

Technical Report

NOISE LEVELS ASSESSMENT FOR NORTHERN LINE PASSENGER CARS BETWEEN EUSTON AND TUFNELL PARK

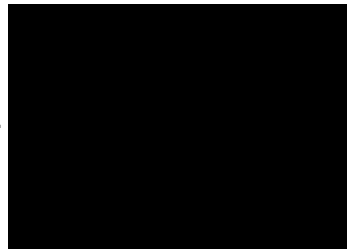
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1. Introduction

The noise and vibration team in Technical Services was asked to measure noise levels within passenger cars on the Northern line, between Euston and Tufnell Park.

2. Summary of the Control of Noise at Work Regulations 2005

To assess customers' noise exposure, no regulation exists which sets out guidelines for an assessment or thresholds regarding noise exposure. However, the Control of Noise at Work Regulation can be used as the duties set out in it extend to the safeguarding of the health and safety of others whom the work may affect.

The regulations define noise exposure limit values and action values. These are provided in Table 1.

Table 1 – Noise exposure limit values and action values

	Daily Personal Noise Exposure $L_{EP,d}$	Peak Sound Pressure L_{Cpeak}
Lower Exposure Action Values	80 dB(A)	135 dB(C)
Upper Exposure Action Values	85 dB(A)	137 dB(C)
Exposure Limit Values	87 dB(A)	140 dB(C)

The equation used to calculate a daily personal noise exposure, $L_{EP,d}$ is defined as

$$L_{EP,d} = L_{Aeq,Te} + 10 \log \left(\frac{T_e}{T_0} \right)$$

where,

$L_{Aeq,Te}$ is the equivalent continuous A-weighted sound pressure level,

T_e is the duration of exposure to the noise, in seconds, and

T_0 is the reference duration of 8 hours (28,800 seconds).

3. Measurements and Results

The LU HSE team asked Technical Services to carry out the monitoring of passengers' noise exposure on the Northern line, between Euston and Tufnell Park.

A passenger's daily noise exposure level is a log average of all the noise levels he/she is exposed to during their daily journey. If the amount of time spent at high noise levels can be reduced, either by reducing the noise levels or exposure time this will reduce the daily noise exposure level. The highest noise level a passenger is exposed, occurs when he/she is in the saloon car and when the train is moving. These noise levels can be broken down into inter-station noise levels.

The measurements were carried out on 4th June 2018, using one handheld sound level meter (SLM), with the microphone located next to passenger ears. The details regarding the meter can be found in Appendix A. Each direction was measured multiple times in randomly selected cabs.

The average levels for all cab runs are presented in the tables below. These measurements start when the train starts moving at the start station and finish when the train departs at the end station.

Table 2 – Interstation noise levels for the northbound road between Euston and Tufnell Park

Interstation Section	L_{Aeq} dB(A)	L_{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)								$L_{EP,d}$ dB(A)
			63	125	250	500	1000	2000	4000	8000	
Euston to Mornington Crescent	86.3	114.1	52.1	59.8	75.4	84.4	79.6	72.5	64.0	55.4	69
Mornington Crescent to Camden Town	81.7	109.1	57.7	63.6	74.3	76.8	77.1	71.7	63.7	51.5	
Camden Town to Kentish Town	89.2	119.3	57.9	63.3	74.6	85.1	86.1	77.7	67.2	54.5	
Kentish Town to Tufnell Park	90.9	118.6	61.4	65.5	78.3	85.5	88.2	81.1	70.0	56.3	



Table 3 – Interstation noise levels for the southbound road between Tufnell Park and Euston

Interstation Section	L _{Aeq} dB(A)	L _{Cpeak} dB(C)	A-Weighted Noise Spectral Analysis in Octave (Hz)								L _{EP,d} dB(A)
			63	125	250	500	1000	2000	4000	8000	
Tufnell Park to Kentish Town	81.3	108.8	54.6	64.2	72.0	78.0	75.7	70.8	63.8	52.6	67
Kentish Town to Camden Town	87.9	115.0	58.6	67.3	76.4	83.1	83.9	79.4	72.8	56.1	
Camden Town to Mornington Crescent	78.1	109.7	53.9	62.5	71.7	73.8	71.7	68.6	62.0	54.5	
Mornington Crescent to Euston	85.5	115.6	65.2	71.0	78.3	80.9	80.3	75.3	68.2	58.5	

4. Conclusions

- Noise levels were greatly influenced by interstation sections with noise levels above 80dB(A).
- Noise within 1995 Tube Stock is dominated by rolling contact noise. This airborne noise outside the train influences the noise levels inside the saloon.
- There are sections of the Northern line track that have corrugation (high rail roughness). Corrugation increases rolling noise and thus cab noise levels. In addition, resilient track has been installed in certain sections to cope with groundborne noise, which had a side effect of increased in-tunnel noise.
- All inter-station sections, with exception of the southbound section Camden Town to Mornington Crescent, exceeded 80dB L_{Aeq}.
- Several inter-station sections exceeded 85dB L_{Aeq}, namely three on the northbound road and two on the southbound road.
- The daily exposure level for a single run on each direction does not exceed the Lower Exposure Action Value (LEAV) for continuous noise at an L_{EP,d} of 80dB(A).
- To exceed the LEAV, customers would have to travel:
 - 11 times on the northbound section between Euston and Tufnell Park
 - or
 - 20 times on the southbound section between Tufnell Park and Euston
 - or
 - 7 round trips between Tufnell Park and Euston
- All of the measured inter-station sections measured below the LEAV for impulsive noise, namely an instantaneous C-weighted peak level (L_{Cpk}) of 135 dB(C). The highest peak level, 118dB(C), was recorded between Camden Town and Kentish town, reaching 119dB(C).

5. References

- Statutory Instrument 2005 No. 1643. The Control of Noise at Work Regulations 2005.
- Controlling Noise at Work, Guidance Document L108, Health and Safety Executive 2005.
- Health and Safety Executive Daily Noise Exposure Calculator
www.hse.gov.uk/noise/dailycalc.xls



APPENDIX A – Equipment Details

Table A.1 – Equipment used for the train operator noise exposure measurements

Item	Make	Model	Serial No.
Sound Level Meter	01dB	Fusion	11489



APPENDIX B – Full Line Testing Results

Table B.1 – Inter-station noise levels on the Northern northbound road between Euston and Tufnell Park

Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Euston to Mornington Crescent	86.7	113.0	50.6	60.3	75.0	85.1	79.7	72.8	64.8	57.4
	87.0	114.1	54.2	59.5	75.4	84.7	81.4	74.4	65.6	56.1
	84.8	111.3	50.5	59.4	75.9	83.1	76.5	68.5	59.7	49.1
Mornington Crescent to Camden Town	81.2	108.9	57.5	63.8	73.9	76.6	76.5	70.5	63.1	50.7
	83.3	109.1	57.9	63.7	74.0	78.7	79.1	73.8	65.5	53.6
	80.0	107.7	57.5	63.3	74.9	74.0	74.7	69.7	61.8	49.1
Camden Town to Kentish Town	89.4	116.3	57.0	64.1	74.6	85.4	86.3	77.5	67.2	54.9
	89.8	117.7	59.2	62.8	74.9	85.5	86.7	78.9	68.4	55.1
	88.3	119.3	57.2	62.9	74.2	84.1	85.3	76.5	65.4	53.2
Kentish Town to Tufnell Park	85.4	110.1	61.5	65.7	78.0	80.9	80.8	72.7	66.0	53.8
	88.7	113.8	62.0	64.7	78.5	83.8	85.9	76.2	66.9	54.3
	94.2	118.6	60.8	66.0	78.3	88.4	91.7	85.2	73.3	58.8

Table B.4 – Inter-station noise levels on the Northern southbound road between Tufnell Park and Euston

Interstation section	L _{Aeq} dB(A)	LC _{peak} dB(C)	Noise Spectral Analysis in Octave (Hz)							
			63	125	250	500	1000	2000	4000	8000
Tufnell Park to Kentish Town	79.1	106.5	54.3	63.3	69.4	75.9	73.2	69.0	61.6	50.5
	82.5	108.6	55.2	64.8	73.2	78.9	77.2	72.1	65.4	53.9
	81.6	108.8	54.3	64.3	72.6	78.5	75.7	70.8	63.7	52.7
Kentish Town to Camden Town	81.5	109.1	58.3	67.5	72.5	78.3	75.6	69.8	59.7	50.3
	85.3	112.2	59.4	68.4	77.0	81.5	80.7	72.2	64.1	51.6
	91.3	115.0	57.8	65.7	77.9	86.0	87.6	83.7	77.3	59.8
Camden Town to Mornington Crescent	75.6	108.1	54.3	63.2	68.7	71.8	68.1	65.8	58.6	53.1
	79.2	109.7	53.5	63.0	73.3	74.7	72.3	69.9	64.5	57.3
	78.7	108.3	54.0	60.8	72.0	74.3	73.1	69.2	60.8	50.3
Mornington Crescent to Euston	83.5	114.6	66.4	71.6	75.7	79.5	77.0	73.0	65.3	56.6
	86.6	115.6	64.9	71.7	79.8	81.9	81.4	75.9	69.9	59.8
	85.9	115.0	63.8	69.3	78.2	81.0	81.2	76.3	68.4	58.7