



C610 Systemwide Main Works

TVS – Acoustics “Give and Get” Information Spreadsheet – Paddington Station

CRL Document Number: C610-ATC-Y-RGN-B071-50004
Contract MDL reference S08.103

1. Contractor Document Approval:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
4.0	02-03-18	TV Acoustics Engineer	M&E Design Manager	Engineering Manager	For Design
Signatures:					

2a. Stakeholder Review Required? YES NO

Stakeholder submission required: LU RFL Purpose of submission: For no objection
 NR LO For information
 DLR Other: _____

This document has been reviewed by the following individual for coordination, compliance, integration and acceptance and is acceptable for transmission to the above stakeholder for the above stated purpose.

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2b. Review by Stakeholder (if required):

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Mott MacDonald Issue and Revision Record

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Design Team

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Signatures:		[Redacted]	[Redacted]	[Redacted]	

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VERSION CHANGES, AUTHORISATION & ISSUE RECORD

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3.0	15/12/17	All	Updated as requested by C610-PMI-01201.				For Design	2
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ATC REVIEW AND ACCEPTANCE

Refer to associated comments sheet number:

	ATC Review and Acceptance Decal This decal is to be used for submitted documents requiring acceptance by ATC.		
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Reviewed/Accepted by: (signature)	Print Name:	Position:	Date:
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<small>Acceptance by ATC does not relieve the designer/supplier from full compliance with their contractual obligations and does not constitute ATC approval of design, details, calculations, analyses, test methods or materials developed or selected by the designer/supplier.</small>			

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Executive Summary

Crossrail requests that C610 assess the potential for a reduction in noise levels as a result of reducing the tunnel air flowrates applied for the cooling of the stationary trains. This reduction became possible upon receipt of the new train supplier information on the rolling stock from Bombardier, compared to when the tunnel ventilation system was designed to previous rolling stock tender information.

Building on the Assessment of Revised Train Thermal Data Report (ref: C610-ATC-Y-RGN-CRG03-50080), this report sets out the agreed mitigations for each station/shaft contractor to meet their contractual obligations relating to cumulative noise predictions at Noise Sensitive Receptors (NSRs). These noise levels are governed by the D25 target of Background Noise Levels (BNLs) – 5dB and have been captured in this document by means of an Acoustics Give and Get Information Sheet (presented within Appendix A). The sheet was produced to summarise the following;

- Direct, in-duct tunnel ventilation noise emanating from tunnel ventilation outlets, as per the noise paths set out in Appendix A of CRL1-XRL-T1-RSP-CR001-50004 Rev 2.0, as calculated by C610;
- Regenerated noise arising from airflow through tunnel ventilation outlet coverings, based on products procured by the station contractor. The performance data is provided by station/shaft contractors;
- Breakout noise permeating through the shaft building fabric, doors/hatches and draught relief shafts, as calculated by C405;
- Station contractor’s fixed installations; and
- HV transformer and switch room noise presented within C650-ALC-T1-RGN-CRG03-50001 v2.0. This is the responsibility of C650. In the case of this document, it has been agreed with C405 that HV Transformer values are replaced with a ‘-’ where the source has been deemed to be negligible.

Subsequently, the station/shaft contractors have used the data to notify C610 of the new TVS Breakout and Station Plant noise values arising at each noise-sensitive receptor. The results were used to advise the quantities of lining required, presenting station/shaft contractors with a value engineering opportunity in terms of reductions in mitigation needed within their respective tunnel ventilation systems.

This document has been produced, as per Crossrail’s request, to support interfacing contractors in their Wrap-Up Gates.

Abbreviations

BNL	Background Noise Level
BOS	Bond Street Station
CWS	Canary Wharf Station.
ELS	Eleanor Street Shaft
ETH	East Ticket Hall
FAR	Farringdon Station
LIS	Liverpool Street Station
NSR	Noise-Sensitive Receptor
PAD	Paddington Station
SPL	Sound Pressure Level, the measure of the effective sound pressure of a sound relative to a specified reference level, on a logarithmic dB scale.
STG	Stepney Green Shaft
SWL	Sound Power Level, a measure of the power of a sound relative to a specified reference level (1pW), on a logarithmic dB scale.
TCR	Tottenham Court Road Station
TVS	Tunnel Ventilation System
UPE	Under-Platform Extract.
WHI	Whitechapel Station
WOO	Woolwich Station
WTH	West Ticket Hall

1 Purpose

An *Acoustics Give and Get Information Sheet* was produced (Appendix A) and distributed to the station/shaft contractors with updated TVS noise levels for each mode of operation, assuming the current level of agreed mitigation (Section 6). These modes are:

- Normal (UPE) Mode (where applicable);
- Congested Mode;
- Maintenance Mode; and
- Incident Mode (These are for station/shaft contractors’ internal assessments only as they do not form part of the D25 cumulative requirements).

Additionally, the fan room noise levels for each mode incorporated the following options:

- Standard flexible couplings (base option);
- Acoustic blanket proposal by Forecast Supplier 1; and
- Acoustic blanket proposal by Forecast Supplier 2.

The station/shaft contractors have used the data provided to undertake TVS breakout calculations in order to assess contributions to the NSRs listed within the template provided and confirm the fan room noise control option required to meet the D25 design target. Similarly, final values of the station plant contribution have also been provided. The final cumulative noise levels and mitigation measures have been agreed between the relevant parties (Appendix A) to allow the completion of all relevant noise demonstration reports.

All interfacing activities relating to this document are available in the relevant Interfacing Control Document (ICD).

2 Scope

The station/shaft contractors and C610 have worked closely to agree a series of in-principle noise mitigation options with the aim of meeting the cumulative D25 design target of BNL (Background Noise Level) -5dB at each NSR in accordance with the following Project Manager’s Instructions:

- C610-PMI-00159; C610-PMI-00254; C610-PMI-00478; C610-PMI-00606.

The cumulative rating levels at D25 NSRs were assessed by C610, considering the following contributions:

- Direct, in-duct tunnel ventilation noise emanating from tunnel ventilation outlets, as per the noise paths set out in Appendix A of CRL1-XRL-T1-RSP-CR001-50004 Rev 2.0, as calculated by C610;
- Regenerated noise arising from airflow through tunnel ventilation outlet coverings, based on products procured by the station contractor. The performance data is provided by station/shaft contractors;
- Breakout noise permeating through the shaft building fabric, doors/hatches and draught relief shafts, as calculated by C405;
- Station contractor’s fixed installations; and
- HV transformer and switch room noise presented within C650-ALC-T1-RGN-CRG03-50001 v2.0. This is the responsibility of C650.

These assessments were based on the design of the tunnel ventilation system to maintain a steady-state bulk temperature of 40°C within the running tunnels, using train data available at the time of design. Recently, C610 has received updated train data based on the actual trains manufactured by Bombardier.

As a result, this document has been produced to summarise the effects of reducing the flowrates of the procured fans, whilst maintaining the aforementioned temperature within the running tunnels. As such, the reduction in the flowrates allowed for lower sound power levels (SWL), and hence the noise levels within the tunnel ventilation shafts (TVS). The intentions of the updated assessments were to allow for compliance to be achieved with the D25 design target of background noise level (BNL) – 5dB at all noise-sensitive receptors (NSRs).

3 Controlling Documents

This document considers the current design of the C610 tunnel ventilation system, in addition to the new reduced fan flow rate calculations, which are detailed in the following documents;

- Paddington Station TVS Internal Noise and Pressure Requirements – (C610-ATC-H-RGN-CRG03-50029);
- TVS Acoustic Lining Requirements (C610-ATC-H-RGN-CRG03-50069 Revision 2.0);
- Tunnel Ventilation System - Outlet Covering Requirements (C610-ATC-T1-GUI-CRG03-50001); and
- Tunnel Ventilation System - Assessment of Revised Train Thermal Data (C610-ATC-Y-RGN-CRG03-50080).

4 Roles and Responsibilities

C610 Owns this document. Reviews and maintains this document. Communicates requirements. Presents cumulative rating levels at NSRs within Noise Demonstration Reports.

Interfacing Parties Produce and own the ICD document applicable at a given location. Demonstration of compliance with requirements contained herein. Provide acoustic lining, TVS outlet coverings and doors/hatches. Undertake assessments of rating levels at NSRs due to station plant fixed installations and noise breakout through building fabric. Responsible for noise mitigation made to building fabric and lining in non-TVS areas.

5 Assumptions

The following assumptions were made during the preparation of the data given within the spreadsheet.

1. SPLs in sections within the tunnel ventilation shafts are listed in dB(A). These are for the three operational modes provided in each plenum.
2. Noise levels in fan rooms are primarily due to breakout from the fan casing, 5mm thick transition ducts and flexible couplings.
3. SPL values have been adjusted to account for room reverberation.
4. It has been assumed that the building fabric is acoustically impermeable.

5. Any additional acoustic treatment provided by the station contractor to the room interiors will cause these values to change.
6. Fan and Attenuator performance values are derived from supplier data.
7. The design of the fan acoustic blanket (Forecast Supplier 1) is in progress with the appointed supplier. Final performance data is awaited. C610 have proceeded on the basis of the information provided by the proposed supplier that the acoustic coupling will match the acoustic performance of the transition ducts.
8. Mott MacDonald is not liable for the accuracy of input information from third parties or the ATC supply chain.

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6 Agreed level of Mitigation

6.1 Outlet Coverings

It is understood that C405 will procure the following products at each outlet covering:

			C405	
			PAD	
			WTH	ETH
Outlet Coverings	FV	Forced Ventilation	Bespoke Grille with bird mesh*	Bespoke Grille with bird mesh*
			Outlet Area = 75m ²	Outlet Area = 75m ²
	DRS-E	Eastbound Draught Relief	Bespoke Grille with bird mesh*	Bespoke Grille with bird mesh*
			Outlet Area = 24m ²	Outlet Area = 24m ²
	DRS-W	Westbound Draught Relief	Bespoke Grille with bird mesh*	Bespoke Grille with bird mesh*
			Outlet Area = 24m ²	Outlet Area = 24m ²

*C405 have informed C610 that these products will not achieve 90% free area, hence not complying with Appendix A of C610-ATC-T1-GUI-CRG03-50001.

The above products have been reviewed by C610. This review is based on the regenerated noise sound power levels estimated by C610 (Table 5-4 – Type 1 Outlets, C610-ATC-T1-GUI-CRG03-50001), as there is no performance data available for the Bespoke Grille; maximum design airflows anticipated during operation of the tunnel ventilation system (C610); the design area and type of the outlets (C405), which assumes a free area of 87%; the calculated environmental insertion loss from outlet to receptor (C610); and the design target at each receptor. These are predicted to comply with the D25 design target.

6.2 Acoustic Blankets

C405 has requested the incorporation of “Forecast Supplier 1” to complement the fan flexible coupling at both ticket halls.

6.3 Acoustic Lining

It is understood from C405 that the product supplier for acoustic lining within the Paddington tunnel ventilation shafts is SAS. The product and associated sound absorption coefficients provided by the station contractor are presented in the table below.

	Sound Absorption Coefficient (α)							
	63	125	250	500	1000	2000	4000	8000
SAS 100 mm SL10 Acoustic Shaft Lining System	0.25	0.65	1.00	1.00	1.00	1.00	0.95	0.90

C405 has requested the following quantities of acoustic lining within the tunnel ventilation shafts at this location:

			C405	
			PAD	
			WTH	ETH
Acoustic Lining [m ²]	TVS Section	Description	Product: SAS SL10	Product: SAS SL10
	1	Between forced vent outlet and primary atmosphere-side attenuator	0	0
	2	Between primary and secondary atmosphere-side attenuators	N/A	N/A
	3	Between secondary atmosphere-side attenuator and fan isolation dampers	N/A	N/A
	4	Between tunnel-side transition duct and tunnel-side attenuator	N/A	N/A
	5	Between tunnel-side attenuator and tunnel isolation dampers	0	0
	6	Between eastbound tunnel isolation damper and eastbound draught relief damper	0	0
	7	Eastbound draught relief shaft	0	0
	8	Between westbound tunnel isolation damper and westbound draught relief damper	0	0
	9	Westbound draught relief shaft	0	0
	FR	Fan room	200	200
	Total		200	200

The noise levels for the above noise control measures are presented in the “Noise within the tunnel ventilation shafts” section in Appendix A.

7 Flowrates by Operating Mode

It is understood that the Operating Modes will adopt the following flowrates:

Location	Fan flowrate (m ³ /s)	Incident Mode		UPE Mode		Congested Mode		Maintenance Mode	
		Fan speed	Shaft flowrate (m ³ /s)	Fan speed	Shaft flowrate (m ³ /s)	Fan speed	Shaft flowrate (m ³ /s)	Fan speed	Shaft flowrate (m ³ /s)
PAD-W	150	2 fans 100%	300	1 fan 72%	100	2 fans 75%	225	2 fans 75%	225
PAD-E	150	2 fans 100%	300	1 fan 72%	100	2 fans 75%	225	2 fans 75%	225

8 Key Information

The Tunnel Ventilation System sections presented are described below. Please note that not all sections are applicable to every shaft.

8.1 Section Definitions

Section	Description
1	Between forced vent outlet and primary atmosphere-side attenuator
2	Between primary and secondary atmosphere-side attenuators
3	Between secondary atmosphere-side attenuator and fan isolation dampers
4	Between tunnel-side attenuator and tunnel isolation dampers
5	Between eastbound tunnel-side attenuator and tunnel isolation dampers
6	Between eastbound tunnel isolation damper and eastbound draught relief damper
7	Eastbound draught relief shaft
8	Between westbound tunnel isolation damper and westbound draught relief damper
9	Westbound draught relief shaft
Fan Room	Fan chamber

8.2 Key

The colour coding applied to the results indicating D25 compliance at each noise receptor at each shaft within Appendix A are as follows.

Condition	Colour
For values ≤ -5	Green
For values between 0 and -5	Yellow
For values between 0 and +5	Orange
For values $\geq +5$	Red

Similarly, the colour coding applied to Community Buildings are shown below. Please note that these do not have to comply with the D25 requirements of BNL -5.

Condition	Colour
For values ≤ 0	Green
For values > 0	Red



Appendix A Give and Get Spreadsheet

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PAD WTH

1. Noise within the tunnel ventilation shafts

Normal (UPE) Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	68	68	62	60	59	63	64	73	76
2	N/A								
3	N/A								
4	N/A								
5	75	77	73	67	64	69	73	81	84
6	N/A								
7	58	56	45	38	32	30	26	29	61
8	N/A								
9	62	59	50	46	43	39	31	32	64

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	80	87	90	94	92	86	75	76	98
Forecast Supplier 1	72	77	80	89	80	74	66	62	90
Forecast Supplier 2	80	87	90	92	86	76	66	62	96

FR Option Chosen:

Congested Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	73	66	67	65	66	69	68	77	80
2	N/A								
3	N/A								
4	N/A								
5	79	75	78	72	71	75	77	85	88
6	N/A								
7	63	54	50	40	34	34	29	32	64
8	N/A								
9	66	57	53	43	38	37	33	36	67

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	85	85	95	97	97	91	79	80	102
Forecast Supplier 1	76	75	85	92	85	79	70	66	94
Forecast Supplier 2	85	85	95	95	90	80	70	66	99

2. Cumulative predictions at D25 NSRs

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Prince of Wales	Tunnel Vent	23	23	17	15	14	17	16	19	28	54	-26
	Outlet Coverings	-30	-19	-11	-6	-4	-5	-13	-10	1	54	-53
	TVS Breakout	-1	5	5	6	-11	-23	-36	-41	10	54	-44
	Station Plant	1	20	28	28	24	17	7	-11	32	54	-22
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Normal Mode	Total	23	25	28	28	24	20	17	19	34	54	-20

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Prince of Wales	Tunnel Vent	28	21	22	20	21	22	20	22	32	54	-22
	Outlet Coverings	-33	-24	-16	-10	-9	-10	-19	-17	-4	54	-58
	TVS Breakout	3	3	10	9	-6	-18	-32	-37	13	54	-41
	Station Plant	19	21	28	29	26	20	14	10	33	54	-21
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Congested Mode	Total	29	24	29	30	27	24	21	22	36	54	-18

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1. Noise within the tunnel ventilation shafts

Maintenance Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	73	66	67	65	66	69	68	77	80
2	N/A								
3	N/A								
4	N/A								
5	79	75	78	72	71	75	77	85	88
6	N/A								
7	63	54	50	40	34	34	29	32	64
8	N/A								
9	66	57	53	43	38	37	33	36	67

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	85	85	95	97	97	91	79	80	102
Forecast Supplier 1	76	75	85	92	85	79	70	66	94
Forecast Supplier 2	85	85	95	95	90	80	70	66	99

Incident mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	79	72	73	70	71	74	74	83	86
2	N/A								
3	N/A								
4	N/A								
5	85	80	83	76	75	80	82	90	93
6	N/A								
7	68	59	55	47	42	39	35	38	69
8	N/A								
9	72	62	58	50	46	43	38	41	72

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	90	90	100	102	102	96	84	85	107
Forecast Supplier 1	82	80	90	97	90	84	75	71	99
Forecast Supplier 2	90	90	100	100	96	86	75	71	104

2. Cumulative predictions at D25 NSRs

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Prince of Wales	Tunnel Vent	28	21	22	20	21	22	20	22	32	53	-21
	Outlet Coverings	-33	-24	-16	-10	-9	-10	-19	-17	-4	53	-57
	TVS Breakout	3	3	10	9	-6	-18	-32	-37	13	53	-40
	Station Plant	19	21	28	29	26	20	14	10	33	53	-20
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Maintenance Mode	Total	29	24	29	30	27	24	21	22	36	53	-17

Incident mode values are for the station contractor's internal assessments only. These do not form part of the D25 requirements. As such, cumulative predictions at the Noise Sensitive Receptors are not required.

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PAD ETH

1. Noise within the tunnel ventilation shafts

Normal (UPE) Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	68	68	62	60	59	63	64	73	76
2									
3									
4									
5	75	77	73	67	64	69	73	81	84
6									
7	58	56	45	38	32	30	26	29	61
8									
9	62	59	50	46	43	39	31	32	64

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	80	87	90	94	92	86	75	76	98
Forecast Supplier 1	72	77	80	89	80	74	66	62	90
Forecast Supplier 2	80	87	90	92	86	76	66	62	96

FR Option Chosen: Forecast Supplier 1

Congested Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	73	66	67	65	66	69	68	77	80
2									
3									
4									
5	79	75	78	72	71	75	77	85	88
6									
7	63	54	50	40	34	34	29	32	64
8									
9	66	57	53	43	38	37	33	36	67

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	85	85	95	97	97	91	79	80	102
Forecast Supplier 1	76	75	85	92	85	79	70	66	94
Forecast Supplier 2	85	85	95	95	90	80	70	66	99

2. Cumulative predictions at D25 NSRs

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Pride of Paddington	Tunnel Vent	18	17	9	6	5	8	7	11	22	57	-35
	Outlet Coverings	-32	-23	-14	-7	-3	-3	-12	-8	1	57	-56
	TVS Breakout	1	7	7	8	-9	-21	-34	-38	12	57	-45
	Station Plant	10	27	34	35	34	28	17	-7	40	57	-17
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Normal Mode	Total	19	27	34	35	34	28	17	11	40	57	-17

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Hilton Hotel*	Tunnel Vent	37	37	31	28	27	31	31	38	43	63	-20
	Outlet Coverings	-24	-14	-7	-2	0	-1	-8	-2	6	63	-57
	TVS Breakout	23	31	35	31	21	9	-7	-6	38	63	-25
	Station Plant	13	34	41	43	41	36	29	18	47	63	-16
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Normal Mode	Total	37	39	42	43	41	37	33	38	49	63	-14

* Community Building

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
16 Chilworth Street	Tunnel Vent	17	15	6	1	0	0	0	0	20	49	-29
	Outlet Coverings	-42	-34	-29	-27	-28	-32	-43	-46	-22	49	-71
	TVS Breakout	-9	-3	-3	-3	-19	-32	-45	-49	2	49	-47
	Station Plant	4	22	28	26	25	19	10	-11	32	49	-17
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Normal Mode	Total	17	23	28	26	25	19	10	0	32	49	-17

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Pride of Paddington	Tunnel Vent	23	15	14	11	12	14	12	14	25	57	-32
	Outlet Coverings	-40	-29	-22	-17	-15	-16	-24	-22	-10	57	-67
	TVS Breakout	5	5	12	11	-4	-16	-30	-34	15	57	-42
	Station Plant	24	27	33	35	33	29	26	24	40	57	-17
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Congested Mode	Total	27	27	33	35	33	29	26	24	40	57	-17

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Hilton Hotel*	Tunnel Vent	42	35	36	33	34	36	35	42	47	63	-16
	Outlet Coverings	-16	-6	1	6	8	7	-1	5	13	63	-50
	TVS Breakout	27	29	40	34	26	14	-3	-2	42	63	-21
	Station Plant	27	34	42	43	41	36	34	34	48	63	-15
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Congested Mode	Total	42	38	45	44	42	39	38	43	51	63	-12

* Community Building

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
16 Chilworth Street	Tunnel Vent	22	13	11	6	4	3	0	0	23	49	-26
	Outlet Coverings	-36	-28	-24	-21	-22	-26	-38	-41	-17	49	-66
	TVS Breakout	-5	-5	2	0	-14	-27	-41	-45	5	49	-44
	Station Plant	13	22	28	27	25	19	11	2	32	49	-17
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Congested Mode	Total	23	23	28	27	25	19	11	4	33	49	-16

PAD ETH

1. Noise within the tunnel ventilation shafts

Maintenance Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	73	66	67	65	66	69	68	77	80
2	N/A								
3	N/A								
4	N/A								
5	79	75	78	72	71	75	77	85	88
6	N/A								
7	63	54	50	40	34	34	29	32	64
8	N/A								
9	66	57	53	43	38	37	33	36	67

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	85	85	95	97	97	91	79	80	102
Forecast Supplier 1	76	75	85	92	85	79	70	66	94
Forecast Supplier 2	85	85	95	95	90	80	70	66	99

Incident Mode

Section	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
1	79	72	73	70	71	74	74	83	86
2	N/A								
3	N/A								
4	N/A								
5	85	80	83	76	75	80	82	90	93
6	N/A								
7	68	59	55	47	42	39	35	38	69
8	N/A								
9	72	62	58	50	46	43	38	41	72

Fan Room Option	Sound Pressure Level (SPL) [dB(A)]								
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
Standard	90	90	100	102	102	96	84	85	107
Forecast Supplier 1	82	80	90	97	90	84	75	71	99
Forecast Supplier 2	90	90	100	100	96	86	75	71	104

2. Cumulative predictions at D25 NSRs

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Pride of Paddington	Tunnel Vent	23	15	14	11	12	14	12	14	25	56	-31
	Outlet Coverings	-40	-29	-22	-17	-15	-16	-24	-22	-10	56	-66
	TVS Breakout	5	5	12	11	-4	-16	-30	-34	15	56	-41
	Station Plant	24	27	33	35	33	29	26	24	40	56	-16
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Maintenance Mode	Total	27	27	33	35	33	29	26	24	40	56	-16

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
Hilton Hotel*	Tunnel Vent	42	35	36	33	34	36	35	42	47	63	-16
	Outlet Coverings	-16	-6	1	6	8	7	-1	5	13	63	-50
	TVS Breakout	27	29	40	34	26	14	-3	-2	42	63	-21
	Station Plant	27	34	42	43	41	36	34	34	48	63	-15
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Maintenance Mode	Total	42	38	45	44	42	39	38	43	51	63	-12

Address	Source	Frequency (Hz)									BNL (dB)	Difference (dB)
		63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall		
16 Chilworth Street	Tunnel Vent	22	13	11	6	4	3	0	0	23	47	-24
	Outlet Coverings	-36	-28	-24	-21	-22	-26	-38	-41	-17	47	-64
	TVS Breakout	-5	-5	2	0	-14	-27	-41	-45	5	47	-42
	Station Plant	13	22	28	27	25	19	11	2	32	47	-15
	HV Transformer	-	-	-	-	-	-	-	-	-	-	-
Maintenance Mode	Total	23	23	28	27	25	19	11	4	33	47	-14

Incident mode values are for the station contractor's internal assessments only. These do not form part of the D25 requirements. As such, cumulative predictions at the Noise Sensitive Receptors are not required.

