APPENDIX – 7-3

Details of Operational
Groundborne Noise Assessment

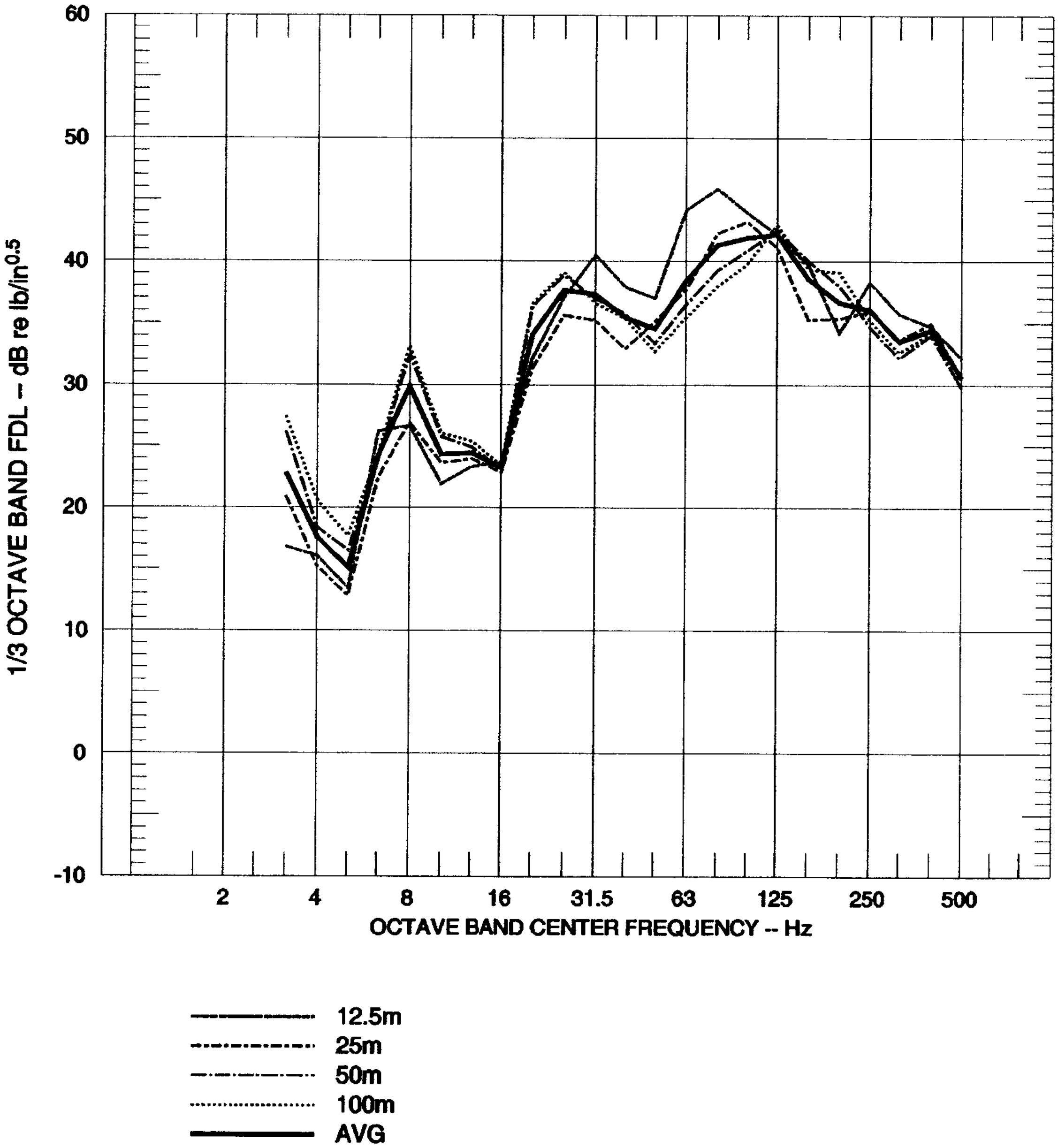
INFORMATION PERTAINING TO THE REPRESENTATIVE NOISE SENSITIVE RECEIVERS

	Location	Floor	Description	Up Track Distance, m		Down Track Depth, m		Rockhead Depth, m	Foundation Depth, m	Speed, kph	
				Plan	Depth	Plan	Depth			Up	Dn
GN 1	Sheraton Hong Kong Hotel	4/F	Guestroom	25	14	12	14	16	8	65	65
GN 2	Peninsula Hotel - Guestroom	2/F	Guestroom	32	14	26	13	16	5	65	65
GN 3	Hong Kong Space Museum - Planetarium	1/F	Planetarium	26	13	33	11	16	3	65	65
GN 4	Hong Kong Space Museum - Recording Room	1/F	Recording Room	50	13	57	11	16	3		
GN 5	YMCA Hotel	4/F	Guestroom	16	16	8	14	8	7	65	65
GN 6	Hong Kong Cultural Centre	2/F	Studio Theatre	29	16	38	13	13	7	65	65
GN 7	Hong Kong Cultural Centre	1/F	Concert Hall	52		60					
GN 8	Hong Kong Cultural Centre	1/F	Grand Theatre	65		73					
GN 9	Former Marine Police Headquarter	G/F	Future guestroom	0	33	0	24	12	1	65	65
GN 10	Macro Polo Hong Kong Hotel	2/F	Guestroom	18	21	22	12	8	7	65	65
GN 11	No.2-16 Canton Road	1/F	Residential	16	25	14	18	20	1	65	65
GN 12	Imperial Building, Canton Road	1/F	Residential	17	27	17	18	18	1	65	65
GN 13	Marco Polo Prince Hotel & Marco Polo Gateway Hotel	3/F	Guestroom	6	27	6	18	18	7	65	65
GN 14	Canton Road Government School	1/F	Classroom	21	26	11	15	7	1	72	72
GN 15	Fire Services Department Kowloon South Divisional HQ	3/F	Residential	5	25	14	15	9	3	72	72
GN 16	R(A) Development at Road D112B, 5R5, and D13D	1/F	Future Residential	43	20	70	15	19	6	72	60
GN 17	WKN Potential Topside Development	1/F	Future Residential	0	15	0	15	19	6	65	63
GN 18	Man King Building	1/F	Residential	50	15	30	15	29	1	71	90
GN 19	Charming Garden Block 1	2/F	Residential	92	19	82	19	35	1	92	106
GN 20	Park Avenue Phase II Block 1	5/F	Residential	75	19	62	19	37	6	99	110
GN 21	Olympian City - Phase 3	2/F	Future Residential	16	7	10	7	37	2	96	109

Correction factors for groundborne noise assessment

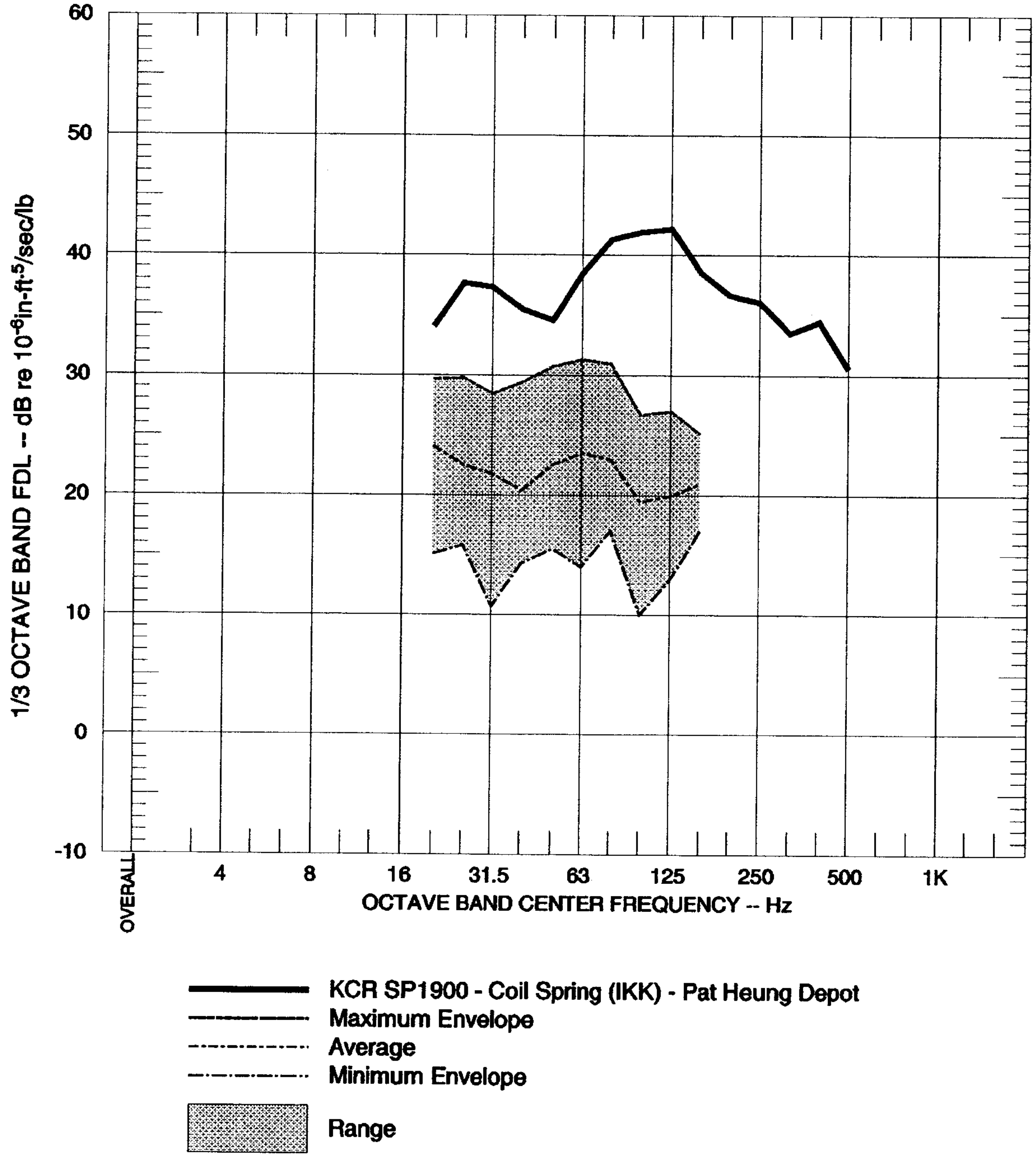
Correction Factor	Unit	1/3 Octave Band vibration Level, dB re 10^{-6} in/sec												
		32	40	50	63	80	100	125	160	200	250	315	400	500
CCF	dB	10	10	10	10	10	10	10	10	10	10	10	10	10
TCF	dB	0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
BCF	dB	-14	-14	-14	-14	-13.3	-12.6	-12	-11.3	-10.6	-10	-10	-10	-10
BVR	dB/ Floor	1	1	1	1	1	1	1	1	1	1	1	1	1
CTN	dB	2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB	10	10	10	10	10	10	10	10	10	10	10	10	10

FORCE DENSITY LEVEL (FDL) FOR THE SP1900 EMU



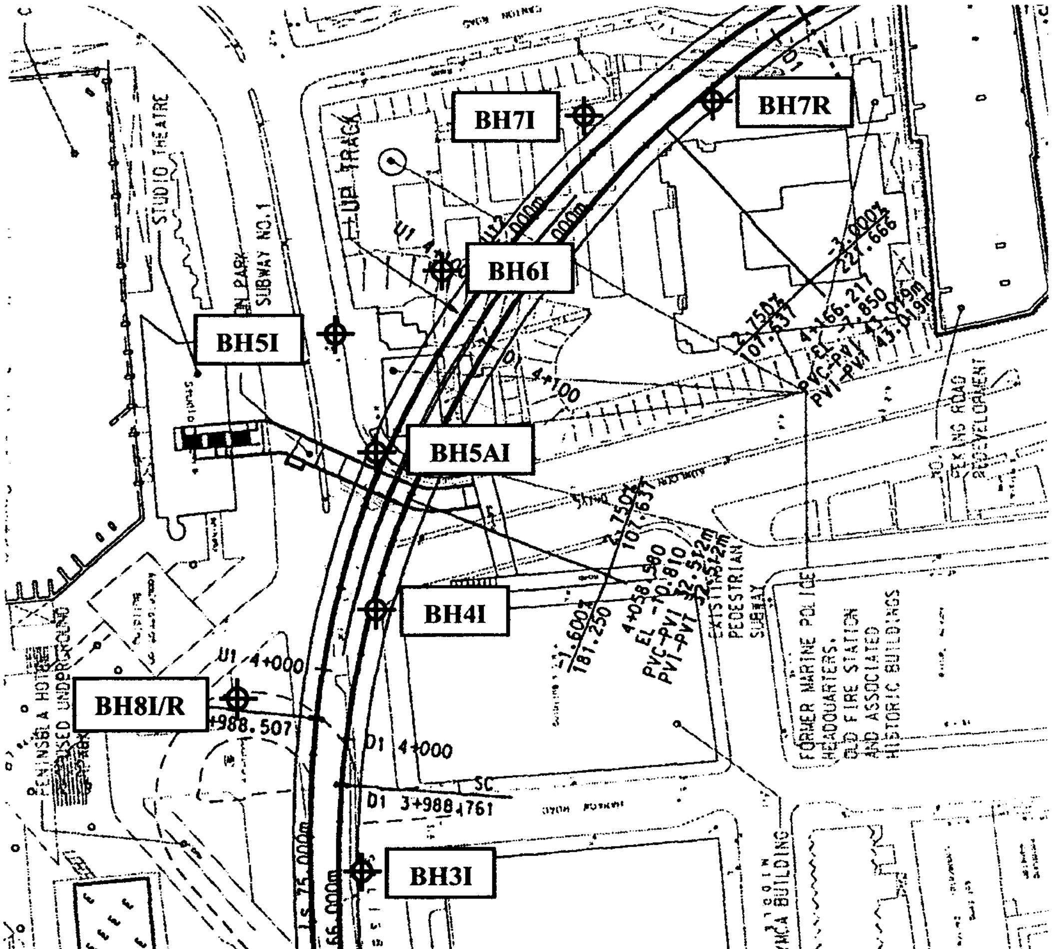
FORCE DENSITY LEVEL (FDL) FOR THE SP1900 EMU OPERATING AT 60kph ON BALLAST AND SLEEPER (UP) TRACK AT PAT HEUNG DEPOT FOR VARIOUS SETBACKS FROM TRACK

COMPARISON OF FDLS



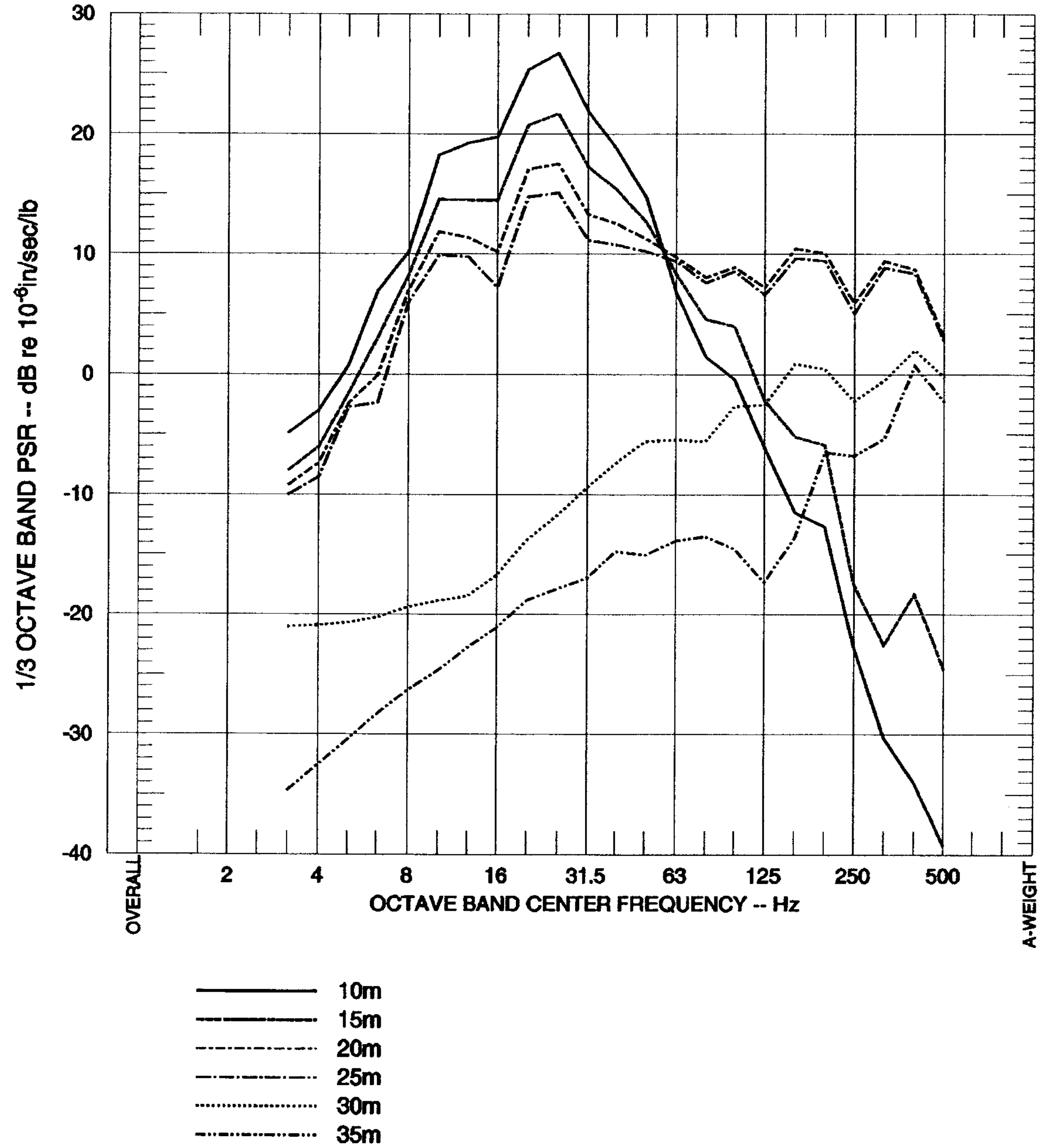
COMPARISON ABOVE THE LOW FREQUENCY LIMIT OF HEARING OF THE AVG FORCE DENSITY LEVEL (FDL) FOR THE SP1900 EMU (AT 60kph) TO THE RANGE OF FDL's FOR OTHER TRANSIT TRAINS EITHER IN OPERATION IN HONG KONG OR WITH SIMILAR SUSPENSION SYSTEMS

VIBRATION MEASUREMENTS AT SALISBURY ROAD



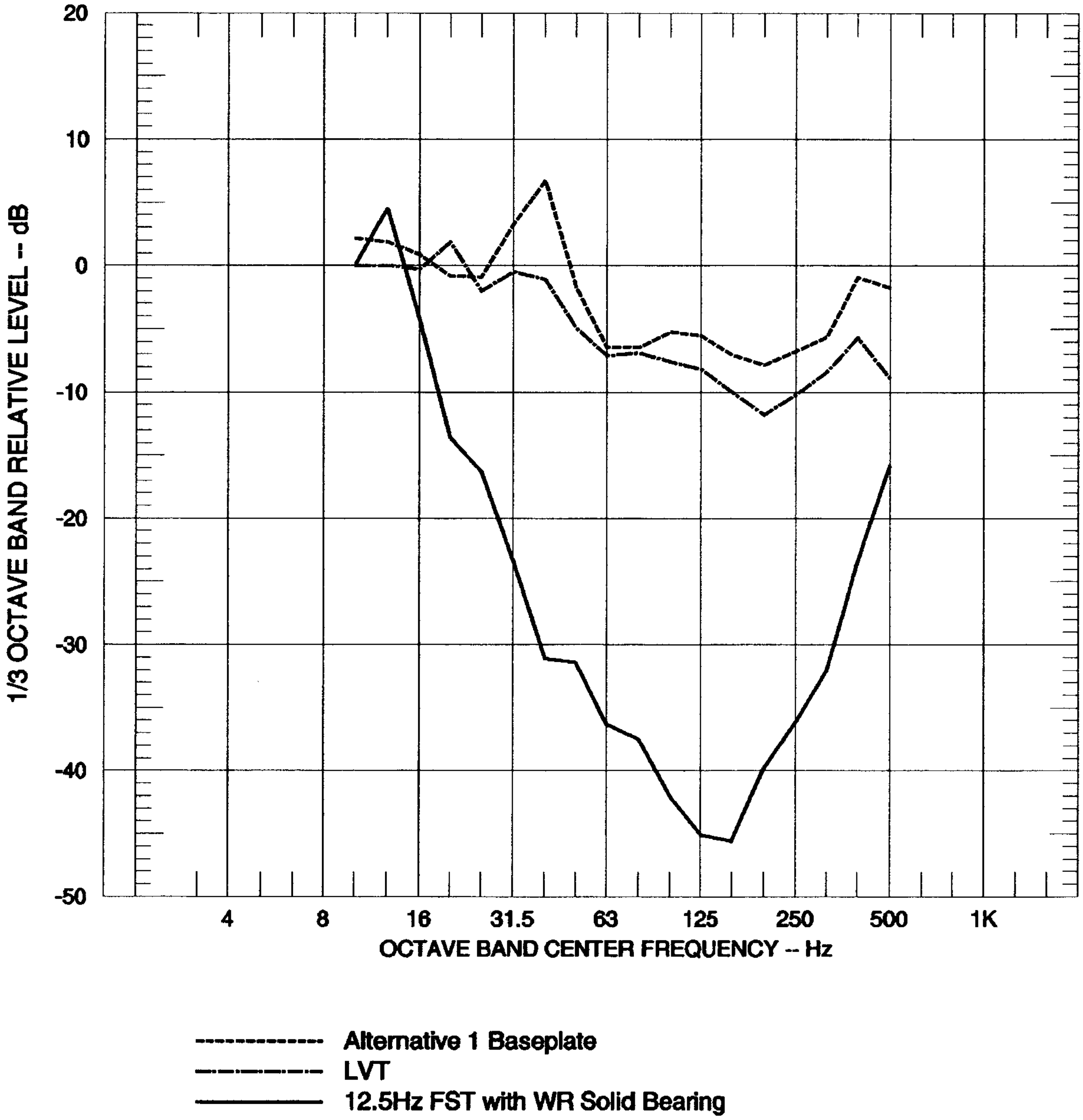
LOCATIONS OF IMPACT (I) AND RECEIVER (R) BOREHOLES ALONG SALISBURY AND CANTON ROADS

LINE SOURCE RESPONSE



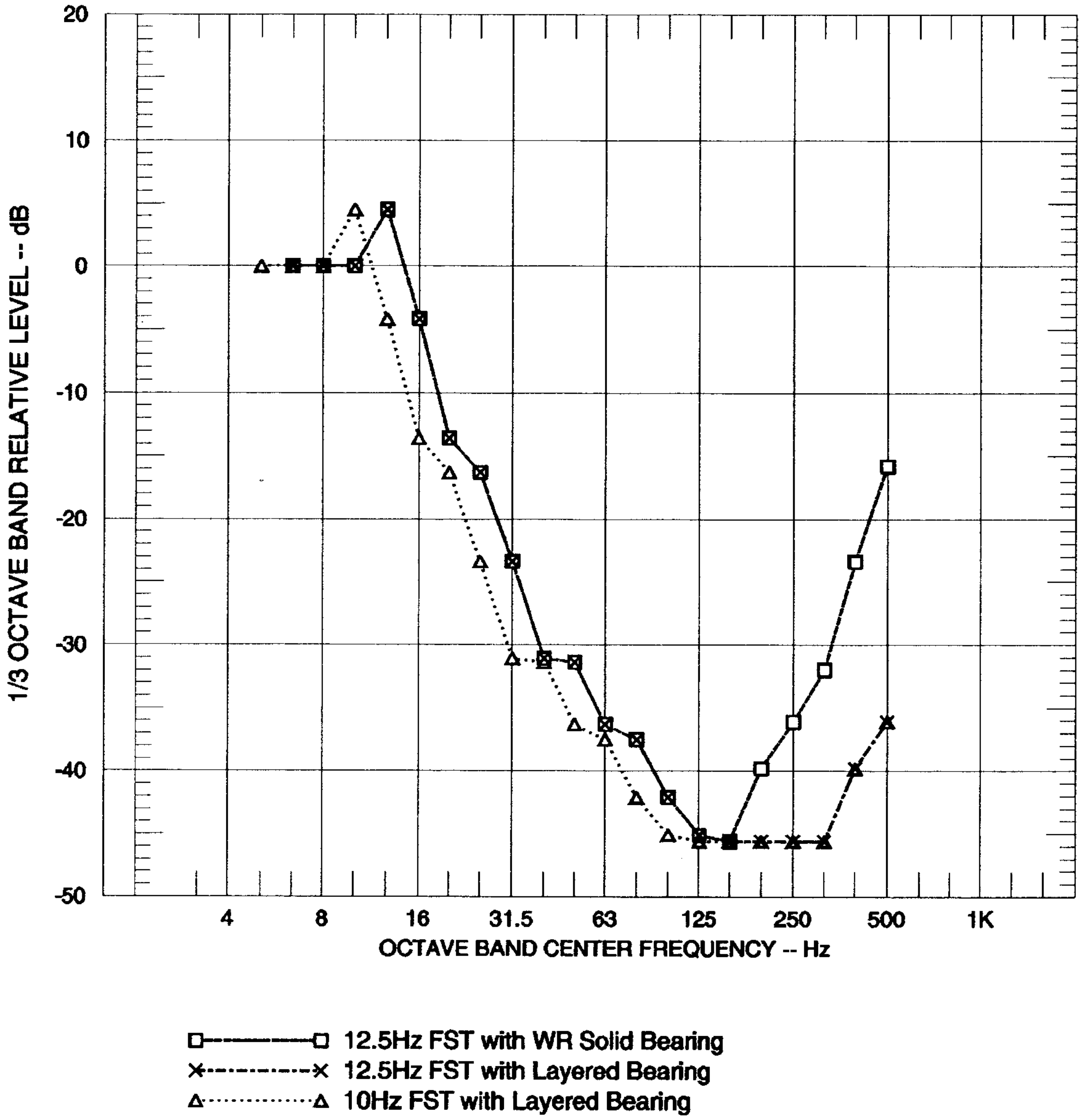
LINE SOURCE RESPONSE FOR VARIOUS TOP OF RAIL DEPTHS AT A BUILDING SET BACK 20m FROM TRACK CENTRE LINE AND ROCK HEAD AT 15m

Insertion Loss for West Rail Tunnel Trackfroms



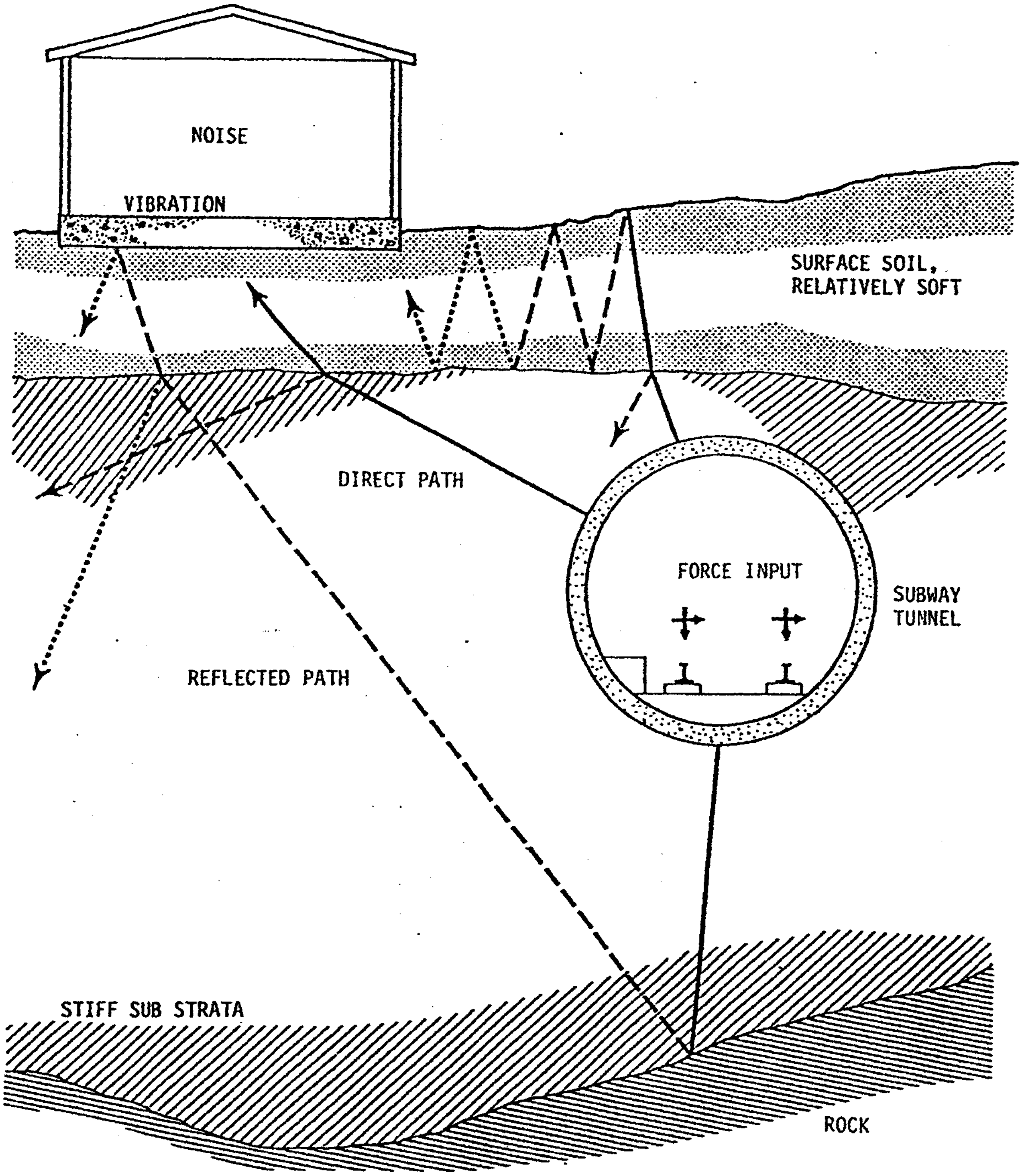
INSERTION LOSS FOR WEST RAIL TUNNEL TYPE FST WITH SOLID BEARINGS AND MOS TYPE LVT RELATIVE TO BALLAST AND SLEEPER TRACK OBTAINED DURING WORKS TRAIN PASSBYS IN WEST RAIL TUNNELS

Project Attenuation for FST Variant



COMPARISON OF INSERTION LOSS FOR WEST RAIL TUNNEL TYPE FST WITH SOLID BEARINGS AND PROJECTED PERFORMANCE OF A SIMILAR 12.5 Hz RESONANCE FST WITH LAYERED BEARINGS AND A 10 Hz FST WITH LAYERED BEARINGS.

GROUND VIBRATION TRANSMISSION



SCHEMATIC OF VIBRATION PROPAGATION PATHS FROM TRANSIT TUNNEL TO RECEIVER BUILDING

HARRIS MILLER MILLER & HANSON INC.
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July 16, 2004

Mr. Richard K. Kwan
Environmental Manager
Kowloon-Canton Railway Corporation
New Railway Projects Division
8th Floor, Citylink Plaza, Sha Tin
New Territories, Hong Kong SAR

Subject: Independent Acoustic Design Review of Draft Final Report
"Groundborne Noise & Vibration Assessment and Trackform Specification for KCRC KSL Extension: From ETST Station to Nam Cheong Station"

Reference: HMMH Project Number 300200.000

hmmh

Dear Mr. Kwan:

This letter summarizes the conclusions of an independent review of the subject report prepared for the Kowloon-Canton Railway Corporation (KCRC) by Wilson, Ihrig and Associates - Hong Kong, Limited (WIAHK) and dated 9 March 2004. An update to Annex H of the report, titled "Vibration and Noise Measurements Results at Kwai Tsing Theatre" and dated 1 June 2004, was also included in the review. The report describes a detailed analysis of ground-borne noise and vibration and presents trackform design recommendations for the Kowloon Southern Link (KSL), a planned underground railway extension with an alignment close to a number of sensitive facilities (including the Hong Kong Cultural Centre, the Space Museum and several hotels). This review, carried out for KCRC by Harris Miller Miller & Hanson Inc. (HMMH), was supplemented by site visits conducted by David Towers of HMMH during the week of June 14-18, 2004.

Overall, we believe that WIAHK has prepared a well-documented report based on a very thorough analysis using internationally recognized, state-of-the art methods. Based on our review and observations, it is our opinion that the WIAHK ground-borne noise and vibration analysis for the KCRC KSL Extension is extremely conservative. Thus, we expect that with implementation of the recommended trackform designs, ground-borne noise and vibration levels from future train operations are likely to meet the very stringent criteria established for sensitive receivers adjacent to the KSL alignment with a sizeable margin of safety.

Sincerely yours,

HARRIS MILLER MILLER & HANSON INC.

David A. Towers

David A. Towers, P.E.
Principal Engineer

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1 June 2004

Kowloon-Canton Railway Corporation
West Rail Division
8th Floor, Citylink Plaza
Shatin, New Territories,
Hong Kong SAR

To: Mr. Richard Kwan, Environmental Manager

Subject: KCRC Kowloon Southern Link
Results from Vibration and Noise Measurements Taken During SP1900 EMU Passbys on KCRC West Rail at the Kwai Tsing Theatre

VIBRATION AND NOISE MEASUREMENTS RESULTS AT KWAI TSING THEATRE

Noise and vibration measurements were performed at the Kwai Tsing Theatre (KTT) adjacent to the KCRC West Rail during routine operation of transit trains before the commencement of revenue operation. This study is comprised of the following parts:

1. Comparisons of measured vibration levels on the foundation of KTT are made against vibration projections using the foundation and soil structure data obtained previously from the design of West Rail in 1999, and the current West Rail EMU and trackform. The predictions were made using a methodology derived from the US Federal Transit Administration (FTA) similar to the one used in the Kowloon Southern Link (KSL) Environmental Impact Assessment (EIA) study.

2. Comparisons of the noise and vibration propagation characteristics of the ground conditions and foundation structures at Kwai Tsing Theatre and Hong Kong Cultural Centre (HKCC) Studio Theatre with reference to data presented in the FTA Transit Noise and Vibration Impact Assessment Manual.

3. Noise levels are projected for the HKCC Studio Theatre starting with the ground borne vibration levels measured on the foundation at KTT, and compared with the predicted noise levels and design criteria as presented in the KSL EIA Study.

It should be noted that the methodology, supporting data and terminology used in the projection of ground borne noise and vibration contained herein are exhaustively described in report titled "Groundborne Noise & Vibration Assessment and Trackform Specification for KCRC KSL Extension: From ETST Station to Nam Cheong Station" (KSL GBN&V Report) developed by Wilson, Ihrig & Associates – Hong Kong, Limited (WIAHK). This report on the KTT measurements and their implications is meant to be understood in conjunction with the KSL GBD&V Report, and thus, the reader is referred for a complete technical description.

MEASUREMENT DATE, TIME AND PERSONNEL

Measurement of groundborne noise and vibration induced by West Rail operation was conducted at Kwai Tsing Theatre by WIAHK and witnessed by EPD officers. The measurement was conducted from 2100 hours to 2330 hours on 7 December 2003.

MEASUREMENT LOCATIONS

The vibration measurement was conducted at building edge close to the West Rail alignment, at roughly 25m setback, as shown in Figures 1A, 1B and 1C. Accelerometers were affixed on a foundation plinth beneath the isolation bearing closest to the undercroft access door adjacent to the West Rail alignment (Photo 1).

The noise measurement was conducted at the 1/F Exhibition Hall. The microphone was set at 1.5 m height at the centre of Exhibition Hall.

Four-channel digital data recording was used to record the noise and vibration signals. The measurement locations of the microphone and the accelerometers are indicated in Figure 1.

INSTRUMENTATION

The noise and vibration (after analogue integration to obtain velocity signal) data were simultaneously recorded by an 8-channel DAT recorder with a bandwidth of 20kHz. Noise calibrations were performed before and after the measurement with an acoustical calibrator to confirm no significant shift of microphone response. The recorded signals were played back and analysed by a 12-channel B&K Pulse Analyser to obtain average 1/3 octave spectrum during the identified West Rail train passbys. The instrumentation is given in Table (KTT) 1 below.

TABLE (KTT) 1 INSTRUMENTATION USED FOR THE VIBRATION AND NOISE MEASUREMENTS

Instrument	Model No.	Serial Number
12-Channel Spectrum Analyser,	B&K Pulse, Model 3560D,	2382079
Seismic Accelerometer and Pre-amplifier	Wilcoxon Research, Model 731A / P31	2182 / 1505
Microphone	B&K 4189	2386403
Microphone preamplifier	G.R.A.S. Type 26CA	41903
4-channel Conditioning Amplifier	B&K Nexus, Type 2693 A 014	2407019
8-channel DAT Recorder	Teac RT135	731107
Acoustical Calibrator	B&K Type 4231	1795390

DATA ANALYSIS

Train passbys were only audible through the accelerometer mounted on the foundation plinth below the isolated structure. Train passbys were not distinguishable from the ambient condition through the microphone placed in the Exhibition Hall. As measurement data were taken simultaneously, data analysis of the train passbys was possible by analysing the recorded tape segment corresponding to the passby as identified through the accelerometer mounted on the plinth.

The rms level during the audible passby was obtained in 1/3 octave bands. Overall linear and A-weighted levels were obtained from the 1/3 octave band data for each passby. Five passbys were averaged for each sensor.

RESULTS

Measurement Data

Measurement results are given in Figures 2 to 4. In Figure 2, the average vibration level measured on the foundation plinth beneath the isolation bearing is shown and compared to the average ambient vibration level recorded about the time of the passbys. The overall A-weighted vibration level is −11 dB(A) and 0 dB(A) for the ambient and train passby, respectively. The resonance appearing at 50 Hz in both the train passby and the ambient is believed to be caused, in part by, the unique foundation structure consisting of large underground beams, which are likely the source of the resonance.

Figure 3 shows the train passby vibration level and the ambient corrected train passby level. As standard ambient corrections are not accurate when the ambient level is close to that of the train passby level, the ambient correction is performed in 1/3 octaves in the following way: if the 1/3 octave ambient level is more than 2 dB below the passby level, the ambient level is energetically subtracted from the passby level; if the 1/3 octave ambient level is less than or equal to 2 dB below the passby level, 4.3 dB is subtracted from the passby level.

Figure 3 also indicates that the effect of the ambient level is not significant as regards the overall A-weighted vibration level during the passby. The ambient corrected A-weighted vibration level of train passby is found to be 0 dB(A). The vibration level can be converted to groundborne noise with considerable accuracy, by applying a conversion to noise (assuming 2dB as in line with the KSL EIA Study) and a correction due to the effect of the structure (assuming 0 dB for underground level). The A-weighted groundborne noise level is therefore 2 dB(A).

The average ambient and train passby noise levels measured in the exhibition hall (Figure 4) are indistinguishable, with the overall A-weighted level of about 31 dB(A). Thus the interior noise in the Exhibition Hall is dominated by building noise sources other than the structure radiated noise from the train passby. The noise level during the train passbys is at least 10 dB lower than that of the ambient (i.e. maximum 21 dB(A)).

Ground Borne Vibration Projections

In Figure 5, a comparison is given of the measured and projected vibration levels on the foundation plinth below the isolation bearing. The projected vibration levels are obtained using Force Density levels from SP1900 EMU, Type 2 (12.5 Hz) floating slab track (FST2) as installed, and the Line Source Response (LSR) determined previously by borehole impact testing at Kwai Tsing Theatre in 1999. It can be seen that even the projection has a high degree of conservatism at lower frequency range (between 4 and 31.5 Hz) and that the projection agrees closely with the measured data at higher frequency range (between 40 and 220 Hz). The overall A-weighted vibration level of the projection agrees well with the measured data.

Ground Conditions and Building Coupling Factors

The LSR used in this Study has taken into account the effect of geological conditions and building foundation on noise and vibration propagation. The KTT LSR data are obtained by averaging the Point Source Response taken atop columns 5 and 6 (on the foundation just below the isolation bearings), at 17m and 34m setback, respectively, from the impact borehole at impact depths of 12.5m, 19.7m and 23.6m, which approximately span the depth interval of the tunnel. The point to line source correction is then added to the average PSR. The KSL LSR data are obtained by a similar borehole impact testing programme conducted along Salisbury Road and lower Canton Road as described in KSL GN&V Report.

In Figure 6, a comparison is given for the LSRs determined for the HKCC Studio Theatre and for KTT. The setback of the Studio Theatre is 29m from the down track centreline and a depth to top of rail is 16m. The LSR obtained from the KTT ground impact data, as described above, is shown at 25m setback and 18m depth. Also shown is the LSR at 29m extrapolated from Figure 11-4 of the FTA Manual, which gives LSR data taken at the Transportation Test Centre in Pueblo, CO, and with Building Coupling Factor (BCF) for heavy structures applied (Figure 11-5 FTA Manual). The LSR projections indicate that ground conditions and building coupling up to the lower foundations at the KTT and at the HKCC along the KSL are very similar from the standpoint of vibration transmission. The LSR projections using KSL and KTT ground data are also higher, and thus more conservative than that given in the FTA manual.

The LSRs for KTT and HKCC Studio Theatre together with the corresponding noise and vibration prediction calculations are shown in Table (KTT) 2&3.

Ground Borne Noise Projections

Whilst it is true that noise levels measured within the non-isolated part (Exhibition Hall) of the Kwai Tsing Theatre (KTT) were high (31 dB(A)) relative to the predicted ground borne noise levels, on account of building ambient vibration levels, we do not consider this a major limitation as regards a like-to-like comparison between KTT and the Hong Kong Cultural Centre (HKCC). The measured vibration levels on the foundation below the building isolation system of the KTT during train passbys were sufficiently above ambient levels so as to be meaningful. These vibration levels can be converted to ground borne noise within the occupied spaces above foundation level with considerable accuracy, by applying a conversion to noise (+2 dB), and any other small corrections due to the effect of the structure (-1 dB per floor above foundation level) in accordance with the KSL EIA Study.

In Figure 7, the measured vibration level on the foundation at KTT is used as the basis of the projection of ground borne noise levels in the Studio Theatre at HKCC. Adjustments to the measured vibration level, given in Table (KTT) 4, are made for:

- Conversion to noise (+2 dB);
- Two stories above foundation level (-2 dB);
- Setback (10*Log(25m/29m);
- Simultaneous passbys of trains on both the Up and Down Tracks (+2.54 dB); and
- Difference in FDLs at the KTT (123 kph) and HKCC (65 kph).

No safety factor is added. The additional insertion loss of the modified trackform (10Hz layered bearing floating slab track) is also not taken in account.

Comparisons are then given in Figure 7 against threshold of hearing, absolute ambient noise level for the Studio Theatre which is based on measured noise levels within the Studio Theatre (See KSL EIA Report) as well as against the EIA prediction for the Studio theatre (KSL model and data - assuming the recommended 10Hz Type 4 FST (Table (KTT) 3) and excluding the 10 dB safety factor). It can be seen that the predictions closely agree, with overall A-weighted noise levels at about –3 dB(A), and in octave bands, the projected levels are roughly 10 dB to 15 dB below both the threshold of hearing and the absolute ambient level assumed for the Studio Theatre.

Figure 8 is exactly the same as Figure 7, except the 10 dB safety factor is included for the EIA prediction and added to the projection based on the Vibration measurement data taken on the foundation of KTT. With the safety factor applied, the overall A-weighted levels at about +7 dB(A) and the predictions range in octave bands roughly from 0 dB to 5 dB below both the threshold of hearing and the absolute ambient level assumed for the Studio Theatre. The prediction methodology used for the KTT and the KSL is based on that described in the FTA Manual, which does not recommend the use of any safety factor. We have added a 10 dB safety factor to be conservative in the KSL EIA study, however the conservatism relative to the most stringent criteria inherent in the projections without a safety factor applied, as given in Figure 7, questions whether any safety factor at all is appropriate.

CONCLUSIONS AND SUMMARY

The conclusions of this study are as follows:

1. Noise and vibration levels within the Kwai Tsing Theatre during train passbys cannot be distinguished from existing ambient levels; however, train passbys are audible through an

accelerometer affixed to the foundation plinth.

2. The structure borne noise level during train passbys, estimated from the foundation plinth vibration level, is roughly 2 dB(A), which is below the threshold of hearing.

3. The train passby noise level is not distinguishable at the Exhibition Hall with an overall A-weighted level of about 31 dB(A). The structure borne noise level during train passbys is therefore at least 10 dB lower than the ambient and is estimated to be 21 dB(A) maximum.

4. Comparison of measured vibration levels on the foundation plinth with projection of West Rail corrected to 12.5 Hz FST indicates close agreement between the measured levels and projection in the overall A-weighted level. The project has higher conservatism at lower frequency range between 4 and 31.5 Hz.

5. The LSR calculations using ground impact data taken at the KTT and along the KSL adjacent to the HKCC indicate that ground conditions and building coupling up to the lower foundations at the KTT and at the HKCC are very similar from the standpoint of vibration transmission. The LSR calculations are also more conservative than those given in the FTA Manual.

6. Figures 7 and 8 confirm both the accuracy and conservatism of the prediction models used regarding ground borne noise, as well as the appropriateness of the trackform selection at the KTT along West Rail and the HKCC along the proposed KSL.

Photographs

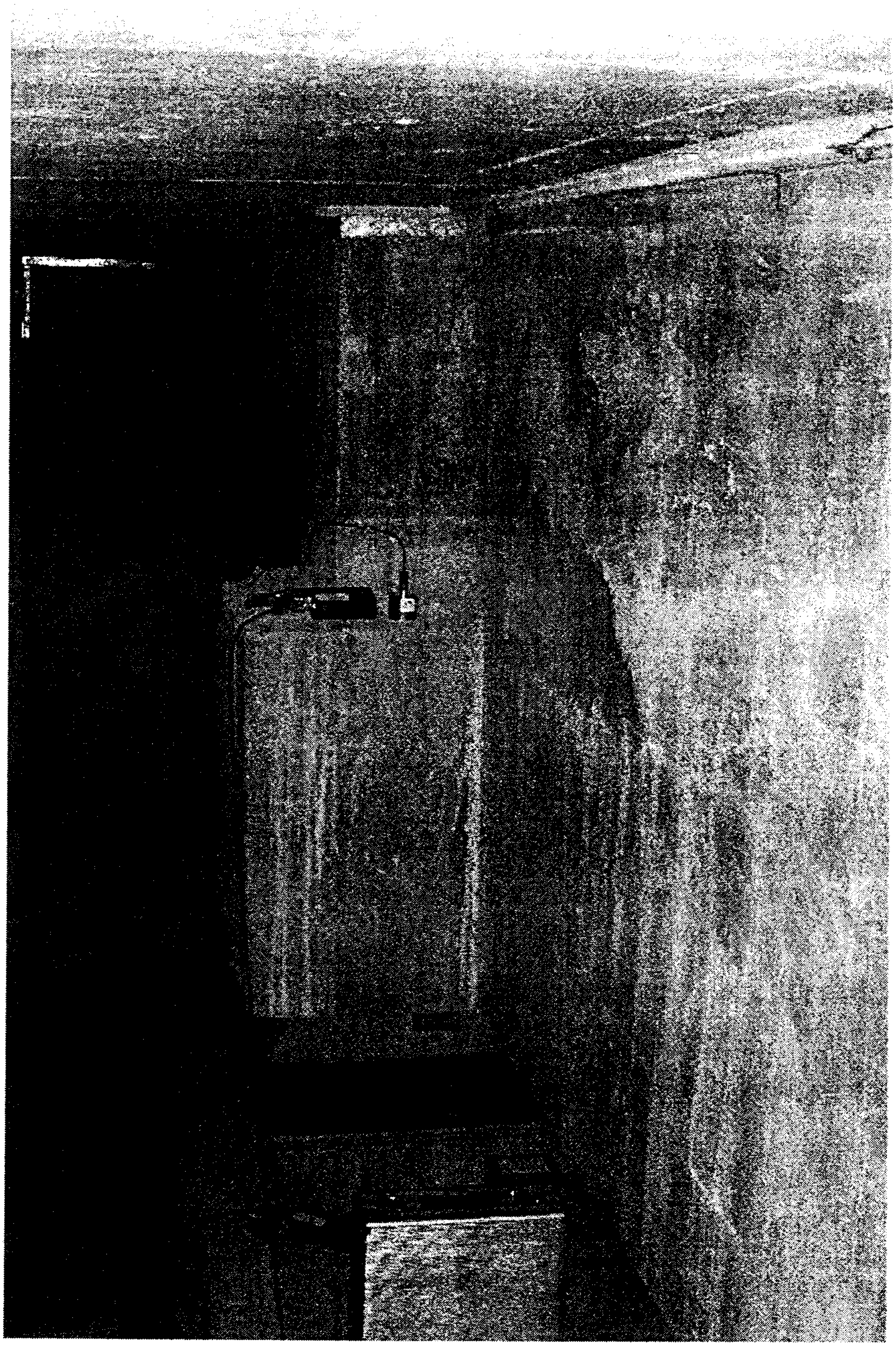

PHOTO 1 ISOLATION BEARING CLOSEST TO THE UNDERCROFT ACCESS DOOR ADJACENT TO THE KCRC WEST RAIL ALIGNMENT. SHOWN WITH ACCELEROMETERS MOUNTED ABOVE ON A FLOOR BEAM AND BENEATH ON THE FOUNDATION PLINTH

KEY:
M – MICROPHONE AT EXHIBITION HALL
S – VIBRATION SENSOR AT FOUNDATION PLINTH BELOW ISOLATION BEARING

FIGURE 1A LOCATIONS OF NOISE AND VIBRATION MEASUREMENT - WEST RAIL RUNNING UNDERNEATH KWAI FUK ROAD

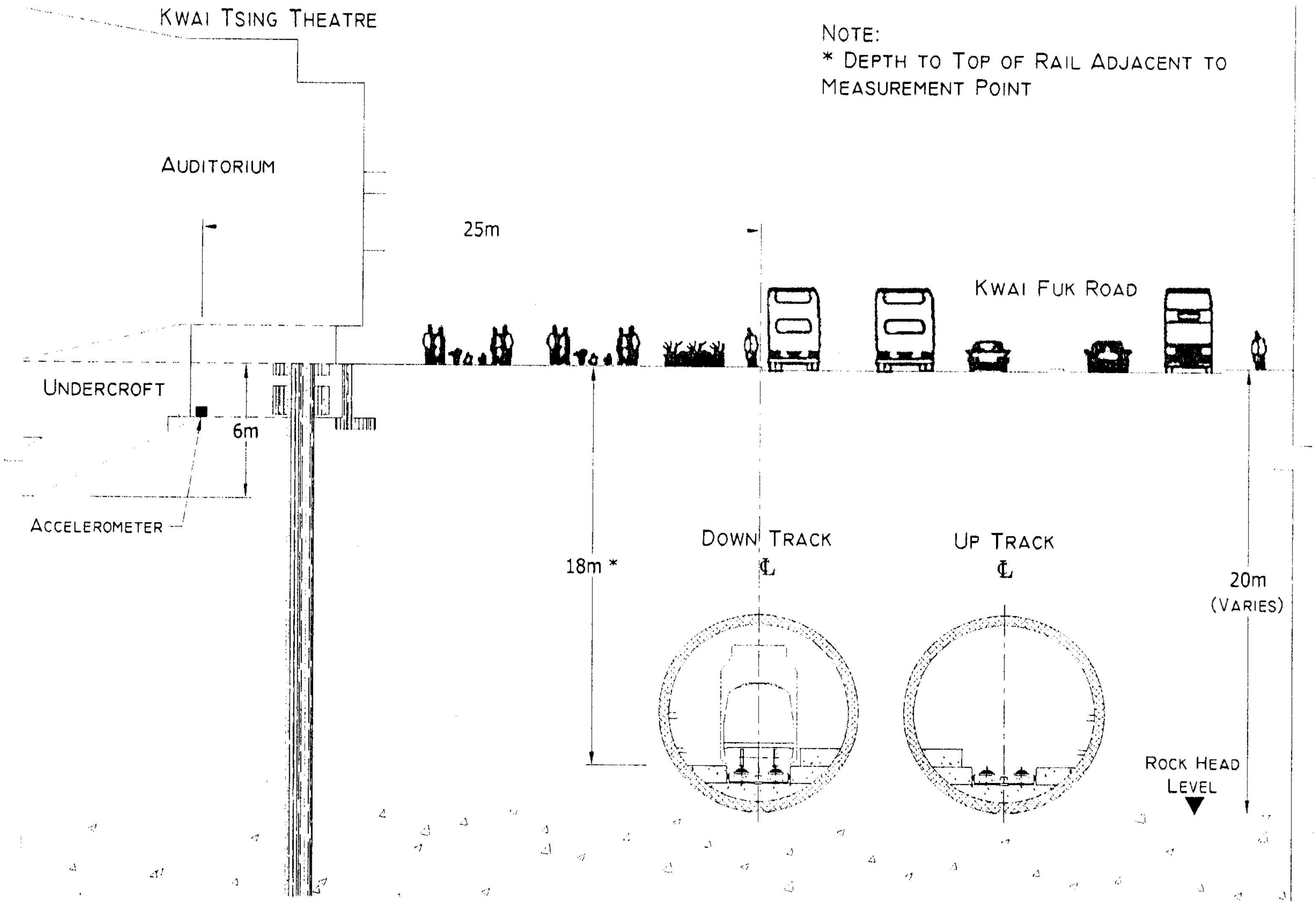

FIGURE 1B SCHEMATIC SECTION OF THE TUNNEL ALIGNMENT ADJACENT TO KWAI TSING THEATRE

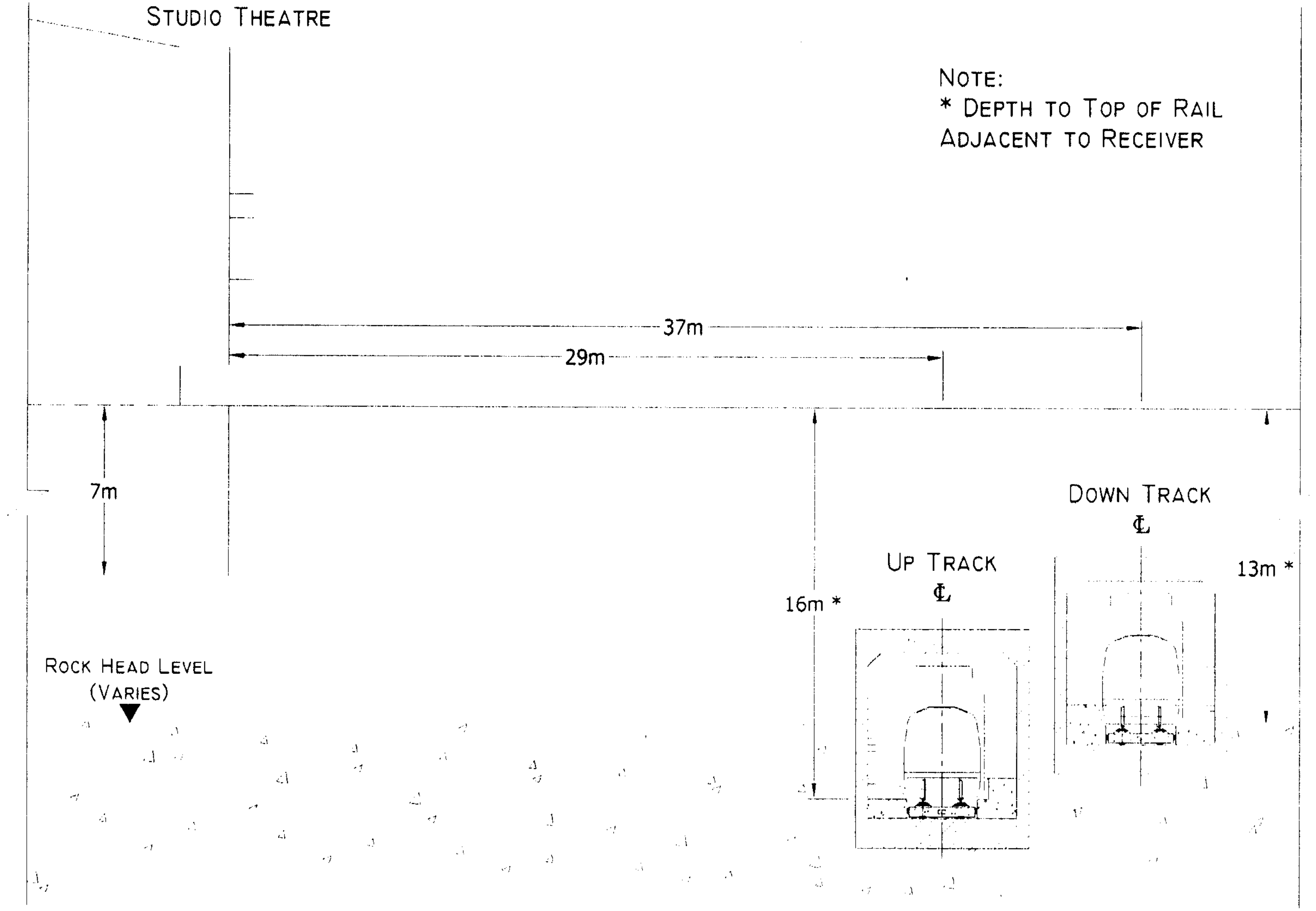

FIGURE 1C SCHEMATIC SECTION OF THE TUNNEL ALIGNMENT ADJACENT TO HKCC STUDIO THEATRE

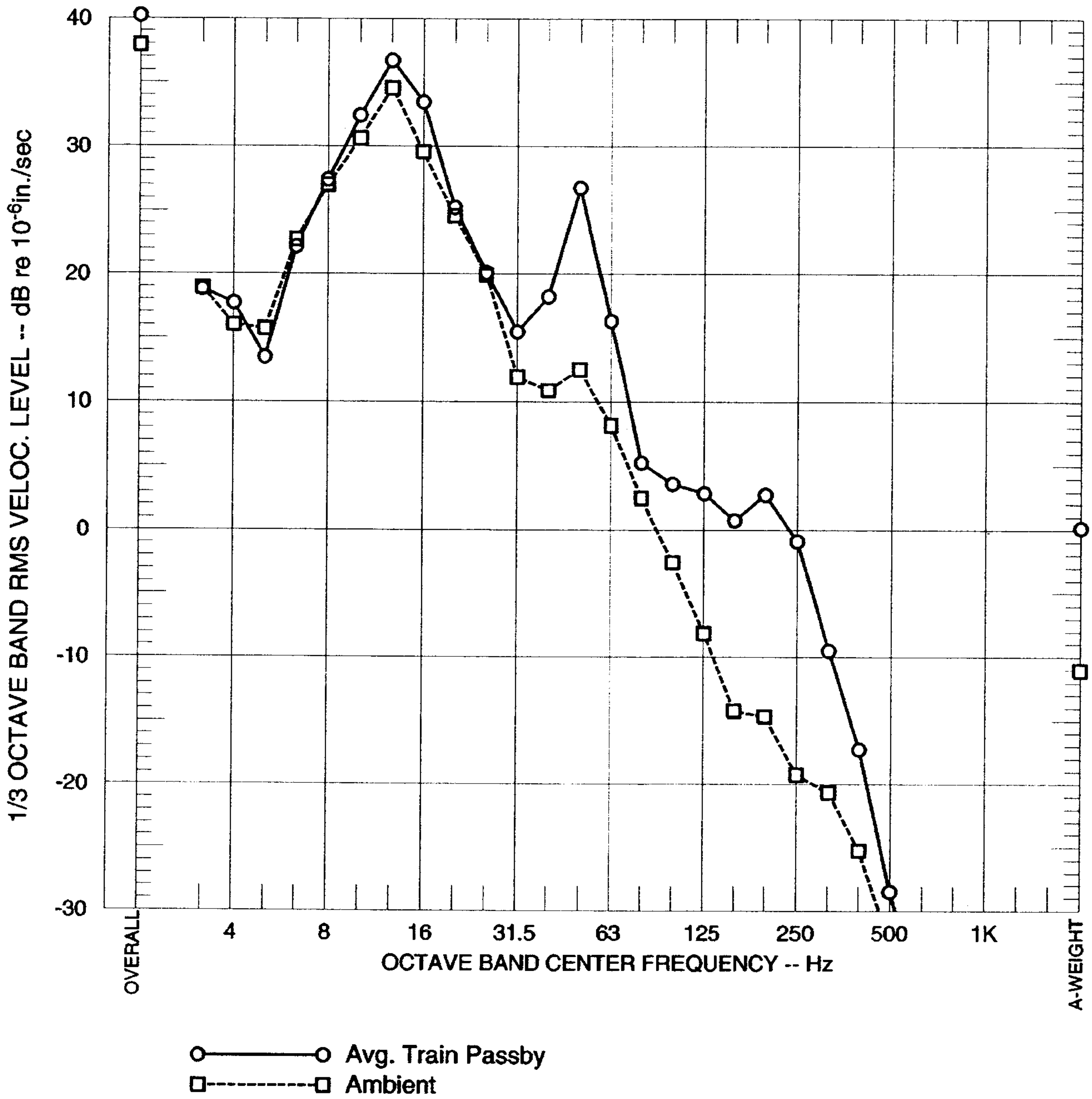

FIGURE 2 AVERAGE VIBRATION LEVELS MEASURED ON FOUNDATION PLINTH BENEATH ISOLATION BEARING.

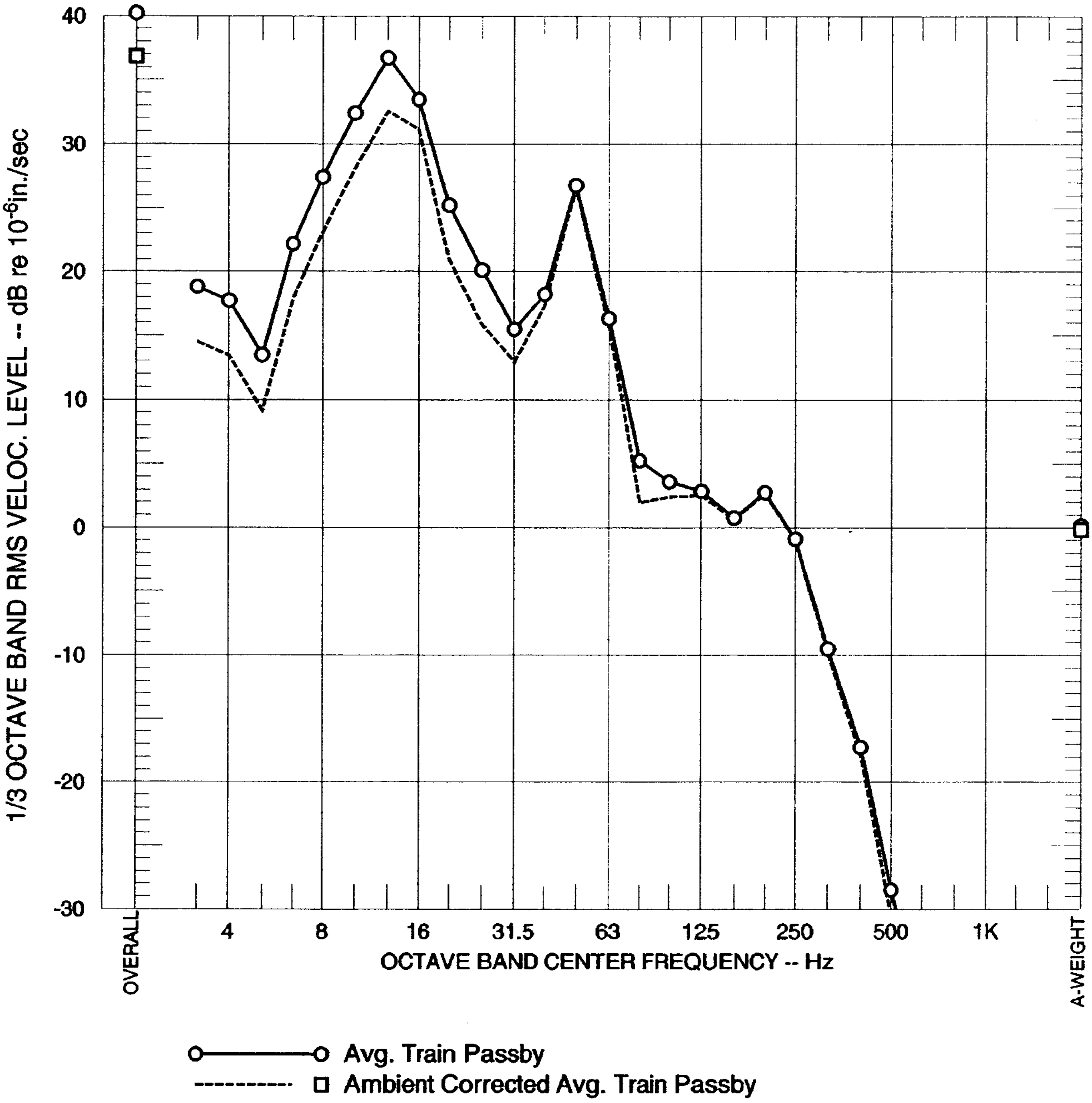

FIGURE 3 AVERAGE VIBRATION LEVELS AND AMBIENT CORRECTED LEVEL MEASURED ON FOUNDATION PLINTH BENEATH ISOLATION BEARING.

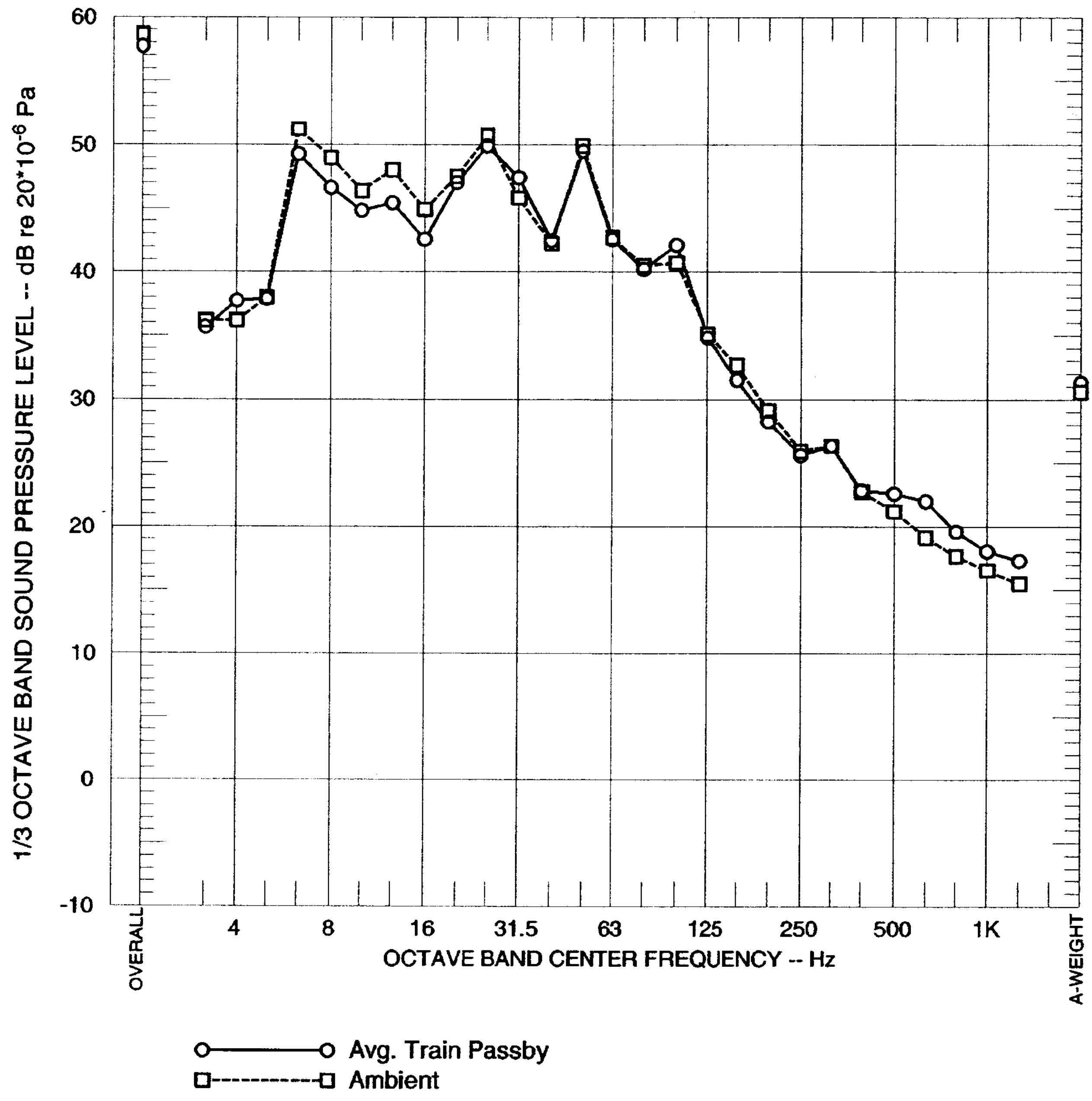

FIGURE 4 AVERAGE NOISE LEVELS MEASURED IN THE EXHIBITION HALL.

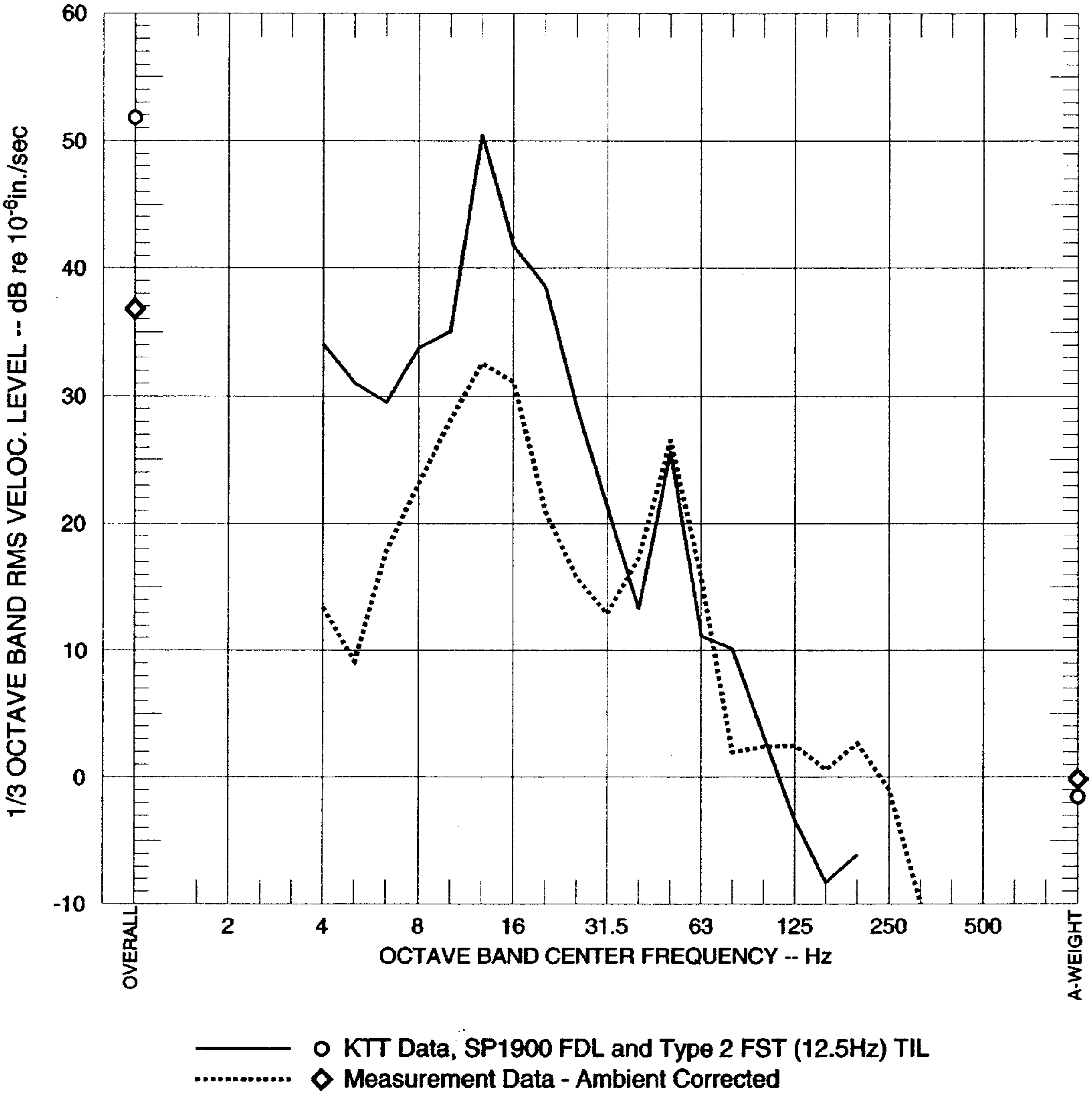

FIGURE 5: COMPARISON OF MEASURED AND PROJECTED VIBRATION LEVELS ON A FOUNDATION PLINTH BELOW THE ISOLATION BEARING AT KWAI TSING THEATRE: PROJECTIONS USING GROUND IMPACT DATA TAKEN AT KTT TOGETHER WUTH THE SP1900 FDL AND TYPE 2 FST (12.5 Hz) FST TIL - WITHOUT THE 10 dB SAFETY FACTOR

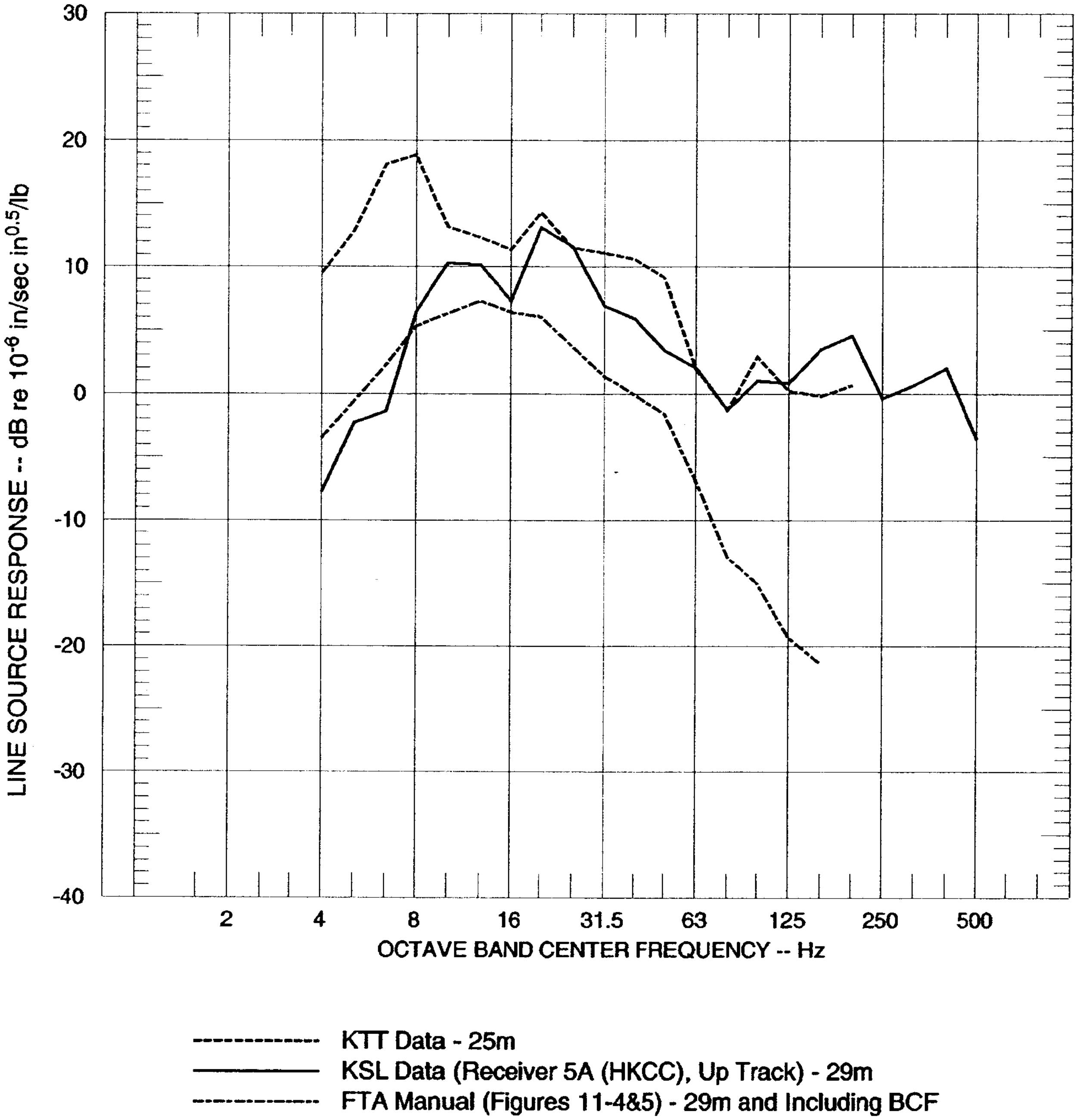

FIGURE 6 COMPARISON OF LINE SOURCE RESPONSE WITH BUILDING COUPLING FACTOR INCLUDED FOR THE HKCC STUDIO THEATRE TAKEN FROM KSL GORUND IMPACT DATA, KTT GROUND IMPACT DATA AND FROM THE TRANSPORTATION TEST CENTER, PUEBLO, CO (FIGURES 11-4&5 OF THE FTA MANUAL)

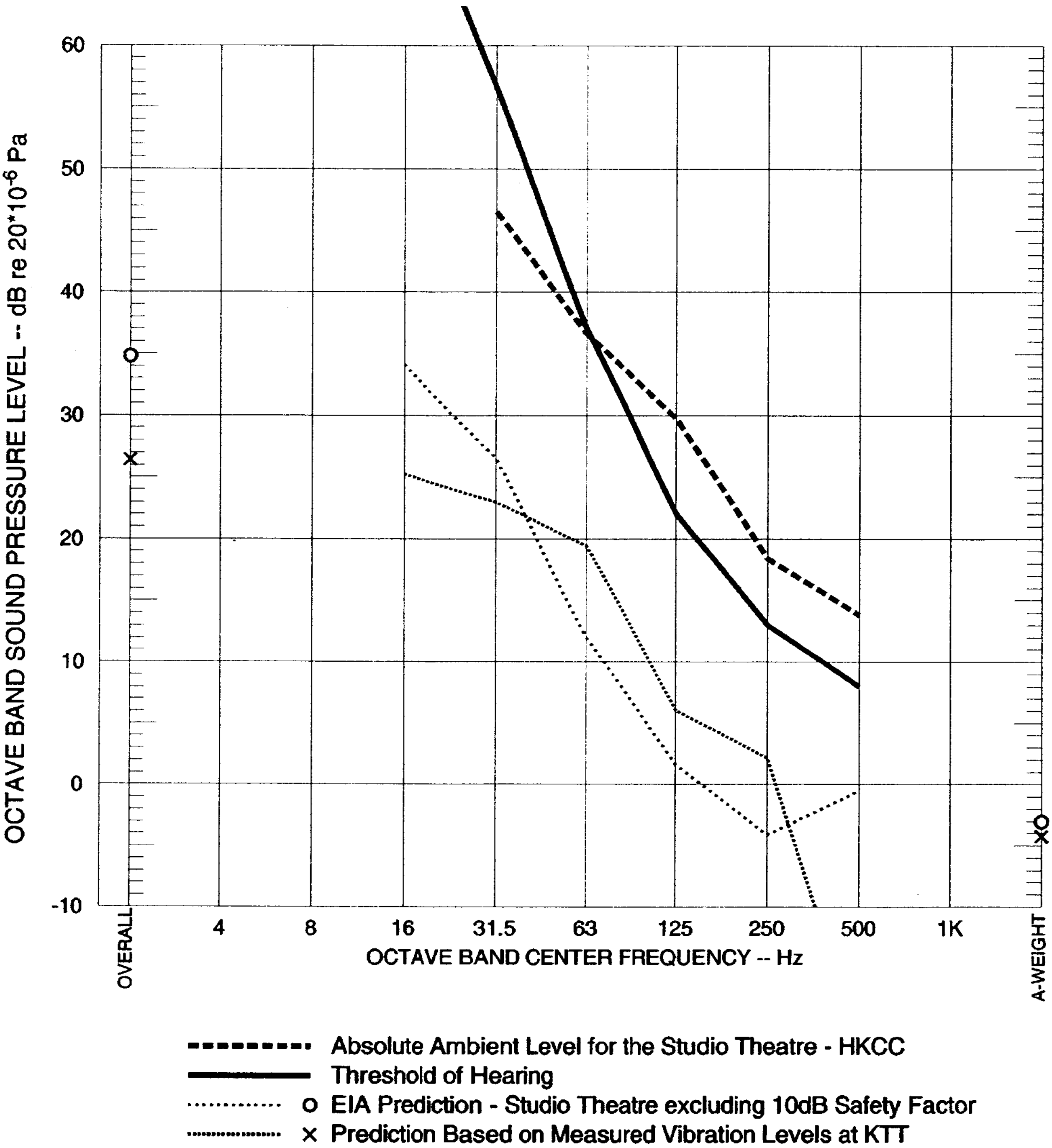

FIGURE 7 COMPARISON OF NOISE PREDICTIONS AT THE HKCC STUDIO THEATRE OBTAINED FROM PROJECTED AND MEASURED VIBRATION LEVELS - WITHOUT 10dB SAFETY FACTOR

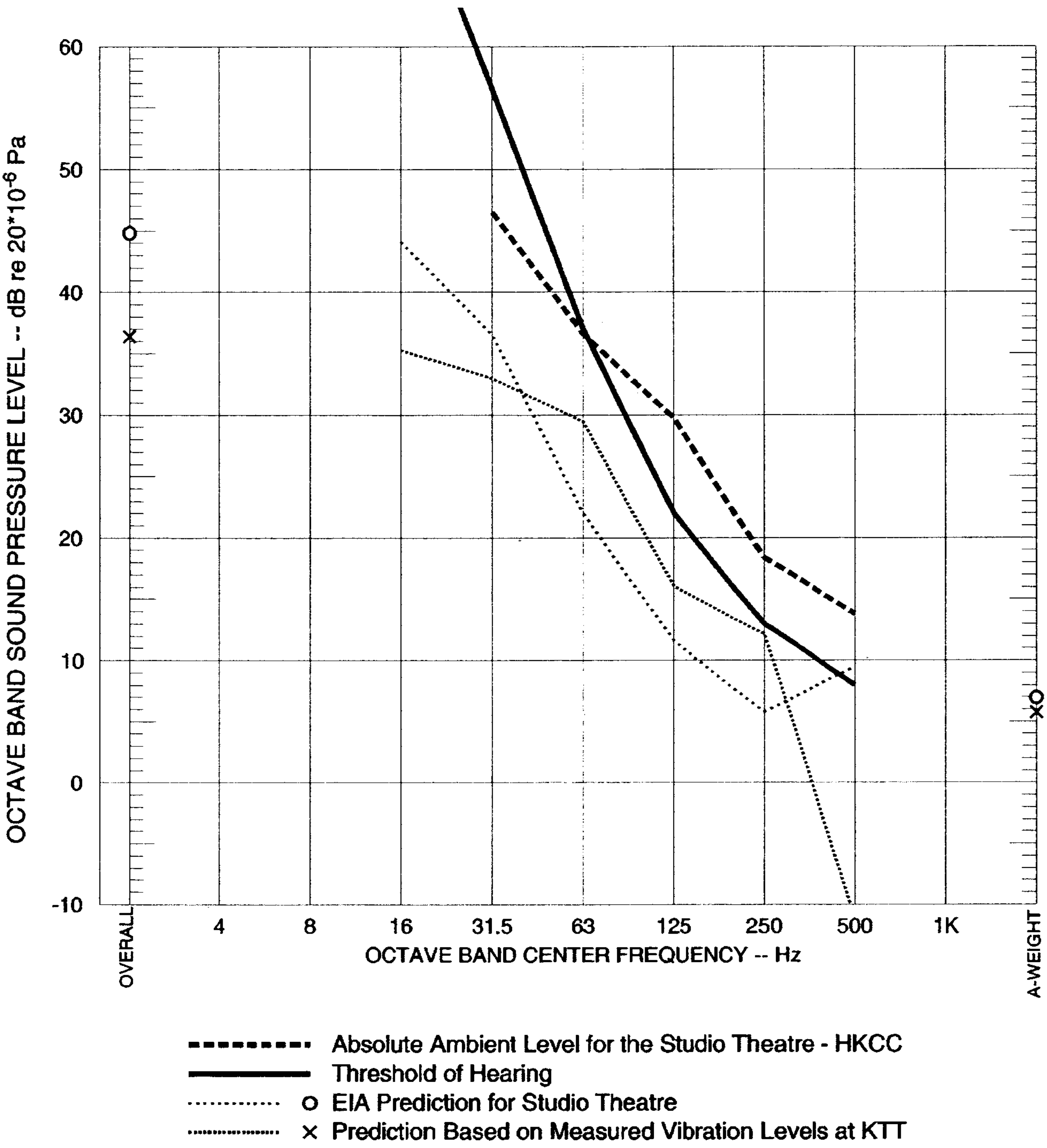

FIGURE 8 COMPARISON OF NOISE PREDICTIONS AT THE HKCC STUDIO THEATRE OBTAINED FROM PROJECTED AND MEASURED VIBRATION LEVELS - WITH 10dB SAFETY FACTOR ADDED

TABLE (KTT) 2 VIBRATION PROJECTION FOR KWAI TSING THEATRE USING KTT GROUND PROPAGATION DATA, SP1900 FDL AND TYPE 2 12.5 Hz FST AS INSTALLED

Description				1/3 Octave Band Centre Frequency, Hz																		
				3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Down Track Calculation																						
FDL	dB re 1 lb/in$^{0.5}$			32.7	29.6	23.9	21.0	28.9	33.7	36.4	37.0	35.4	34.0	37.8	38.3	46.5	46.5	50.2	47.4	47.2	42.5	39.5
CCF	dB	Y/N	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TIL	dB	Type		0.0	0.0	0.0	-0.4	-5.3	-4.4	4.5	-4.2	-13.6	-16.3	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8
TCF	dB			0.0	0.0	0.0	-1.0	-2.0	-2.5	-1.5	-1.5	-1.0	-2.0	0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			10.9	9.5	12.9	18.1	18.9	13.2	12.3	11.4	14.3	11.5	11.1	10.6	9.2	1.9	-1.3	2.9	0.2	-0.2	0.7
BCF	dB	Y/N	N	BCF is accounted in LSR																		
BVR	dB	Floor	0	-5.6	-5.0	-5.8	-8.2	-6.6	-4.9	-1.2	-1.0	3.4	2.1	-4.5	-3.5	1.3	0.3	0.1	0.2	0.3	-1.0	-3.5
SAF	dB			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted Vibration Level	**1/3 Oct, dB**			**38.1**	**34.1**	**31.0**	**29.5**	**33.8**	**35.1**	**50.5**	**41.7**	**38.5**	**29.3**	**21.4**	**13.3**	**25.6**	**11.2**	**10.2**	**3.3**	**-3.4**	**-8.3**	**-6.1**

Track Distance=25m; Track depth = 18m; Rock head depth = 20m; Foundation depth = 6m, Train speed= 123 kph; Track = 12.5Hz FST Type 2

TABLE (KTT) 3 PROJECTED STRUCTURE BORNE NOISE LEVEL FOR THE HKCC STUDIO THEATRE AS DETERMINED FOR THE KSL EIA USING KSL METHODOLOGY AND DATA – 10 Hz FST (TYPE 4)

Descriptions				1/3 Octave Band Center Frequency, Hz																						
				3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																										
FDL	dB re 1 $lb/in^{0.5}$			20.2	13.9	11.4	20.6	30.8	26.7	24.7	22.9	31.0	35.9	38.8	37.5	36.3	42.2	44.4	47.4	43.4	32.8	36.1	36.5	32.8	36.8	31.6
CCF	dB	Y/N	N																							
TIL	dB	Type	4	0.0	0.0	-0.4	-5.3	-4.4	4.5	-4.2	-13.6	-16.3	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.0	0.0	0.0	-1.0	-2.0	-2.5	-1.5	-1.5	-1.0	-2.0	0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			-9.5	-7.8	-2.3	-1.4	6.4	10.3	10.2	7.3	13.1	11.6	6.9	5.9	3.4	2.0	-1.3	1.0	0.8	3.5	4.6	-0.4	0.7	2.0	-3.6
Up Track Vib	dB re $10^{-6}in/sec$			10.7	6.1	8.8	12.9	30.8	39.1	29.2	15.1	26.7	22.1	15.1	11.0	3.3	5.4	-0.2	-1.8	-7.4	-13.3	-7.9	-11.6	-14.1	-3.1	-10.1
Down Track Calculation																										
FDL	dB re 1 lb/in0.5			18.0	11.1	10.8	20.9	32.0	26.4	23.7	22.1	36.0	37.1	39.5	39.1	37.8	46.5	47.6	49.4	45.2	39.6	35.2	33.8	31.3	34.7	33.8
CCF	dB	Y/N	N																							
TIL	dB	Type	4	0.0	0.0	-0.4	-5.3	-4.4	4.5	-4.2	-13.6	-16.3	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.0	0.0	0.0	-1.0	-2.0	-2.5	-1.5	-1.5	-1.0	-2.0	0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			-7.8	-6.0	-1.2	0.3	7.6	10.9	10.0	7.9	9.0	10.8	8.3	4.8	2.2	-0.2	-3.8	-3.5	-4.0	-0.6	2.4	-3.9	-2.9	-1.1	-8.6
Down Track Vib	dB re $10^{-6}in/sec$			10.2	5.1	9.2	14.9	33.1	39.4	28.0	15.0	27.7	22.5	17.2	11.5	3.7	7.6	0.5	-4.2	-10.5	-10.6	-11.0	-17.7	-19.2	-8.2	-12.9
Up and Down Tracks																										
Groundborne Vibration Level				13.4	8.7	12.0	17.0	35.1	42.3	31.6	18.1	30.3	25.3	19.3	14.2	6.5	9.7	3.2	0.2	-5.7	-8.7	-6.1	-10.6	-12.9	-1.9	-8.3
BCF	dB	Y/N	N	BCF is accounted in LSR																						
BVR-up	dB	Floor	2	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level	1/3 Oct, dB			23.4	18.7	22.0	27.0	45.1	52.3	41.6	28.1	40.3	35.3	29.3	24.2	16.5	19.7	13.2	10.2	4.3	1.3	3.9	-0.6	-2.9	8.1	1.7
Predicted Noise Level	Oct, dB				26.6			53.0			44.1			36.6			22.0			11.6			5.8			9.5
Overall Predicted Noise Level	dB(A)			<15																						

TABLE (KTT) 4 PROJECTED STRUCTURE BORNE NOISE LEVEL FOR THE HKCC STUDIO THEATRE STARTING WITH THE MEASURED TRAIN PASSBY VIBRATION LEVEL (AMBIENT CORRECTED) ON THE KTT FOUNDATION - 12.5 Hz FST, AS INSTALLED

Description		1/3 Octave Band Centre Frequency, Hz																						
		3.15	4	5	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500
Measured Vibration on KTT Foundation -Ambient Corrected		14.5	13.4	9.2	17.9	23.1	28.1	32.6	31.1	20.9	15.8	12.9	17.3	26.6	15.6	2.0	2.4	2.5	0.6	2.7	-0.9	-9.8	-18.0	-30.7
Difference between FDL at 123 kph and 65 kph		-12.5	-15.7	-12.5	-0.4	1.9	-7	-11.7	-14.1	-4.4	1.9	1	-0.8	-10.2	-4.3	-5.8	0	-3.8	-9.7	-3.4	-6.4	-6.1	-5.4	-6.5
Two Floors Attenuation		-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
Simultaneous Pass of Trains on Up and Down Tracks		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Conversion to Noise		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Setback correction from 25m (KTT) to 29m (Studio Theatre)		-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Predicted Noise Level	**1/3 Octave band - dB**	**3.9**	**-0.4**	**-1.4**	**19.4**	**26.9**	**23**	**22.8**	**18.9**	**18.4**	**19.6**	**15.8**	**18.4**	**18.3**	**13.2**	**-1.9**	**4.3**	**0.6**	**-7.2**	**1.2**	**-5.4**	**-14**	**-21.5**	**-35.3**
	Octave band - dB		**6.1**			**28.9**			**25.3**			**23.0**			**19.5**			**6.1**			**2.2**			**-21.2**

Note: Physical conditions pertinent to HKCC and KTT are summarised below:

Venue	**Uptrack**		**Downtrack**		**Rockhead depth (m)**	**Foundation depth (m)**	**Train speed (kph)**	**Trackform**
	Plan (m)	**Depth (m)**	**Plan (m)**	**Depth (m)**				
HKCC	29	16	37	13	13	7	65	10Hz FST (layered bearing)
KTT	-	-	25	18	20	6	123	12.5 Hz FST (plain bearing)

TABLE 1: CALCULATION FOR HONG KONG SPACE MUSEUM - PLANETARIUM

Descriptions				1/3 Octave Band Centre Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track																
FDL	dB re 1 $lb/in^{0.5}$			39.5	38.5	36.3	43.9	45.3	49	44	32.5	35.7	36.2	32.3	37.1	32.3
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			13.6	11	6.3	2.4	-2.7	-0.9	-3.5	-5.6	-4.6	-14	-14	-8.4	-16.4
Vibration Level	dB re $10^{-6}in/sec$			22.6	17.1	6.3	7.7	-0.7	-2.1	-11.1	-22.7	-17.6	-25.4	-29.3	-13.1	-22.2
Down Track																
FDL	dB re 1 lb/in0.5			39.5	39.1	37.8	46.5	47.6	49.4	45.2	39.6	35.2	33.8	31.3	34.7	33.8
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			14.1	9.7	4.2	0.1	-5.9	-6.7	-10.2	-13	-12.5	-22.5	-28.6	-22.4	-27.7
Vibration Level	dB re $10^{-6}in/sec$			23.1	16.3	5.7	7.9	-1.7	-7.4	-16.6	-23	-25.9	-36.3	-44.9	-29.5	-32
Up and Down Tracks																
Ground Vibration Level				25.8	19.7	9	10.8	1.8	-0.9	-10	-19.8	-17	-25.1	-29.2	-13	-21.8
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
CTN	dB			2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB			10	10	10	10	10	10	10	10	10	10	10	10	10
Predicted Noise Level			1/3 Oct, dB	36.8	30.7	20	21.8	12.8	10.1	1	-8.8	-6	-14.1	-18.2	-2	-10.8
Predicted Noise Level			Oct, dB	43.3			24.3			10.6			-5.1			2.3
Lmax			dB(A)	<15												
Leq(30minutes)			dB(A)	<15												
L24			dB(A)	<15												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 2: CALCULATION FOR HONG KONG SPACE MUSEUM - RECORDING ROOM

Descriptions				1/3 Octave Band Centre Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track																
FDL	dB re 1 lb/in$^{0.5}$			36.3	35.7	35	41.5	43.5	43.4	47.9	42	41.4	36	35.2	33.3	29.9
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			2.9	-3.6	-3.9	-9.2	-9	-10.4	-11.4	-16	-15.1	-18.5	-16.5	-8.6	-17.5
Up Track Vibration Level	dB re 10^{-6}in/sec			8.7	-0.3	-5.3	-6.4	-8.8	-17.1	-15.1	-23.6	-22.3	-30.2	-28.9	-17.2	-25.7
Down Track																
FDL	dB re 1 lb/in0.5			38	35.7	33.5	36.1	37.8	40	43.6	39.2	40.4	36.6	34	34.9	30.6
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			1.8	-5.1	-6.2	-10.1	-11.3	-13.9	-16.3	-22.3	-24.6	-28.3	-32.2	-22.1	-28
Down Track Vibration Level	dB re 10^{-6}in/sec			9.2	-1.8	-9	-12.7	-16.8	-24	-24.3	-32.7	-32.9	-39.4	-45.8	-29	-35.5
Up and Down Tracks																
Ground Vibration Level				12	2	-3.7	-5.5	-8.2	-16.3	-14.6	-23.1	-21.9	-29.7	-28.8	-16.9	-25.3
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
CTN	dB			2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB			10	10	10	10	10	10	10	10	10	10	10	10	10
Predicted Noise Level			1/3 Oct, dB	23	13	7.3	5.5	2.8	-5.3	-3.6	-12.1	-10.9	-18.7	-17.8	-5.9	-14.3
Predicted Noise Level			Oct, dB	34.7			10.3			-1			-9.6			1.1
Lmax			dB(A)	<15												
Leq(30minutes)			dB(A)	<15												
L24			dB(A)	<15												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 3: CALCULATION FOR HONG KONG CULTURAL CENTRE – STUDIO THEATRE

Descriptions			1/3 Octave Band Centre Frequency, Hz												
			31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track															
FDL	dB re 1 lb/in$^{0.5}$		38.8	37.5	36.3	42.2	44.4	47.4	43.4	32.8	36.1	36.5	32.8	36.8	31.6
CCF	dB	Y/N N													
TIL	dB	Type 4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB		0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb		6.9	5.9	3.4	2	-1.3	1	0.8	3.5	4.6	-0.4	0.7	2	-3.6
Up Track Vib	dB re 10^{-6}in/sec		15.1	11	3.3	5.4	-0.2	-1.8	-7.4	-13.3	-7.9	-11.6	-14.1	-3.1	-10.1
Down Track															
FDL	dB re 1 lb/in0.5		39.5	39.1	37.8	46.5	47.6	49.4	45.2	39.6	35.2	33.8	31.3	34.7	33.8
CCF	dB	Y/N N													
TIL	dB	Type 4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB		0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb		8.3	4.8	2.2	-0.2	-3.8	-3.5	-4	-0.6	2.4	-3.9	-2.9	-1.1	-8.6
Down Track Vibration	dB re 10^{-6}in/sec		17.2	11.5	3.7	7.6	0.5	-4.2	-10.5	-10.6	-11	-17.7	-19.2	-8.2	-12.9
Up and Down Tracks															
Ground Vibration Level			19.3	14.2	6.5	9.7	3.2	0.2	-5.7	-8.7	-6.1	-10.6	-12.9	-1.9	-8.3
BCF	dB	Y/N N	BCF is accounted in LSR												
BVR-up	dB	Floor 2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
CTN	dB		2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB		10	10	10	10	10	10	10	10	10	10	10	10	10
Predicted Noise Level		1/3 Oct, dB	29.3	24.2	16.5	19.7	13.2	10.2	4.3	1.3	3.9	-0.6	-2.9	8.1	1.7
Predicted Noise Level		Oct, dB	36.6			22			11.6			5.8			9.5
Lmax		dB(A)	<15												
Leq(30minutes)		dB(A)	<15												
L24		dB(A)	<15												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 4: CALCULATION FOR HONG KONG CULTURAL CENTRE – CONCERT HALL

Descriptions				1/3 Octave Band Centre Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track																
FDL	dB re 1 lb/in$^{0.5}$			37.8	35.7	33.7	37	38.8	40.6	44.2	39.7	40.5	36.5	34.2	34.6	30.4
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-0.5	-4.8	-4.6	-7.1	-6.2	-7	-6.4	-8.3	-4.7	-9.8	-6	-1.1	-11.3
Up Track Vibration Level	dB re 10^{-6}in/sec			6.6	-1.5	-7.3	-8.9	-10.8	-16.5	-13.8	-18.3	-12.9	-21	-19.5	-8.3	-19
Down Track																
FDL	dB re 1 lb/in0.5			38	35.7	33.5	36.1	37.8	40	43.6	39.2	40.4	36.6	34	34.9	30.6
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-2.3	-5.9	-6.9	-8.5	-7.8	-8.6	-7.4	-10.3	-6.3	-12.3	-7.5	-2	-12.2
Down Track Vibration Level	dB re 10^{-6}in/sec			5.1	-2.6	-9.8	-11.1	-13.3	-18.7	-15.4	-20.8	-14.5	-23.4	-21.1	-8.9	-19.7
Up and Down Tracks																
Ground Vibration Level				9	1	-5.3	-6.8	-8.8	-14.5	-11.5	-16.3	-10.6	-19	-17.2	-5.6	-16.3
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
CTN	dB			2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB			10	10	10	10	10	10	10	10	10	10	10	10	10
Predicted Noise Level			1/3 Oct, dB	20	12	5.7	4.2	2.2	-3.5	-0.5	-5.3	0.4	-8	-6.2	5.4	-5.3
Predicted Noise Level			Oct, dB	31			9			2.1			1.7			6.8
Lmax			dB(A)	<15												
Leq(30minutes)			dB(A)	<15												
L24			dB(A)	<15												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 5: CALCULATION FOR HONG KONG CULTURAL CENTRE – GRAND THEATRE

Descriptions				1/3 Octave Band Centre Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track																
FDL	dB re 1 $lb/in^{0.5}$			38	35.7	33.5	36.1	37.8	40	43.6	39.2	40.4	36.6	34	34.9	30.6
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			-3.7	-7	-7.5	-9.7	-8.6	-9.7	-7.9	-11.6	-7.1	-13.8	-8.4	-2.6	-12.8
Up Track Vibration Level	dB re $10^{-6}in/sec$			3.7	-3.6	-10.4	-12.3	-14.1	-19.8	-15.9	-22	-15.4	-24.9	-22	-9.5	-20.3
Down Track																
FDL	dB re 1 lb/in0.5			38	35.7	33.5	36.1	37.8	40	43.6	39.2	40.4	36.6	34	34.9	30.6
CCF	dB	Y/N	N													
TIL	dB	Type	4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-45.6	-45.6	-45.6	-45.6	-39.8	-36.1
TCF	dB			0.5	-1	0	-1.3	-1.3	-5	-6	-4	-3	-2	-2	-2	-2
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			-6.3	-9	-8.9	-12	-11.8	-12.6	-9.4	-13.7	-8.6	-16.1	-9.6	-3.4	-13.5
Down Track Vibration Level	dB re $10^{-6}in/sec$			1.2	-5.7	-11.8	-14.6	-17.3	-22.7	-17.5	-24.1	-16.8	-27.2	-23.2	-10.3	-21.1
Up and Down Tracks																
Ground Vibration Level				5.6	-1.5	-8	-10.3	-12.4	-18	-13.6	-19.9	-13.1	-22.8	-19.5	-6.9	-17.6
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
CTN	dB			2	2	2	2	2	2	2	2	2	2	2	2	2
SAF	dB			10	10	10	10	10	10	10	10	10	10	10	10	10
Predicted Noise Level			1/3 Oct, dB	16.6	9.5	3	0.7	-1.4	-7	-2.6	-8.9	-2.1	-11.8	-8.5	4.1	-6.6
Predicted Noise Level			Oct, dB	27.7			5.9			-0.6			-0.8			5.8
Lmax			dB(A)	<15												
Leq(30minutes)			dB(A)	<15												
L24			dB(A)	<15												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A as per measurement at Pat Heung Depot); Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 6: CALCULATION FOR SHERATON HONG KONG HOTEL

Descriptions				1/3 Octave Band Center Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																
FDL	dB re 1 lb/in$^{0.5}$			36.8	35.0	36.6	38.2	41.8	43.3	41.5	34.8	37.2	36.6	33.8	35.2	30.8
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			11.4	9.8	6.8	3.8	-0.7	1.3	-1.1	0.2	3.2	-3.1	-0.8	1.9	-8.5
Up Track Vibration Level	dB re 10^{-6}in/sec			25.4	12.6	12.0	4.4	2.4	-2.5	-10.6	-14.7	-2.5	-4.6	-1.1	11.6	4.5
Down Track Calculation																
FDL	dB re 1 lb/in0.5			41.9	38.7	40.1	44.2	46.9	45.3	42.6	40.2	35.3	39.3	37.2	36.0	33.5
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			19.2	15.5	15.1	15.4	10.5	13.7	8.2	8.9	10.1	7.3	19.9	12.5	2.6
Down Track Vibration Level	dB re 10^{-6}in/sec			38.3	22.2	23.7	22.1	18.7	12.0	-0.4	-0.6	2.6	8.5	23.1	23.1	18.3
Up and Down Tracks																
Ground Vibration Level				38.5	22.6	24.0	22.1	18.8	12.1	0.0	-0.4	3.8	8.7	23.1	23.4	18.5
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	4	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level			1/3 Oct, dB	46.5	30.6	32.0	30.1	26.8	20.1	8.0	7.6	11.8	16.7	31.1	31.4	26.5
Predicted Noise Level			Oct, dB	51.4			34.9			20.6			31.3			32.6
Lmax			dB(A)	<35												
Leq(30minutes)			dB(A)	<35												
L24			dB(A)	<35												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 7: CALCULATION FOR FORMER MARINE POLICE HEADQUARTERS

Descriptions				1/3 Octave Band Center Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																
FDL	dB re 1 lb/in$^{0.5}$			38.8	37.5	36.3	42.2	44.4	47.4	43.4	32.8	36.1	36.5	32.8	36.8	31.6
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-10.8	-8.0	-8.6	-8.7	-7.8	-6.1	-8.1	-5.4	2.3	-0.5	0.2	6.4	1.5
Up Track Vibration Level	dB re 10^{-6}in/sec			5.2	-2.7	-3.7	-4.1	-2.1	-5.8	-15.8	-22.2	-4.4	-2.1	-1.0	17.8	15.3
Down Track Calculation																
FDL	dB re 1 lb/in0.5			35.9	33.9	36.8	36.3	40.4	41.2	40.3	35.6	37.4	36.6	34.4	34.4	30.5
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-4.2	-0.7	0.0	0.0	1.1	6.4	7.8	9.0	11.8	8.8	12.1	14.7	13.8
Down Track Vibration Level	dB re 10^{-6}in/sec			8.9	1.1	5.4	-1.3	2.7	0.5	-3.0	-5.1	6.4	7.3	12.5	23.7	26.5
Up and Down Tracks																
Ground Vibration Level				10.4	2.6	5.9	0.5	4.0	1.4	-2.8	-5.0	6.7	7.7	12.7	24.7	26.8
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level			1/3 Oct, dB	21.4	13.6	16.9	11.5	15.0	12.4	8.2	6.0	17.7	18.7	23.7	35.7	37.8
Predicted Noise Level			Oct, dB	25.9			19.8			14.5			25.7			39.9
Lmax			DB(A)	37												
Leq(30minutes)			DB(A)	<35												
L24			DB(A)	<35												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 8: CALCULATION FOR CANTON ROAD GOVERNMENT SCHOOL

Descriptions				1/3 Octave Band Center Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																
FDL	dB re 1 lb/in$^{0.5}$			38.4	36.5	39.5	38.0	40.8	41.8	42.8	36.7	39.7	37.9	34.7	34.4	31.1
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-17.7	-15.6	-15.8	-14.5	-14.1	-15.5	-18.4	-14.6	-7.7	-7.6	-6.1	0.0	-2.8
Up Track Vibration Level	dB re 10^{-6}in/sec			-2.2	-11.2	-7.7	-14.1	-12.0	-20.8	-26.8	-27.5	-10.8	-7.8	-5.4	8.9	10.4
Down Track Calculation																
FDL	dB re 1 lb/in0.5			43.1	39.7	42.8	45.2	48.3	47.0	42.8	40.8	36.8	40.5	39.7	37.9	35.8
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			-11.8	-9.1	-9.6	-9.5	-8.7	-7.5	-9.5	-6.7	1.0	-1.4	-0.6	5.5	1.0
Down Track Vibration Level	dB re 10^{-6}in/sec			8.5	-1.5	1.8	-1.9	0.8	-7.6	-17.8	-15.5	-5.1	1.0	5.1	18.0	19.0
Up and Down Tracks																
Ground Vibration Level				8.9	-1.1	2.2	-1.7	1.0	-7.4	-17.3	-15.2	-4.0	1.5	5.5	18.5	19.6
BCF	dB	Y/N	N	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR	BCF is accounted in LSR
BVR-up	dB	Floor	1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level			1/3 Oct, dB	19.9	9.9	13.2	9.3	12.0	3.6	-6.3	-4.2	7.0	12.5	16.5	29.5	30.6
Predicted Noise Level			Oct, dB	22.2			16.6			4.6			18.3			33.1
Lmax			dB(A)	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35
Leq(30minutes)			dB(A)	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35
L24			dB(A)	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 9: CALCULATION FOR MAN KING BUILDING

Descriptions				1/3 Octave Band Center Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																
FDL	dB re 1 $lb/in^{0.5}$			39.5	36.8	34.9	38.0	39.2	41.1	43.4	39.7	40.6	37.3	34.6	35.3	31.4
CCF	dB	Y/N	N													
TIL	dB	Type	1	3.0	6.8	-2.0	-6.5	-6.5	-5.1	-5.5	-7.0	-7.6	-6.8	-5.5	-1.0	-1.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			1.8	-4.9	-3.8	-9.5	-13.1	-17.0	-21.8	-27.0	-29.2	-30.1	-35.4	-37.7	-41.6
Up Track Vibration Level	dB re $10^{-6}in/sec$			44.8	37.7	29.1	20.7	18.3	14.1	10.0	1.7	0.8	-1.6	-8.2	-5.3	-14.1
Down Track Calculation																
FDL	dB re 1 lb/in0.5			40.1	43.4	41.3	44.8	45.0	49.0	42.8	32.5	39.8	40.8	34.2	38.5	33.6
CCF	dB	Y/N	N													
TIL	dB	Type	1	3.0	6.8	-2.0	-6.5	-6.5	-5.1	-5.5	-7.0	-7.6	-6.8	-5.5	-1.0	-1.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re $10^{-6}in/s*in^{0.5}/lb$			13.6	8.1	3.5	-1.2	-8.0	-9.5	-14.4	-18.1	-17.8	-26.1	-32.4	-36.1	-40.7
Down Track Vibration Level	dB re $10^{-6}in/sec$			57.2	57.2	42.9	35.9	29.3	29.4	16.9	3.4	11.4	6.0	-5.6	-0.6	-10.9
Up and Down Tracks																
Ground Vibration Level				57.4	57.3	43.1	36.0	29.6	29.5	17.7	5.7	11.7	6.7	-3.7	0.7	-9.2
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level	1/3 Oct, dB			68.4	68.3	54.1	47.0	40.6	40.5	28.7	16.7	22.7	17.7	7.3	11.7	1.8
Predicted Noise Level	Oct, dB			71.7			55.0			40.8			24.0			12.4
Lmax	dB(A)			36												
Leq(30minutes)	dB(A)			<35												
L24	dB(A)			<35												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A as per measurement at Pat Heung Depot); Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.

TABLE 10: CALCULATION FOR OLYMPIAN CITY PHASE 3

Descriptions				1/3 Octave Band Center Frequency, Hz												
				31.5	40	50	63	80	100	125	160	200	250	315	400	500
Up Track Calculation																
FDL	dB re 1 lb/in$^{0.5}$			40.3	42.3	44.0	45.2	45.7	47.5	47.0	40.2	38.5	42.3	35.8	34.6	33.2
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			22.5	19.3	11.7	2.9	-3.8	-7.7	-13.2	-19.6	-23.9	-29.7	-35.0	-38.9	-45.2
Up Track Vibration Level	dB re 10^{-6}in/sec			40.0	29.6	24.2	10.5	3.2	-7.3	-17.4	-29.1	-28.3	-25.5	-33.2	-29.7	-29.8
Down Track Calculation																
FDL	dB re 1 lb/in0.5			40.5	41.8	43.7	50.8	50.2	48.7	44.7	42.0	37.7	44.2	43.6	39.9	38.3
CCF	dB	Y/N	N													
TIL	dB	Type	2	-23.4	-31.1	-31.4	-36.3	-37.5	-42.1	-45.1	-45.6	-39.8	-36.1	-32.0	-23.4	-15.8
TCF	dB			0.5	-1.0	0.0	-1.3	-1.3	-5.0	-6.0	-4.0	-3.0	-2.0	-2.0	-2.0	-2.0
LSR	dB re 10^{-6}in/s*in$^{0.5}$/lb			24.0	21.2	14.3	7.5	2.4	0.3	-5.7	-11.5	-16.0	-22.3	-29.9	-35.3	-41.9
Down Track Vibration Level	dB re 10^{-6}in/sec			41.6	30.9	26.6	20.8	13.8	1.9	-12.1	-19.1	-21.1	-16.2	-20.4	-20.8	-21.4
Up and Down Tracks																
Ground Vibration Level				43.9	33.3	28.6	21.1	14.2	2.4	-11.0	-18.7	-20.3	-15.7	-20.1	-20.2	-20.8
BCF	dB	Y/N	N	BCF is accounted in LSR												
BVR-up	dB	Floor	2	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0
CTN	dB			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAF	dB			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Predicted Noise Level			1/3 Oct, dB	53.9	43.3	38.6	31.1	24.2	12.4	-1.0	-8.7	-10.3	-5.7	-10.1	-10.2	-10.8
Predicted Noise Level			Oct, dB	59.3			39.5			12.6			-3.4			0.7
Lmax			dB(A)	<35												
Leq(30minutes)			dB(A)	<35												
L24			dB(A)	<35												

Note: Calculations are based on 9-car train scenario. Lmax = Leq(double passbys) + 0.5dB(A) as per measurement at Pat Heung Depot; Leq(30mins) = Leq(double passbys) + 10*log(Passby duration in sec) + 3dB(A) + 10*log(no.of events in 30 mins) – 32.6dB(A) (3dB(A) correction is added to Leq(30mins) for leading and trailing effect for conservative approaches.) Leq(30mins) and Leq(24hrs) are based on maximum target frequency of 34 trains per hour in each direction running for 19 hours daily.