is expected that landscaping works associated with the CTRL construction will extend this far, thus making this area undevelopable. For granting planning permission, NEC B means that "noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise."

NEC's apply generally to residential use, so noise will not affect the granting of planning permission for commercial or industrial use. For institutional use, other standards are applied to internal noise levels and this will depend on the layout of the site and such buildings. The increase from NEC A to NEC B over the majority of the Ashford Barracks site will have implications for the re-development of the site.

## 4.2 IMPLICATIONS OF NOISE ON DEVELOPMENT

As discussed, the entire Barracks site will fall within NEC B with the CTRL operational. PPG 24 (DoE, 1994) suggests imposing planning conditions in respect of noise in this category to ensure an adequate level of protection against the noise. It is likely that conditions will need to be imposed on planning permission granted for the re-development of Ashford Barracks. Conditions can be imposed on any aspect of the development but they should be necessary, relevant to planning, relevant to the development, enforceable, precise and reasonable. Attention must be paid to the individual circumstances of the development and in the case of Ashford Barracks, conditions on noise control would fulfil these criteria. Options could be the design of garages and other structures to act as noise barriers, and sound insulation measures.

Residents of any new developments will want to enjoy outside amenities such as gardens and any measures to reduce noise should reduce levels within these areas to 55 dB (A) (the level above which WHO states significant community annoyance is caused). Careful design and layout planning with brick walls, garages and other structures to screen noise would make this possible over most of the Barracks site, according to the predicted future levels with the CTRL operating. A brick wall, for example, would provide a minimum of 5 dB(A) reduction (in the line of sight of the noise source), and in areas where the level is in the lower end of NEC B, this would be sufficient. Also, locating gardens at the rear on the "blind-side" of houses (i.e. the opposite side of the house from the CTRL) would help to reduce outdoor noise levels in those gardens. This could pose problems if bedrooms at the front of the house face the CTRL but this can be controlled by good construction of this façade. Single-aspect houses and flats (where "living rooms" face away from the noise source) are a possibility, but these are generally used in higher noise levels found in NEC C.

The noise from the CTRL is not a quantity that can be controlled at source so control must be in the transmission path or at the receiver. Mitigation has already been introduced and along with layout planning of any new development, this will provide noise control in the transmission path. Control at the receiver could be through the design of the buildings themselves in order to insulate the sufficiently to comply with WHO criteria for sleep disturbance. Annex 6 of PPG 24 (DoE, 1994) gives guidance on this aspect. Noise from outside can enter a room through windows, ventilators, walls, roof and doors. In most cases, windows provide the main path and it is important to ensure that their insulation is specified correctly. Table 4.1 shows the typical reduction provided by different types of windows. It should be noted that an open window of any type provides 10-15 dB reduction.

## TABLE 4.1 - SOUND REDUCTION OF DIFFERENT WINDOW TYPES

| Noise Source | Single Glazing | Thermal Double Glazing | Secondary Glazing |
|---|---|---|---|
| Electric Train | 30 | 36 | 41 |

(From PPG 24 (DoE, 1994))

Assuming a predicted night-time level of 54 dB(A), which occurs at point C2 and is the highest predicted level across the whole site, normal thermal glazing will reduce the internal level by 36 dB(A) to 21 dB(A) (with a façade correction of 3 dB(A)), well within WHO guidelines. However, opening the window will increase this level to 42 dB(A) at best. This is where other measures such as brick walls, facing bedrooms away from the CTRL and secondary glazing with ventilators will be useful additional measures. The construction of other parts of the building envelope should be controlled, as lightweight or poor quality roofs or walls will allow transmission of sound into the building. This would limit the overall performance of other elements such as the windows (PPG 24, DoE 1994).

In summary, noise must be taken into account when determining planning applications for the re-development of Ashford Barracks. However it is not such an issue that it cannot be overcome by the imposition of planning conditions, the enforcement of policy S22 of the local plan where the site must be laid out to take account of noise from the CTRL, or other agreements with developers. Careful layout design and planning, along with good construction and insulation of buildings can eliminate the predicted noise problems caused by the CTRL.

## 5. CONCLUSIONS

Some limitations in the scope and detail of this study are taken into account in making these conclusions. Several assumptions, to take account of situation and constraints such as time and access, were made in the arrival at noise levels, predicted noise levels and NEC's.

- At present, the noise levels on the Ashford Barracks site fall within PPG 24 NEC A, with the exception of an area to the east of the site which is affected by noise from the A20/M20 and Barracks Link Road and falls within PPG 24 NEC B.
- When the CTRL is operational it is predicted that the noise levels on the entire Ashford Barracks Site will fall within PPG 24 NEC B. This means that noise should be taken into account when determining planning applications for residential development on the site.
- Planning conditions will be likely to be needed to control noise affecting proposed residences on the Ashford Barracks site. These conditions should promote or require careful design and layout; the provision of noise screening by garages, walls etc; the provision of double glazing to all dwellings and good construction of other building elements.

The detailed layout of the re-development of Ashford Barracks will be controlled by many factors. Factors other than noise were discussed in the original study, but are not included in this paper. These include Certificates of Lawfulness of Proposed Development (CLOPUD's) issued for the site, existing features, proposed layouts and Ashford Borough Local Plan matters. Noise from the CTRL should be taken into account as one factor but is not such an issue as cannot be overcome by its consideration in a development brief and the imposition of planning conditions or other agreements with developers.

## 6. GLOSSARY OF TERMS

$L_{eq}$ - Steady noise level which over the period of time specified contains the same amount of energy as the time-varying noise being assessed (usually A-weighted ($L_{Aeq}$)).

$L_N$ - Percentile level, i.e. the sound pressure level which is exceeded for N% of the time interval (e.g. $L_{10}$, $L_{90}$).

$L_{max}$ - Maximum RMS sound pressure level occurring within a specified time period.

SEL - Sound pressure level which if occurring within one second would contain the same amount of energy as the event being assessed (e.g. a train passing).

dB(A) - A-Weighted sound pressure level (to correlate with the response of the human ear).

## 7. REFERENCES


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