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ASSESSMENT OF NOISE CONTROL REQUIREMENTS FOR FOLKESTONE TERMINAL OPERATION, CHANNEL TUNNEL PROJECT

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1. INTRODUCTION

The Channel Tunnel is the largest construction project in Europe and has been an exciting challenge for the contractors, TransManche-Link (TML). As part of the project, BDP were commissioned by TML to design the Folkestone Terminal and this included for BDP Acoustics to undertake an assessment of any noise control measures necessary to meet agreed environmental standards.

The Folkestone Terminal site location is shown in Figure 1 together with the operational layout. The nearest residential areas are the villages of Newington and Peene and the areas of Cheriton and Morehall on the edge of Folkestone. The layout in Figure 1 identifies the basic principles of the Terminal operation, i.e. shuttle loop, platforms, vehicle routes and the main line railway (Continental Main Line).

2. BACKGROUND

The basis of the criteria used to determine the noise control requirements was an environmental assessment of the project undertaken in 1985 (1). This established operational noise criteria at the facades of residential properties and schools.

The assessment also stated that in certain areas, residential properties were likely to be subjected to noise levels above the proposed facade night time criteria of 50 dB LAeq (2200-0700 hours). Subsequently an assurance was given by Eurotunnel to provide these properties with noise insulation (2).

Thus the design criteria for the project were as follows:-

Daytime	(0700-1900 hours)	60 dB LAeq
Evening	(1900-2200 hours)	55 dB LAeq
Night-time	(2200-0700 hours)	50 dB LAeq

at the facades of uninsulated dwellings for typical terminal operation together with a maximum level of 65 dBA. This maximum level was selected to minimise disturbance primarily to train passbys during the night.

Compared with the recommendations of the Mitchell Report (3) at which noise insulation should be provided for new railways, i.e. 61 dB LAeq (2300-0700 hours) and a maximum during train passbys of 85 dBA, the Channel Tunnel criteria appears to be stringent.

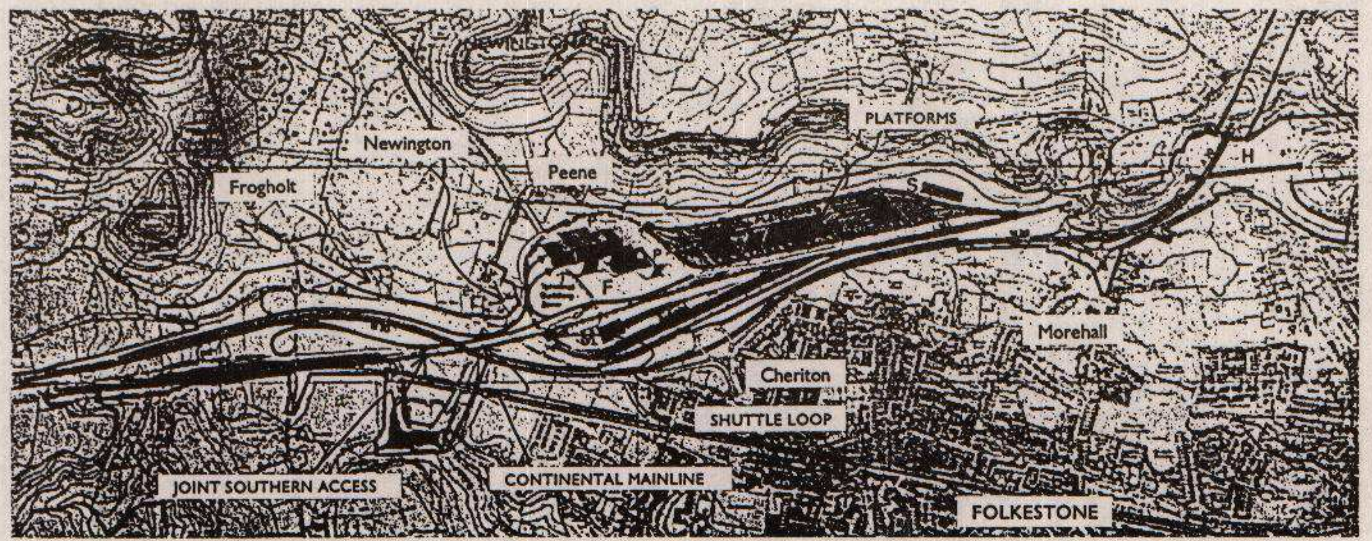

FIGURE 1 FOLKESTONE TERMINAL SITE LOCATION

However, based on guidance given by the World Health Organisation, (4) and Nelson (5), the night time facade criteria of 50 dB LAeq (2200-0700 hours) and 65 dBA as a maximum level for dwellings exposed to a new source and likely to have windows open during a summer night would appear to be appropriate.

3. ASSESSMENT

In order to assess the noise control measures necessary to meet the above design criteria, predictions needed to be made of the noise levels due to day and night time operation. A computer model was therefore produced which had to take account of a variety of sources.

These included:-

- Passenger and freight train movements through the Terminal on the Continental Main Line.
- Shuttles carrying vehicles from the Tunnel into the Terminal and then back into the Tunnel.
- A dual road system carrying vehicles to and from the Terminal.
- Vehicle movements entering the Terminal passing through tolls, various controls and holding areas en-route to the platforms where they embark onto shuttles.
- Purging of the shuttles by fans to remove exhaust fumes.
- Vehicles disembarking from shuttles and leaving the Terminal.
- Various building use activities and operations.

4. COMPUTER MODEL

The computer model employed the principles of screening attenuation due to barriers or topography based on Maekawa (6) and excess attenuation due to low ground cover and atmospheric conditions based on Beranek (7). These had been adopted by Wimpey Laboratories Limited in the Environmental Assessment (1).

The basis of the computer model was the Noise Advisory Council's "A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level Leq" (8). In order to represent all the noise sources the model required in excess of 170 sources, this included line sources such as roads and railways represented as a series of point sources.

The input data required to represent the sources was the location (given in terms of its x, y, z coordinates relative to a selected origin) and its equivalent continuous A-weighted sound power level. The sound power level was input over the octave band centre frequency range of 125 Hz to 4 kHz in order that a more accurate determination of barrier losses and excess attenuation could be made for sources with different frequency spectra.

5. SOURCE DATA

5.1 Road Traffic and Train Line Sources

In order to model the line sources of freely flowing roads and railways, it was necessary to determine the equivalent continuous A-weighted sound power level and assess the appropriate separation of point source locations.

The equivalent continuous A-weighted sound power level for each source was determined by taking into account basic noise level data, the numbers of vehicles or trains passing through in a period of one hour during the day and night and the duration of each individual passby between point source locations. The duration of passbys obviously depended on vehicle speed and for the railways not only the speed of trains but also the length.

As a check, the models for train and road traffic noise propagation were validated independently against the Noise Advisory Council's (8) train noise distance attenuation curve and the Department of Transport's "Calculation of Road Traffic Noise" (9)

The various parameters needed to model the roads and railways are discussed in 5.2-5.5.

5.2 Road Traffic Noise

For freely flowing road traffic, the basic noise level was evaluated from the Calculation of Road Traffic Noise (9). In the case of interrupted flow traffic on the Terminal roads, the basic noise levels were obtained for single vehicles from the Noise Advisory Council as follows:-

Heavy vehicles - 77 dBA at 7.5 m at a speed of 30 kph
Light vehicles - 64 dBA at 7.5 m at a speed of 30 kph

Except for roads with heavy goods vehicles only, where a source height of 1.5 m above road level was assumed, a source height of 0.5 m above road level was used for road traffic.

5.3 Road Traffic Flows on the Terminal

There was substantial data available relating to forecast traffic flows through the Channel Tunnel. Eventually it was decided to adopt the day and night time average hourly traffic flow figures during the peak months of July, August and September. Even then these had to be determined from involved research of traffic forecast tables.

Assumptions had to be made for the number of vehicles likely to use the amenity areas on either the freight or tourist routes and also the number likely to be stopped at customs and security checks although it was assumed that all would slow down.

The average speed of traffic on the Terminal had been taken to be:-

Joint southern access west of tolls	85 kph
Freight/tourist routes to platforms	30 kph
Egress road from platforms to tolls	60 kph

5.4 Train Noise

The basic noise level data obtained for passenger trains was based on a British Rail specified noise limit of 88 dBA at 25 m at a speed of 160 kph. This specified limit exceeded the anticipated noise level from disc braked rolling stock hauled by electrically powered locomotives on good condition continuously welded rail as given by Nelson (5) of 84 dBA at 25 m at 160 kph. Thus a worst case situation has been used.

The shuttles will also be disc braked and hauled by electrically powered locomotives and in this instance the noise levels identified by Nelson (5) were used. For freight trains tread braked rolling stock was assumed and a basic single event noise level of 100 dB LAx at 25 m at a speed of 65 kph was advised by British Rail. On the Terminal all freight trains were assumed to be hauled by electrically powered locomotives and therefore for the shuttles and trains the noise source was assumed to be predominantly at the wheel/rail interface.

5.5 Train/Shuttle Movements

To equate to the typical road traffic flow, the train and shuttle movements had to be determined for similar periods. British Rail provided the data for passenger and freight movements on the CML through the Terminal.

The speeds of trains during the day were taken as 160 kph for passenger trains and 100 kph for freight trains into the Tunnel portal. At night the speed of passenger trains was likely to reduce due to operational reasons.

The speed of shuttles varied around the loop with a maximum of 115 kph at the portal.

The lengths of trains were assumed to be approximately 700 m for shuttles and freight trains and approximately 350 m for passenger trains.

5.6 Tolls/Controls

Since data could not be found or measured for similar circumstances, it was also felt necessary to model vehicle movements at tolls and controls. This was simply achieved assuming an array of vehicle movements at a toll control area, i.e. moving into a queue, stationary in the area and pulling away from the area, and was carried out separately for heavy and light vehicles using the source A-weighted sound power levels below.

Activity	Light	Heavy
Idling	75 dB	85 dB
Moving into a queue (slightly revving)	80 dB	90 dB
Pulling away	90 dB	103 dB

These are based both on measured data and information obtained from the Noise Advisory Council (8) and Nelson (5). Within the toll/control area acoustic screening achieved by the vehicles themselves was also taken into consideration. These models were then used to predict the LAeq (1 hour) noise level at a distance of 200 m and consequently the A-weighted equivalent continuous sound power level for a given vehicle flow rate and assumed transaction time.

5.7 Other Noise Sources

Other noise sources which were considered were:-

- Diesel powered locomotives and a diesel powered crane in the maintenance area.
- Purging of the shuttle wagons by fans.
- Ventilation plant serving buildings.
- Openings in the shuttle arrival loop tunnel.
- Refrigeration units on heavy goods vehicles waiting in the holding area prior to travelling to the platform area.
- Main electricity sub-station.

The A-weighted frequency spectra selected for the model are given below based on a variety of data/references.

A-WEIGHTED FREQUENCY SPECTRA FOR DIFFERENT SOURCES, dB re 2×10^{-5} Pa

Source	Reference	dB(A)	Frequency 125	250	500	1K	2K	4K Hz
Freely flowing mixed traffic	(10)	80	68	70	73	75	74	69
Slow/interrupted flow HGV	(10)	80	73	69	73	76	73	63
Slow/interrupted flow light	(5)	80	70	68	73	75	73	63
Diesel locomotive	(5)	95	84	80	89	91	88	82
CML/shuttle	(5)	100	77	80	84	95	97	93
Ventilation plant	*	85	81	80	78	74	72	72
Main sub-station	*	97	92	88	90	92	85	75
Purging	*	103	72	82	93	97	98	97
Arrival loop tunnel portals and ventilation shafts	(11)	100	72	73	80	97	96	90

* Assumed from BDP data.

6. NOISE CONTROL

Using the model formed, the output could be obtained either in the form of the overall noise level at a single point with the various contributions from all the sources or shown as contours. Both forms of output were useful in determining the optimum noise control requirements.

Since the major sources were due to transportation, noise control was only achievable by means of protective barriers. In addition to those identified in the environmental assessment, i.e. mounding to protect Newington and screening to protect Peene, absorbent barriers have been designed and installed along the railway and road of the Joint Southern Access.

Although the model was used primarily to assess the likely noise levels external to the site during Terminal operation for comparison to the agreed criteria, it also provided useful data relating to noise levels that could be expected on the Terminal. This provided input into the design of the buildings and determined whether additional noise control was necessary to provide reasonable conditions for communication where necessary external to buildings.

7. CONCLUSION

In the absence of similar sized projects on which to base an acoustic appraisal of the Folkestone Terminal operations, compilation of a computer model was necessary. This has been achieved with a model based on Noise Advisory Council's "A Guide to Measurement and Prediction of the Leq" (8) and validated against the appropriate standards. It has been found to be capable of accepting a variety of sources and therefore invaluable in assessing noise control requirements for the major sources on the Terminal.

8. ACKNOWLEDGEMENTS

The cooperation of Transmanche Link and Eurotunnel during preparation of this paper is gratefully acknowledged.

9. REFERENCES

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