FORM 5

[redacted]

Application No. : VEP-547/2018
Reference No. :
(For official use)

FORM 5
ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTION 13(1)

Application for Variation of an Environmental Permit

PART A PREVIOUS APPLICATIONS

☐ No previous application for variation of an environmental permit.

☑ The environmental permit was previously amended.

Application No. : VEP-492/2016

PART B DETAILS OF APPLICANT

B1. Name : (person or company)

MTR Corporation Limited

[Note : In accordance with section 13(1) of the Ordinance, the person holding an environmental permit or a person who assumes responsibility for the designated project may apply for variation of the environmental permit.]

B2. Business Registration No. : (if applicable) [redacted]

B3. Correspondence Address : [redacted]

B4. Name of Contact Person : [redacted]

B5. Position of Contact Person : [redacted]

B6. Telephone No. : [redacted]

B7. Fax No. : [redacted]

B8. E-mail Address : (if any) [redacted]

PART C DETAILS OF CURRENT ENVIRONMENTAL PERMIT

C1. Name of the Current Environmental Permit Holder :

MTR Corporation Limited

C2. Application No. of the Current Environmental Permit : EP-399/2010/D

C3. The Current Environmental Permit was Issued in : month / year

0 2 / 2 0 1 6

Important Notes : Please submit the application together with

(a) 3 copies of this completed form; and

(b) appropriate fee as stipulated in the Environmental Impact Assessment (Fees) Regulation

to the Environmental Protection Department at the following address :

The EIA Ordinance Register Office,
27th floor, Southorn Centre,130 Hennessy Road,
Wan Chai, Hong Kong.

RECEIVED
11 SEP 2018
EIAO Register Office, E.P.D.

☐ Tick (✓) the appropriate box

PART D PROPOSED VARIATIONS TO THE CONDITIONS IN CURRENT ENVIRONMENTAL PERMIT

D1. Condition(s) in the Current Environmental Permit :	D2. Proposed Variation(s) :	D3. Reason for Variation(s) :	D4. Describe the environmental changes arising from the proposed variation(s) :	D5. Describe how the environment and the community might be affected by the proposed variation(s) :	D6. Describe how and to what extent the environmental performance requirements set out in the EIA report previously approved or project profile previously submitted for this project may be affected :	D7. Describe any additional measures proposed to eliminate, reduce or control any adverse environmental impact arising from the proposed variation(s) and to meet the requirements in the Technical Memorandum on Environmental Impact Assessment Process :
Condition 4.5: Only 8-cars M-stock trains, 8-cars K-stock trains, and/or 8-cars C-stock trains shall be deployed in the Project, subject to full and proper implementation of the measures, if any, recommended in the Noise Performance Test Report deposited under Condition 4.4 above. The maximum train frequency operating in the Project from hour 0700 to 2300 shall not exceed 34.3 trains per hour in each direction. The maximum train frequency operating in the Project from hour 2300 to 0700 shall not exceed 17.1 trains per hour in each direction. The total length of the trains shall be approximately 194m.	Condition 4.5: Please see attached	As part of the long-term asset renewal strategy to sustain high quality railway service for passengers, MTRCL has procured new Q-stock trains to replace all the existing first-generation M-stock trains running on the urban lines in phases. In accordance with the FDL Measurement Report given in Annex A of the VEP application supporting document, the Force Density Levels (FDLs) of the Q-stock is lower than that of the M-stock trains adopted in the approved KTE EIA Report.	With the same train frequency proposed in the approved KTE EIA Report, the predicted ground-borne noise levels at the identified existing Noise Sensitive Receivers, as presented in Table 8.11 of the approved KTE EIA Report, will be reduced. Please refer to Table 3.1 of the VEP application supporting document.	There will not be any adverse impact on the environment or the community from the proposed variation, either directly or indirectly.	With proper mitigation measures in place, the environmental impact of KTE will not exceed/violate the environmental performance requirements set in the approved EIA Report. Please refer to Sections 2 and 3 of the VEP application supporting document.	The requirements in the EIAO-TM are complied with. No additional measure is required.

Proposed Variations:

4.5 Only 8-cars M-stock trains, 8-cars K-stock trains, 8-cars C-stock trains, 8-cars Q-stock trains and/or other train types with equivalent or better noise performance supported with justifications by the ET Leader and verified by the IEC as conforming to the information, requirements and recommendations as set out in the EIA Report (Register No. AEIAR-154/2010) shall be deployed in the Project, subject to full and proper implementation of the measures, if any, recommended in the Noise Performance Test Report deposited under Condition 4.4 above. The following operation parameters shall be adopted or otherwise approved by the Director:-

(i) The maximum train frequency operating in the Project from hour 0700 to 2300 shall not exceed 34.3 trains per hour in each direction;
(ii) The maximum train frequency operating in the Project from hour 2300 to 0700 shall not exceed 17.1 trains per hour in each direction; and
(iii) The total length of the trains shall be approximately 194m.

PART E DECLARATION BY APPLICANT

E1. I hereby certify that the particulars given above are correct and true to the best of my knowledge and belief. I understand the environmental permit may be suspended, varied or cancelled if any information given above is false, misleading, wrong or incomplete.

[redacted] [redacted] [redacted]

Signature of Applicant | Full Name in Block Letters | Position

MTR Corporation Limited T&ES ENV ENGG 香港鐵路有限公司

10 SEP 2018

on behalf of _____ _____

Company Name and Chop (as appropriate) | Date

NOTES :

1. A person who constructs or operates a designated project in Part I of Schedule 2 of the Ordinance or decommissions a designated project listed in Part II of Schedule 2 of the Ordinance without an environmental permit or contrary to the permit conditions commits an offence under the Ordinance and is liable to a maximum fine of $5,000,000 and to a maximum imprisonment for 2 years.

2. A person for whom a designated project is constructed, operated or decommissioned and who permits the carrying out of the designated project in contravention of the Ordinance commits an offence and is liable to a maximum fine of $5,000,000 and to a maximum imprisonment for 2 years.

ENVIRONMENTAL REVIEW REPORT

MTR Corporation Limited

Review Report for the Use of Q-stock Trains in KTE

August 2018

Environmental Resources Management
2507, 25/F One Harbourfront
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ENVIRONMENTAL REVIEW REPORT

MTR Corporation Limited

Review Report for the Use of Q-stock Trains in KTE

August 2018

Reference 0432570

For and on behalf of
ERM-Hong Kong, Limited

Approved by: Frank Wan

Signed:

Position: Partner

Date: 22 August 2018

CONTENTS

ANNEX

1 INTRODUCTION

1.1 BACKGROUND

Following the approval of the Kwun Tong Line Extension (KTE) Environmental Impact Assessment (EIA) Report [1] on 19 August 2010 an Environmental Permit (EP) (EP-399/2010) was granted for the KTE on 27 September 2010. Further amendments to the EP were approved from 2010 to 2016, including a Variation of EP (VEP) in January 2015 to include an additional type of train (C-stock trains) for the line. The KTE (hereafter referred to as the Project) is now operating by the MTR Corporation Limited (MTRCL).

In accordance with Condition 4.5 of the current KTE EP (EP-399/2010/D), *"Only 8-cars M-stock trains, 8-cars K-stock trains, and/or 8-cars C-stock trains shall be deployed in the Project."*. As part of the long-term asset renewal strategy to sustain high quality railway service for passengers, MTRCL has procured new Q-stock trains to replace all the existing first-generation M-stock trains running on the urban lines in phases.

In accordance with Section 8.5.2.8 of the approved KTE EIA Report (Register No.: AEIAR-154/2010), the Force Density Level (FDL) of M-stock is higher than that of K-stock trains considering that M-stock trains have a cast iron brake system which tends to cause more rail wear and more vibration than the disc brake system comparing with K-stock trains. According to the approved Environmental Review Report (ERR) in supporting the VEP for the use of C-Stock trains, the FDL of C-Stock trains was measured and shown to be lower than the FDL of M-Stock trains in the approved KTE EIA Report (1), and therefore, ground-borne noise impact caused by the operation of the C-Stock trains was considered to be lower than that by M-Stock trains. Based on the above, the FDL of the Q-stock trains has been measured and the source term for the Q-stock trains has been compared with those assumed for the M-stock (i.e. the worst train) in the approved KTE EIA Report.

To support the application for this VEP, supplementary information has been provided in this *Report* (hereafter referred to as the Review) to demonstrate that the proposed variation will not cause adverse environmental impact, and hence will not constitute a material change to the Project with respect to the requirements of the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*).

[1] Kwun Tong Line Extension Environmental Impact Assessment Report (Register No.: AEIAR-154/2010) (KTE EIA Report)

1.2 *PURPOSE OF THIS REPORT*

This *Report* presents the findings of a review of the potential environmental impacts that may arise from the proposed use of Q-stock in KTE.

1.3 *REPORT STRUCTURE*

The remainder of this *Report* is set out as follows:

- *Section 2* describes the proposed variations and the associated potential environmental issues;
- *Section 3* presents a review of the potential environmental impacts due to the proposed variation; compares the results with that presented in the approved KTE EIA Report; and review the requirements for further environmental mitigation measures;
- *Section 4* provides a review of the environmental monitoring and audit requirements; and
- *Section 5* provides a conclusion of the Review.

2.1 PROPOSED VARIATION

As explained in *Section 1*, MTRCL proposes to use Q-stock trains to replace all the existing first-generation M-stock trains in phases. It is proposed to amend Condition 4.5 of the current KTE EP (EP-399/2010/D). Details of the proposed amendment are given below and in the VEP application form.

Condition 4.5:

Only 8-cars M-stock trains, 8-cars K-stock trains, 8-cars C-stock trains, 8-cars Q-stock trains and/or other train types with equivalent or better noise performance supported with justifications by the ET Leader and verified by the IEC as conforming to the information, requirements and recommendations as set out in the EIA Report (Register No. AEIAR-154/2010) shall be deployed in the Project, subject to full and proper implementation of the measures, if any, recommended in the Noise Performance Test Report deposited under Condition 4.4 above. The following operation parameters shall be adopted or otherwise approved by the Director:-

(i) The maximum train frequency operating in the Project from hour 0700 to 2300 shall not exceed 34.3 trains per hour in each direction;
(ii) The maximum train frequency operating in the Project from hour 2300 to 0700 shall not exceed 17.1 trains per hour in each direction; and.
(iii) The total length of the trains shall be approximately 194m.

2.2 POTENTIAL ENVIRONMENTAL IMPACTS

Table 2.1 identifies the potential sources of environmental impacts associated with the proposed variation.

Table 2.1 Potential Environmental Issues during Operation

Type of Potential Impacts	Potential Impacts Arising from the Proposed Changes
Air-borne noise	×
Ground-borne noise	✓
Air quality	×
Landscape	×
Visual	×
Ecology	×
Fisheries	×
Water quality	×
Waste arisings	×
Land contamination	×
Hazard to life	×
Cultural heritage	×

✓ possible × not expected

3 POSSIBLE IMPACTS ON THE ENVIRONMENT AND MITIGATION MEASURES

3.1 GROUND-BORNE NOISE IMPACT WITH THE OPERATION OF Q-STOCK TRAINS

In the approved KTE EIA Report, use of M-stock trains was assumed in the ground-borne noise (GBN) impact assessment, which was conducted based on the FDL of the M-stock trains presented in Appendix 4.5 of the approved WIL EIA Report.

With the proposed variation, the FDL of the Q-stock trains has been measured and the source term for the Q-stock trains has been compared with those for the M-stock trains adopted in the approved KTE EIA Report.

The measurement results indicate that the FDL of the Q-stock trains is generally lower than that of the M-stock trains assumed in the approved KTE EIA Report. There is significant improvement in the FDL of the Q-stock trains at most of the frequencies, except 20Hz which has negligible contribution in calculating A-weighted ground-borne noise level. Details of the methodology and results of the FDL measurement for the Q-stock trains and comparison with the M-stock trains FDL assumed in the approved KTE EIA Report are given in *Annex A*.

With the reduction in the FDL, it is anticipated that GBN impact arising from the operation of the Q-stock trains will be lower than that from M-stock trains. Based on the above, the predicted GBN levels at the identified Ground-borne Noise Sensitive Receivers (GBNSRs), as presented in Table 8.11 of the approved KTE EIA Report, will be reduced.

A sample calculation of ground-borne noise impact at New King's Hotel (the worst affected NSR under worst case scenario) based on the FDL of the Q-stock trains is presented in *Annex B*. Assumptions, including train speed, train frequency, trackform attenuation and turnout and crossover factor, adopted in the sample calculation are the same as that in the approved EIA Report. The predicted GBN level at New King's Hotel, comparing with that predicted in the approved KTE EIA Report is presented in *Table 3.1*. The GBN level predicted in the approved KTE EIA Report and this *Report* is based on the assumption that all trains are M-stock and Q-stock respectively. In actual operation, the fleet would be a mix of M-stock, C-stock, K-stock and Q-stock trains. The expected GBN level at NSRs during operation would be between the 2 predicted values presented in the approved KTE EIA Report and this *Report* (i.e. will not be greater than that predicted in the approved KTE EIA Report).

Table 3.1 ***Predicted Ground-borne Noise Level and Comparing with the Approved KTE EIA Report***

GBNSR No.	Location	Criteria	GBN level predicted in the approved KTE EIA Report [a]	GBN level based on Q-stock Trains [b]
			dB(A) $L_{eq, 30min}$	
2	New King's Hotel	45	42	36

Notes:

(a) Reference has been made from Table 8.11 of the approved KTE EIA Report, based on the assumption that all trains are M-stock.

(b) GBN level predicted is based on the assumption that all trains are Q-stock.

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4 *REVIEW OF ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS*

No changes to the Environmental Monitoring and Audit Requirements as presented in the approved KTE EIA Report and the associated EM&A Manual will be required.

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5 CONCLUSIONS

An environmental review has been carried out to assess the potential environmental impacts associated with the proposed use of Q-stock trains to replace all the existing first-generation M-stock trains in KTE in phases. The assessment indicates that no adverse environmental impact is anticipated from the proposed variation and the environmental performance requirements set out in the approved KTE EIA Report will be complied with.

It is proposed to amend Condition 4.5 of the current EP (EP No. EP-399/2010/D) of the KTE Project and details of the proposed amendment are given in the VEP application form.

The Project Proponent has reviewed the entire KTE Project as a whole, the proposed variation will not constitute a material change to the KTE Project and the Project fully complies with the EIAO-TM requirements.

Annex A

FDL Measurement Report

MEASUREMENT REPORT

MTR Corporation Limited

FDL Measurement Report for the Q-stock Trains for WIL and KTE

June 2018

Environmental Resources Management
16/F Berkshire House
25 Westlands Road
Quarry Bay
Hong Kong
Telephone: (852) 2271 3000
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E-mail: post.hk@erm.com
http://www.erm.com

MEASUREMENT REPORT

MTR Corporation Limited

FDL Measurement Report for the Q-stock Trains for WIL and KTE

June 2018

Reference 0432570

For and on behalf of ERM-Hong Kong, Limited	
Approved by:	Frank Wan
Signed:	
Position:	Partner
Date:	1 June 2018

CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

As part of the long-term asset renewal strategy to sustain high quality railway service for passengers, MTR Corporation Limited (MTRCL) has procured new Q-stock trains to replace all the existing first-generation M-stock trains running on the urban lines.

The operation of West Island Line (WIL) and Kwun Tong Line Extension (KTE) are governed by the respective Environmental Permits (EPs) under the *Environmental Impact Assessment Ordinance* (EIAO). According to Condition 4.1.2 of the current WIL EP (EP-313/2008/J) and Condition 4.5 of the current KTE EP (EP-399/2010/D), only M-stock trains, K-stock trains and C-stock trains can be deployed. While MTRCL proposes to add Q-stock trains into the current train fleets, a variation of the current EPs (VEP) for WIL and KTE are thus required before the new trains can be deployed for service.

To support the application for VEP, supplementary information in terms of an Environmental Review Report (ERR) is prepared to demonstrate that the proposed change will not cause adverse environmental impact and hence will not constitute a material change to the WIL and KTE projects with respect to the requirements of the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) and the respective approved EIA Reports.

As ground-borne noise would be one of the potential sources of environmental impacts associated with the proposed use of new Q-stock trains, it is necessary to measure the Force Density Level (FDL) of Q-stock trains and compare the source term for Q-stock trains with those assumed for M-stock trains. In accordance with Section 8.5.2.8 of the approved KTE EIA Report (Register No.: AEIAR-154/2010), the Force Density Level (FDL) of M-stock is higher than that of K-stock trains considering that M-stock trains have a cast iron brake system which tends to cause more rail wear and more vibration than the disc brake system comparing with K-stock trains. According to the approved ERR for the use of C-Stock trains, the FDL of C-Stock trains was measured and shown to be lower than the FDL of M-Stock trains in the approved WIL EIA Report, and therefore, ground-borne noise impact by C-Stock trains was considered to be lower than that by M-Stock trains. Based on the same approach, the FDL of the Q-stock trains will be measured and the source term for the Q-stock trains will be compared with those assumed for the M-stock (i.e. the worst train) in the approved EIA Reports.

ERM-Hong Kong, Limited (ERM) was commissioned by MTRCL as the Environmental Consultant for the environmental review in supporting the VEP application. ERM is supported by Wilson Acoustics Limited (WAL) who acts as the ground-borne noise specialist for the study.

1.2 *PURPOSE OF THIS REPORT*

WAL was commissioned to conduct the FDL measurement of Q-stock trains and compare with that of the M-stock trains assumed in the approved EIA Reports for the purpose of applications for VEP for WIL and KTE.

This *FDL Measurement Report* presents the methodology and results of the FDL measurement for Q-stock trains.

2 MEASUREMENT METHODOLOGY

2.1 FDL DETERMINATION PROCEDURE

A schematic diagram showing the FDL measurement arrangement is shown in *Figure 2.1*. The measurement comprises two parts, the Line Source Response (LSR) measurement by hammer impact test, and the measurement of vibration level during train passage of a Q-stock test train.

FDL is determined by subtracting train induced vibration by LSR in logarithmic scale according to the equation below (*reference: "Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06, published by US Federal Transit Administration"* (FTA Manual)):

$$FDL(f) = L_v(f,x,y,z) - LSR(f,x,y,z)$$

where

$L_v(f,x,y,z)$ = *Train passby vibration level at ground surface outside building structure in dB re* 10^{-9}*m/s (in SI unit) or dB re* 10^{-6}*in/s (in Imperial unit), as a function of vibration frequency f and the sensor coordinate x, y, z.*

$FDL(f)$ = *Force Density Level in dB re* $N/m^{0.5}$ *(in SI unit) or dB re* $1lb/ft^{0.5}$ *(in Imperial unit), as a function of frequency f. FDL depends on the geology and train operating conditions.*

$LSR(f,x,y,z)$ = *Line Source Response from tunnel face to ground in dB re* $(10^{-9}m/s)/(N/m^{0.5})$ *(in SI unit) or dB re* $(10^{-6}in/s)/(lb/ft^{0.5})$ *(in Imperial unit), as a function of vibration frequency f and the sensor coordinate x, y, z.*

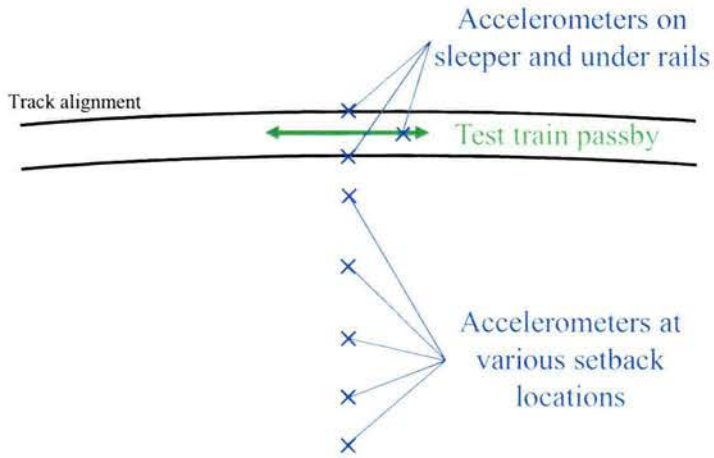
Accelerometers were deployed at the rail and on ground surface at five various setbacks from the alignment which were 4.2m, 13.6m, 20.3m, 28.9m and 38.5m, respectively. Train passby vibration data L_v in 1/3-octave bands were captured for further analysis.

Hammer impact test was conducted to determine the soil mobility of the test site. The impact conducted consecutively gives the Point Source Response (PSR) at individual setback locations. LSR is calculated from numerical integration of the PSR along the alignment for each individual 1/3-octave band.

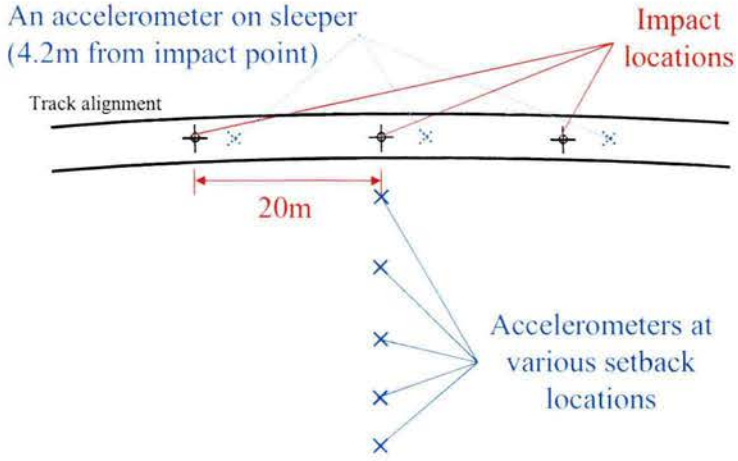
The FDL was then deduced by L_v and LSR.

2.2 MEASUREMENT LOCATION

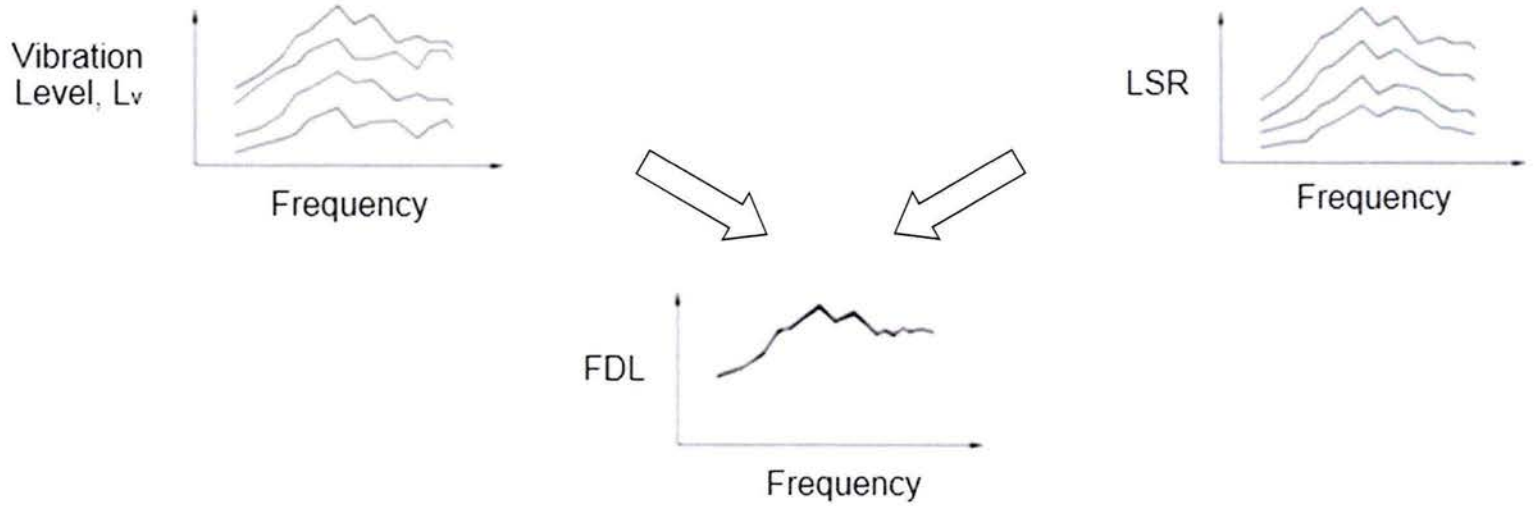
The Q-stock FDL measurement was performed at a ballast track section at Siu Ho Wan Depot test track. The FDL measurement locations are shown in *Figure 2.2*.



Vibration Measurement for Test Train Passby



LSR Measurement by Hammer Impact Test



$$FDL = L_v - LSR$$

Figure 2.1

FDL Analysis Procedure

Date 4 May 2018

Environmental
Resources
Management

ERM

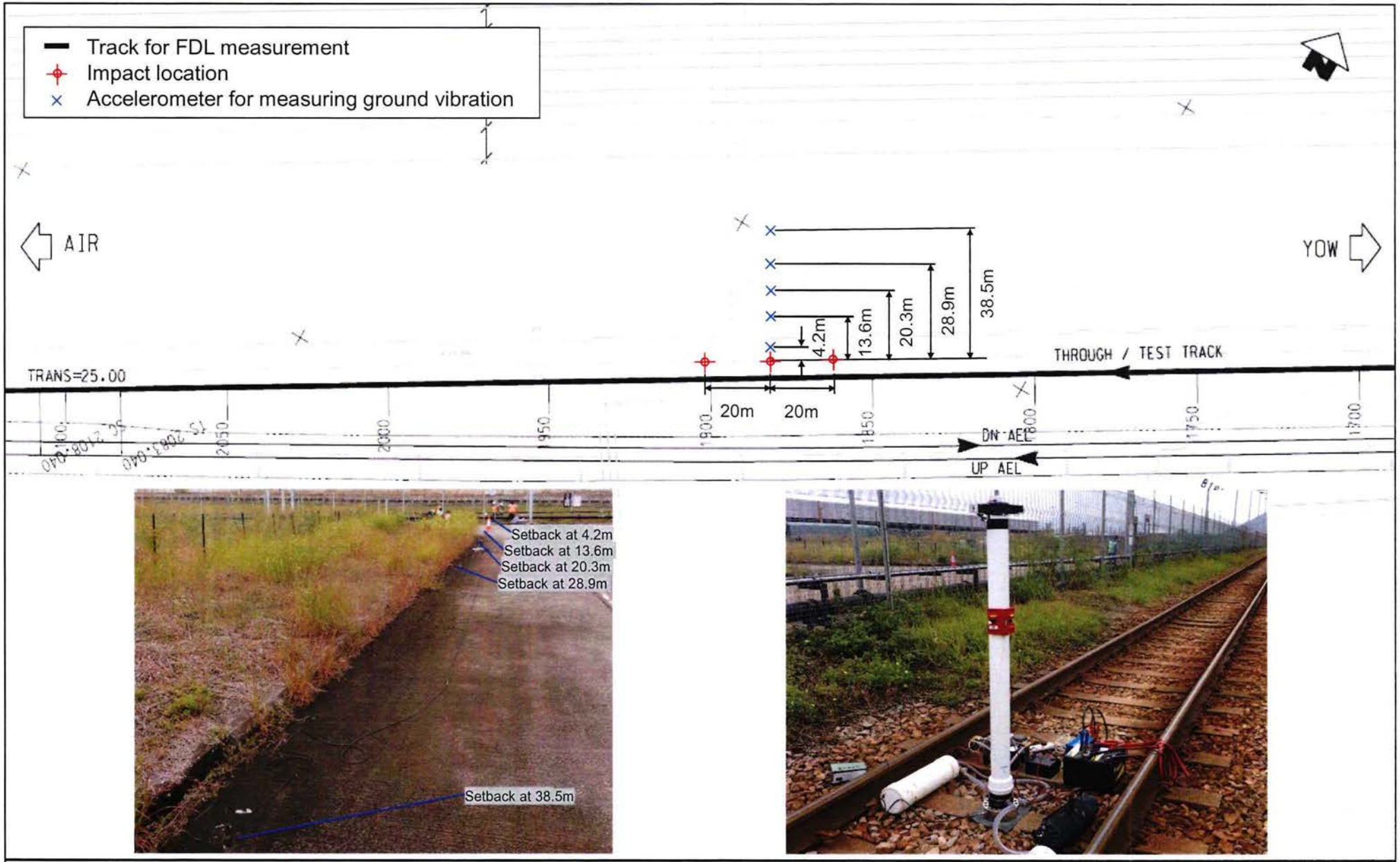


Figure 2.2

Location of Track for FDL Measurement

Date 4 May 2018

Environmental Resources Management

ERM

2.3 MEASUREMENT SCHEDULE

The FDL measurement and the relevant activities were conducted on 14 March 2018, with the measurement schedule listed in *Table 2.1.*

Table 2.1 Measurement Schedule

Time	Measurement Activities
08:00 - 09:00	Entry to test track
	Accelerometers set up at track and setback locations
09:00 - 12:00	Vibration measurement for Q-stock test train (constant speeds at 60kph, 40kph and 30kph, respectively)
15:00 - 16:00	Entry to test track
	Set up of Impact Hammer
16:00 - 17:00	Hammer impact test at 3 locations, 5-10 impacts for each location
17:00 - 18:00	Rail corrugation measurement
	Removal of all measurement equipment from track and setback locations

2.4 WHEEL AND TRACK CONDITIONS

A Q-stock test train was deployed for FDL measurement. The train has no audible wheel-flats.

The test section was a continuously rail on ballast and sleepers.

The vibration level induced by train passage is related to rail roughness. Thus measuring rail roughness at the time of FDL measurement provides a good reference and record for comparison with future measurements.

Rail corrugation measurement was conducted in accordance with *BS EN 15610:2009 - Railway applications. Noise emission. Rail roughness measurement related to rolling noise generation* over a distance of 200m of each rail. Detailed measurement results are presented in *Appendix A.*

The acoustic rail roughness was in general higher than the limit of reference track condition recommended by *ISO 3095:2013 Acoustics – Railway Applications – Measurement of Noise Emitted by Railbound Vehicle"* and *TSI 2011/229/EU Technical Specifications for Interoperability (TSI),* which sets the roughness criteria for noise commissioning test. This indicated the measured FDL was not captured under perfect rail condition, which is conservative to the assessment of ground-borne noise impact arising from Q-stock trains.

Photos of the rail running surface are shown in *Appendix A.*

2.5 MEASUREMENT EQUIPMENT

Measurement instruments and vibration measurement locations are listed in *Table 2.2.* Photos of the measurement equipment are shown in *Figures 2.3* to *2.6.*

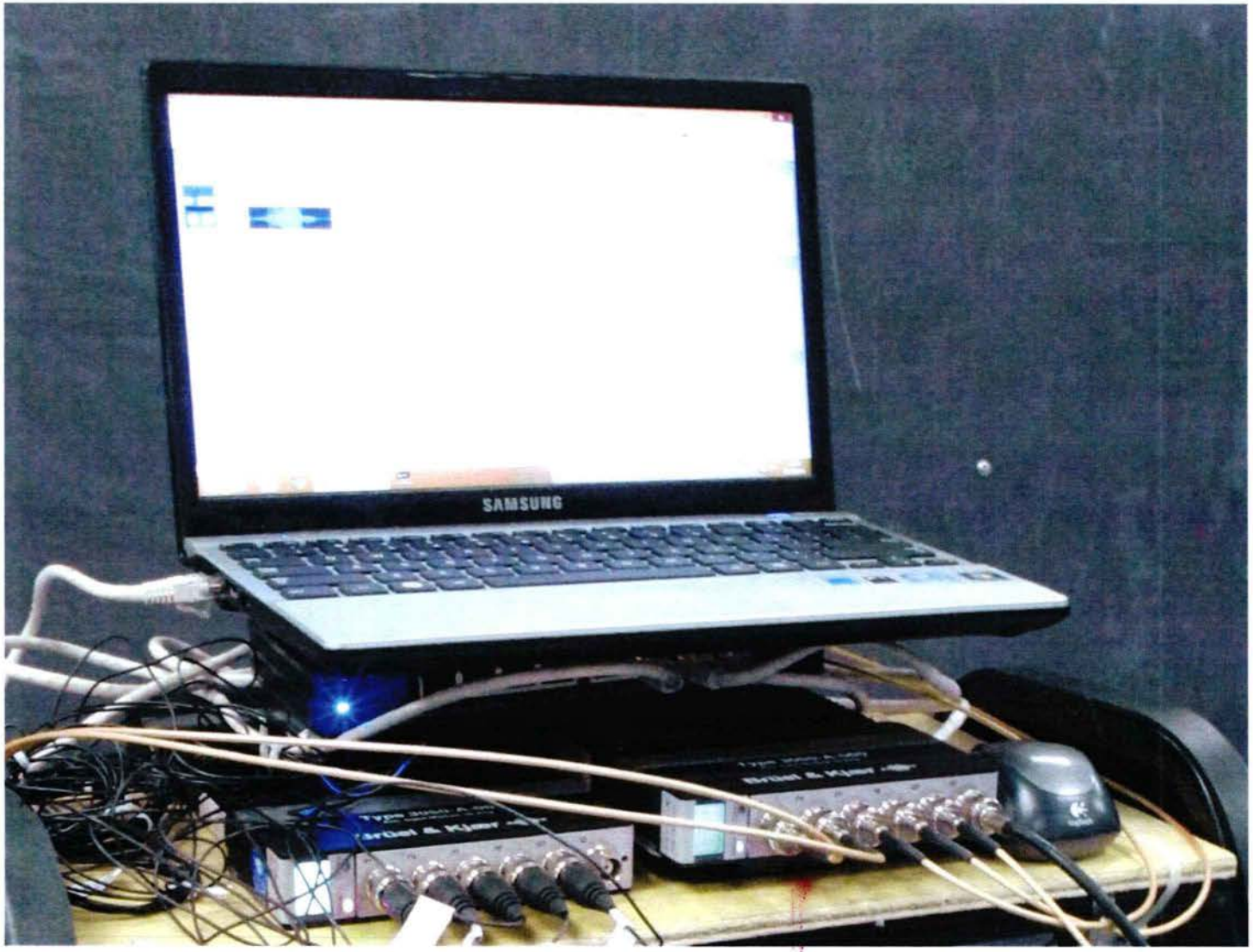


Figure 2.3

Brüel & Kjær Pulse Analyser 3050 with Laptop Computer

Date 4 May 2018

Environmental Resources Management

ERM

CTC AC216-1A

PCB 393A03

Figure 2.4

Accelerometers

Date 4 May 2018

Environmental Resources Management

ERM

Figure 2.5

WAL-001 Impact Hammer

Date 4 May 2018

Environmental
Resources
Management

ERM

Figure 2.6

Corrugation Analysis Trolley (CAT)

Date 4 May 2018

Environmental Resources Management

ERM

Similar to the approved WIL EIA Report, low sensitivity accelerometers were placed at the track and higher sensitivity accelerometers were placed on ground at setbacks. Sensor locations are listed in *Table 2.3*.

Table 2.2 ***Measurement Instruments***

Instrument	Model No.	Qty.	Figure No.
6-Channel Spectrum Analyser	Brüel & Kjær Pulse 3050	2	2.3
Piezoelectric Accelerometer	CTC AC216-1A	3	2.4
Piezoelectric Accelerometer	PCB 393A03	5	2.4
Vibration Calibrator	IMI 699A02	1	
Impact Hammer	WAL-001	1	2.5
Corrugation Analysis Trolley (CAT)	Rail Measurement CAT 3	1	2.6

Table 2.3 ***Deployment of Vibration Sensors***

Location (Figure 2.2)	Accelerometer	Sensitivity
Under left rail	CTC AC216-1A #1	100mV/g
Under right rail	CTC AC216-1A #2	100mV/g
On sleeper (4.2m from impact point)	CTC AC216-1A #3	100mV/g
Setback at 4.2m (from track centreline)	PCB 393A03 #1	1V/g
Setback at 13.6m (from track centreline)	PCB 393A03 #2	1V/g
Setback at 20.3m (from track centreline)	PCB 393A03 #3	1V/g
Setback at 28.9m (from track centreline)	PCB 393A03 #4	1V/g
Setback at 38.5m (from track centreline)	PCB 393A03 #5	1V/g

2.6 *MEASUREMENT PROCEDURE*

For LSR measurement, hammer impact was conducted at 3 different locations along the alignment. For each location, 5-10 hammer impacts were conducted for averaging. LSR is determined by numerical integration of PSR along the alignment.

For train passby vibration measurement, the train run at constant speeds of 30kph, 40kph and 60kph. For each train speed, at least 3 passbys were measured.

3 MEASUREMENT RESULTS AND DISCUSSION

3.1 TRAIN PASSBY VIBRATION MEASUREMENT AND HAMMER IMPACT TEST RESULTS

Train passby vibration level and point source response as determined from hammer impact test are presented in *Appendix B*. The soil at the subject site has peak transfer mobility around 20-125Hz, while train vibration peaks around 20-80Hz.

The A-weighted train passby vibration level is plotted against log train speed. It shows that A-weighted vibration level follows approximately the relationship $\Delta L_v = 20 \log(\text{speed})$.

As A-weighted vibration level is directly correlated to the ground-borne noise level, double train speed results in approximately 6dB(A) increase in ground-borne noise level. The measurement results for Q-stock trains are similar to that for M-stock trains as presented in the approved EIA Reports, and also in line with the FTA manual.

3.2 FDL MEASUREMENT RESULT

The FDL for Q-stock trains is determined from the LSR and train passby vibration level at 60kph, and shown in *Figure 3.1*. Train speed 60kph is selected since the approved WIL EIA report only presents FDL at 60kph available for comparison. Since the correlations between vibration level and train speed are similar, it is anticipated that if FDL of Q-stock is lower than that of M-stock at 60kph, the FDL would also be lower at other train speeds.

Similar to the approved EIA Report, two standard deviations are added on top of the measured average FDL value, in order to account for uncertainties and variations in the measurement. The adjusted FDL value is also presented in *Figure 3.1*.

3.3 COMPARISON WITH EIA ADOPTED FDL

The FDL of Q-stock trains is compared with that of M-stock trains adopted in the approved EIA Reports, as shown in *Figure 3.2*. Both FDL values include two standard deviations to account for measurement uncertainties.

The FDL of Q-stock trains is found to be in general lower than that of the M-stock trains adopted in the approved EIA Reports except at 20 Hz. Considering the frequency at 20Hz has negligible contribution in calculating A-weighted ground-borne noise level and there are significant improvement of Q-stock FDL at other frequencies, it is anticipated that ground-borne noise impact arising from Q-stock trains will be lower than that from M-stock trains.

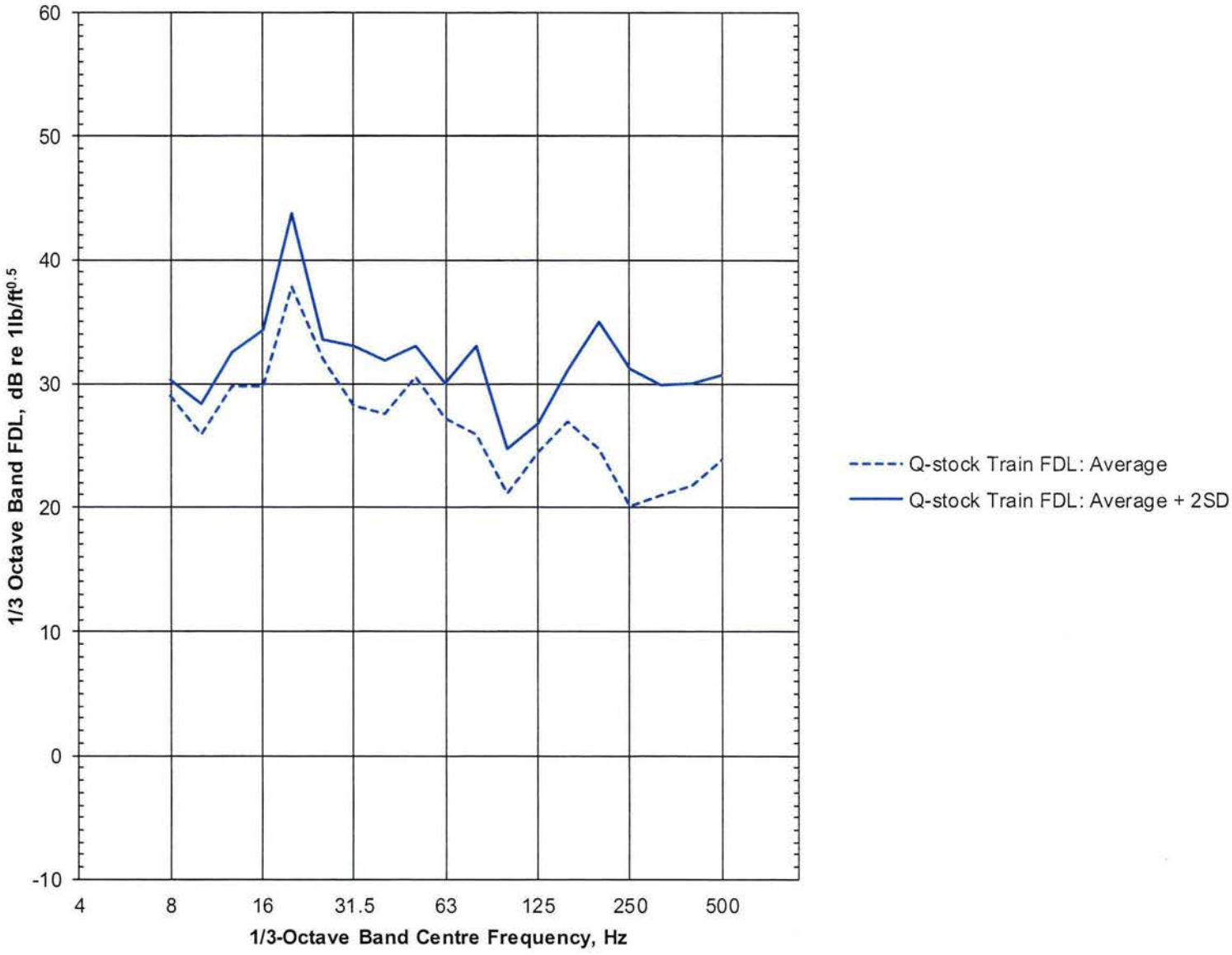


Figure 3.1

Siu Ho Wan Test Track Force Density Level

Date 4 May 2018

Environmental Resources Management

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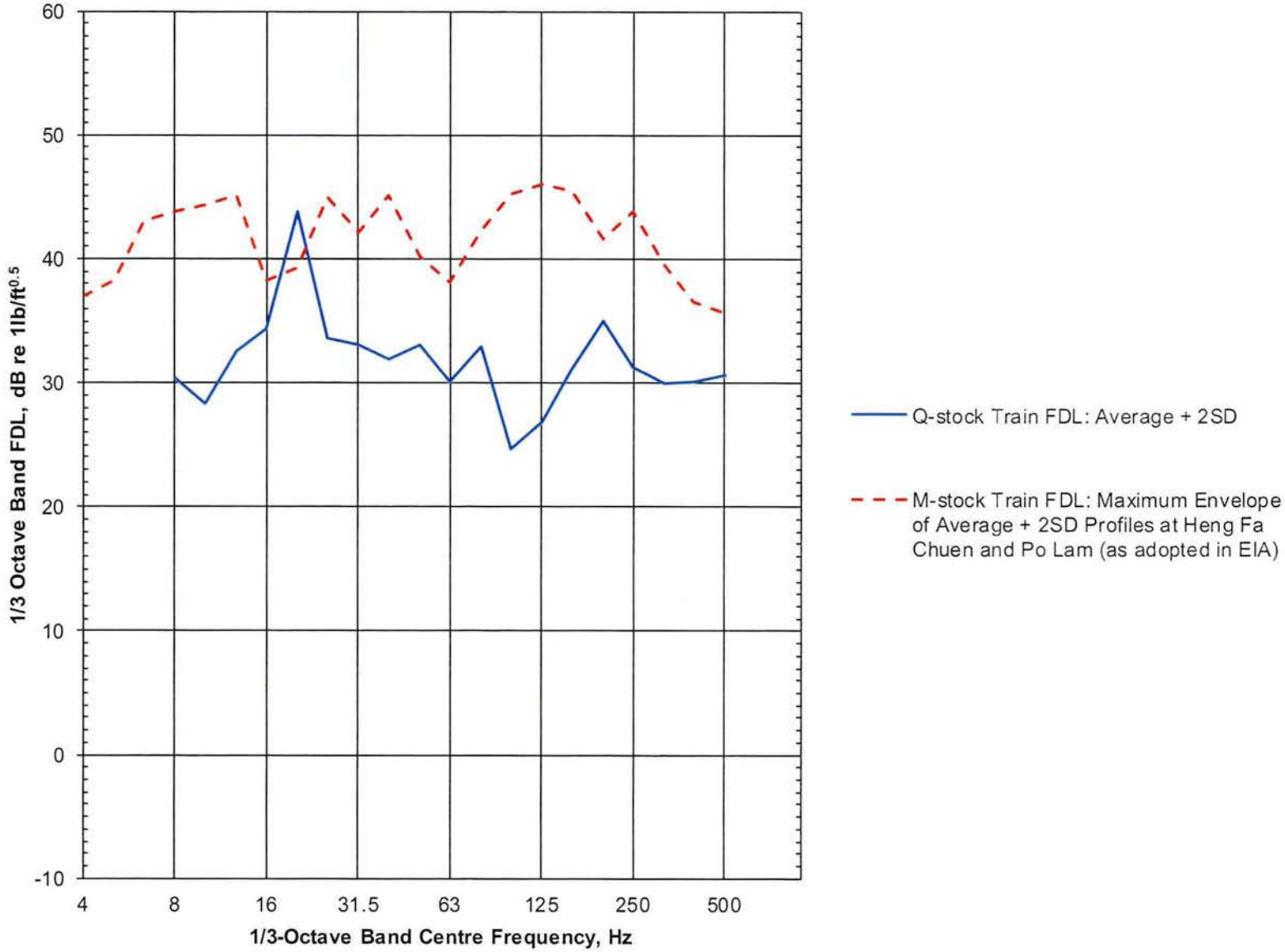

Figure 3.2

Force Density Levels of Q-stock and M-stock Trains

Date 4 May 2018

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4 CONCLUSIONS

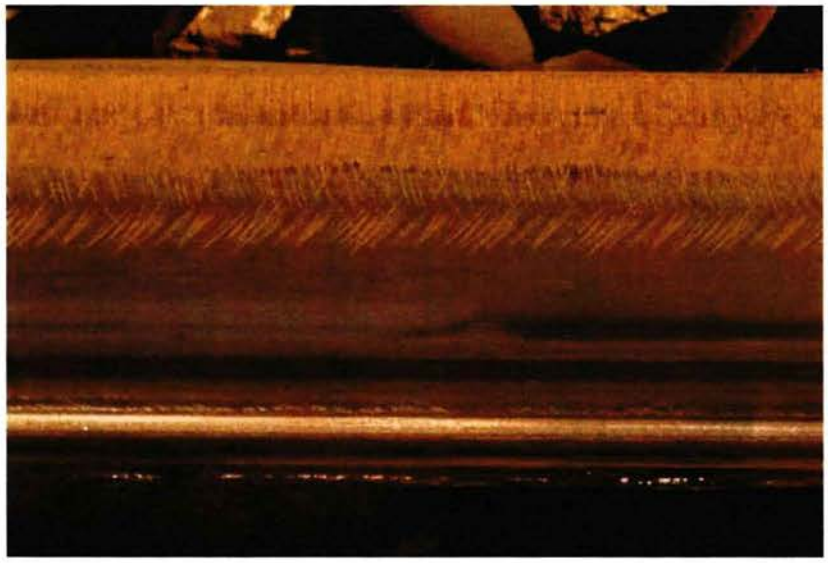
Q-stock FDL Measurement has been conducted at the test track of Siu Ho Wan Depot.

Results indicate that the A-weighted Q-stock passby vibration level increases with train speed approximately according to 20 log(speed). This is similar to that for the M-stock trains as presented in the approved EIA Reports.

The measured Q-stock FDL is found to be in general lower than the M-stock FDL adopted in the approved EIA Reports. Ground-borne noise impact arising from Q-stock trains is anticipated to be lower than that from M-stock trains.

Appendix A

Rail Roughness Measurement Results



Running Surface of Far Rail

Running Surface of Far Rail

EIA

WAL

Running Surface of Near Rail

Running Surface of Near Rail

Figure A.1

Rail Surfaces during EIA measurement at Heng Fa Chuen and WAL measurement at Siu Ho Wan Depot

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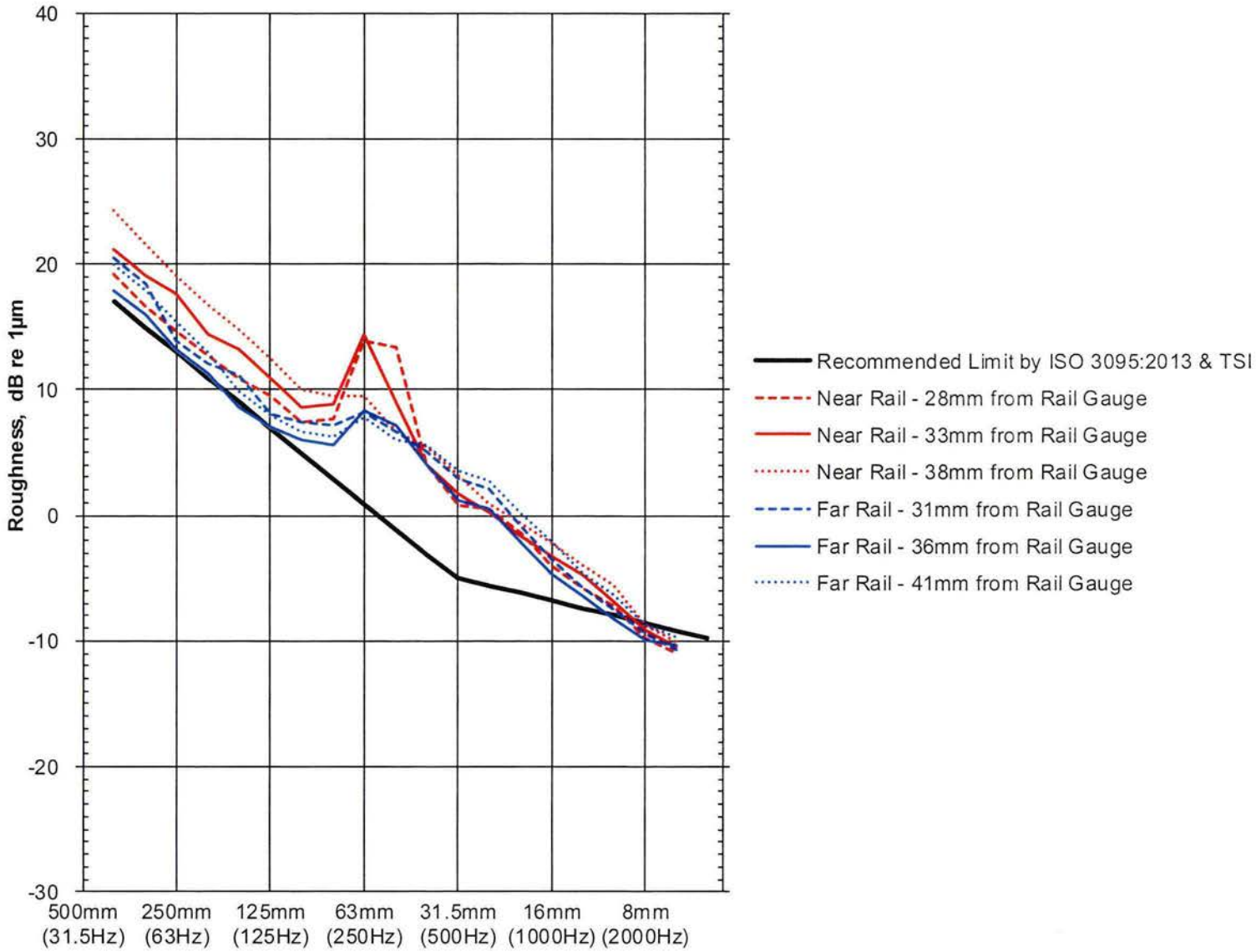

Figure A.2

Rail Roughness Spectra at Siu Ho Wan Test Track

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Appendix B

Train Passby Vibration and Hammer Impact Test Results

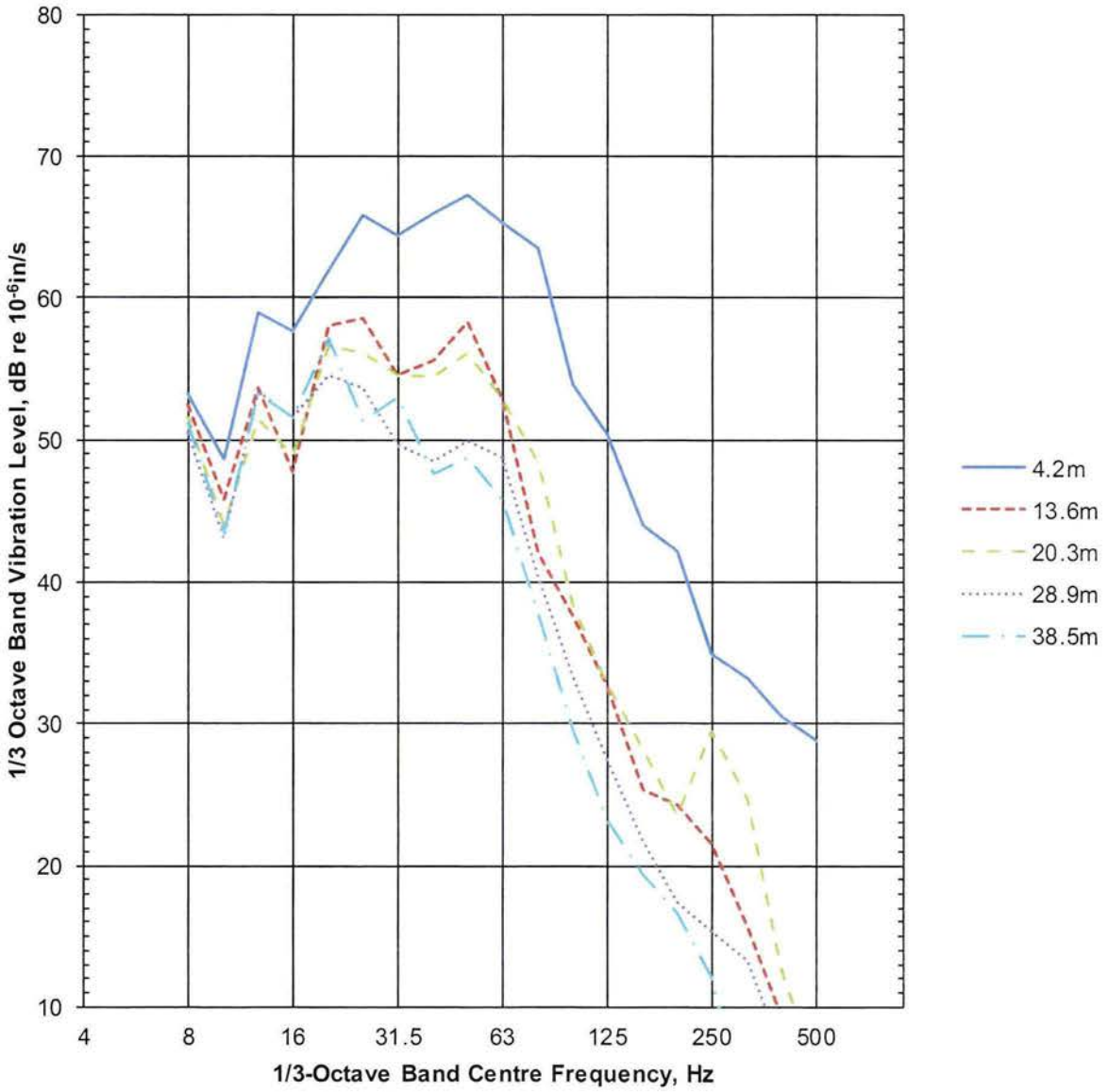

Figure B.1

Siu Ho Wan Test Track Q-stock Train Passby Vibration Levels at Different Setbacks

Date 4 May 2018

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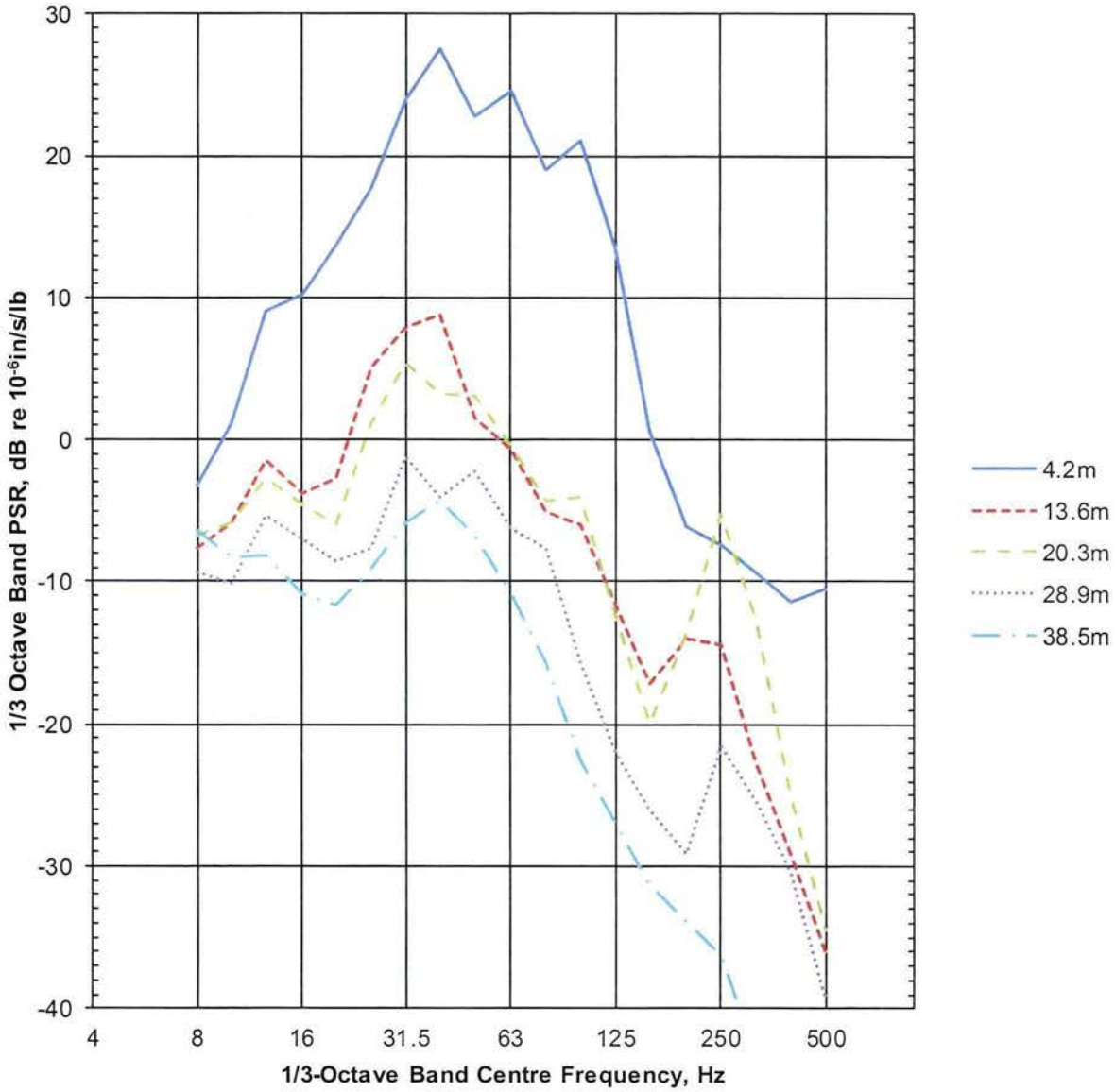

Figure B.2

Siu Ho Wan Test Track Point Source Responses at Different Setbacks

Date 4 May 2018

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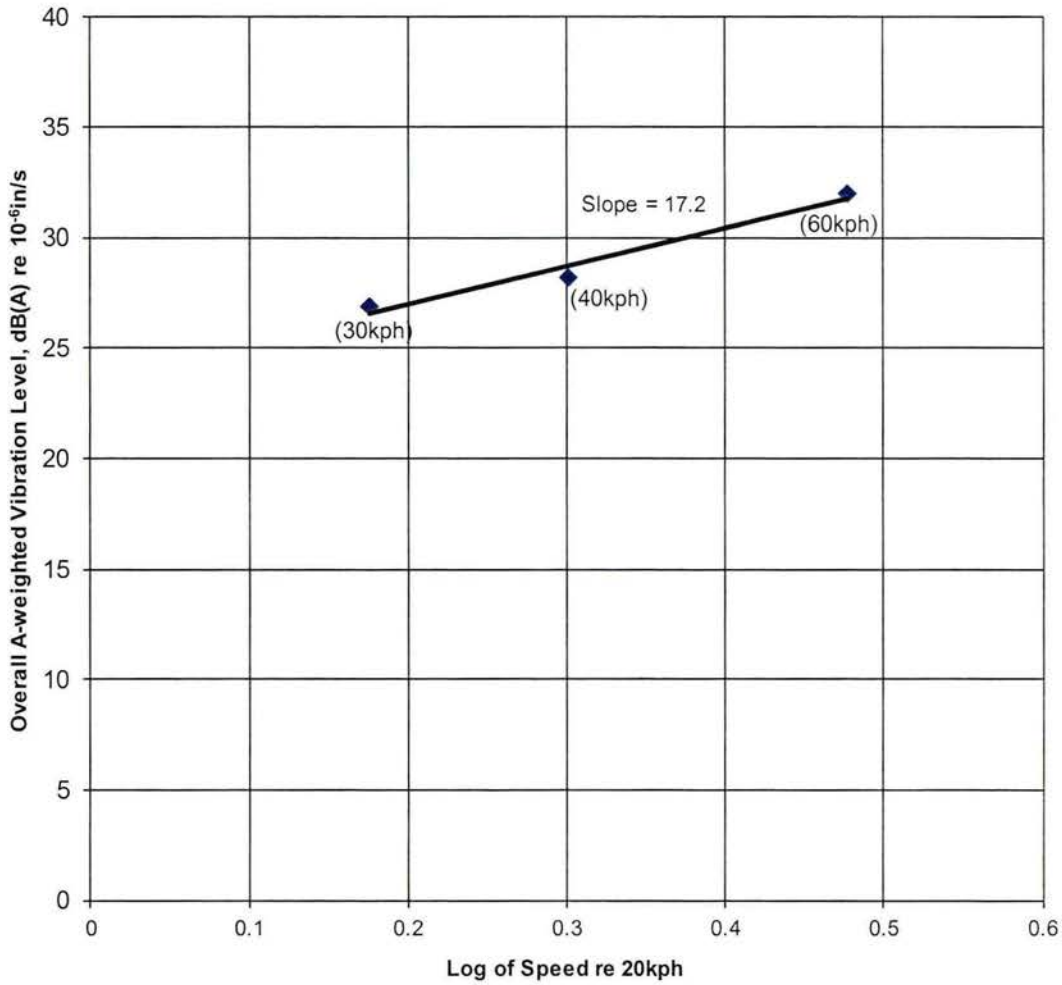

Figure B.3

Speed Correction for Overall A-Weighted Vibration Level

Date 4 May 2018

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Appendix C

Equipment Calibration Certificates

Brüel & Kjær

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

We certify that Brüel & Kjær **-3050-A-060-** Serial No. **3050-100888** has been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.

The final test has been performed using calibrated equipment, traceable to national or international standards or by ratio measurements.

Brüel & Kjær is certified under ISO 9001:2008 assuring that all test data is retained on file and is available for inspection upon request

Nærum 16 dec 2016

Torben Bjørn
Vice President, Operations

Please note that this document is not a calibration certificate.
For information on our calibration services please go to www.bksv.com/service

Brüel & Kjær

Certificate of Conformance

Wilson Acoustics Limited
Unit 601, Block A, Shatin Industrial Centre
Hong Kong

Reference number	Service request	Date
	CAS-120988-Z1H8V0	29-Mar-2016

We hereby declare that

-3050-A-060- 6-ch Input Module LAN-XI 51.2kHz (Mic, CCLD, V) Serial Number: 3050-105894

has been tested and passed all test

The instrument has been tested according to published specifications at the date of the test.
All tests have been performed using calibrated equipment, traceable to National or International Standards or by ratio measurements.

Certificate issued
29-Mar-2016

Torben Bjørn

Vice President - Operations
For and behalf of Brüel & Kjær HQ

Recommended date for next check: Mar-2017

Brüel & Kjær is certified under ISO 9001:2008 assuring that all calibration data is retained on file and is available for inspection upon request

Note

Brüel & Kjær Sound & Vibration Measurement A/S

Figure C.1

Calibration Certificates – Vibration Analyzer

Date 4 May 2018

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深圳市计量质量检测研究院
Shenzhen Academy of Metrology & Quality Inspection
国家高新技术计量站
National Hi-tech Metrology Station

校 准 报 告
CALIBRATION REPORT

报告编号：[illegible]

客户名称 ： 威信声学顾问有限公司
Name of Customer

客户地址 ： 香港新界沙田工业中心A座601
Address of Customer

计量器具名称： 振动校准器
Name of Instrument

器具用途 ： ——
Use of Instrument

型号/规格 ： 089A02
Type/Specification

出厂编号 ： 989
Serial №

资产编号 ： ——
Asset №

制造单位 ： IMI
Manufacturer

校准依据 ： JJG 1062-2010 便携式振动校准器
Calibrated in Accordance to

合 格

（校准专用章）
Stamp

批准人 ： 张国庆(副所长)
Authorized by

签名 ： 张国庆
Signature

核验员 ： [signature]
Checked by

校准员 ： [signature]
Calibrated by

校准日期 ： 2017 年 10 月 27 日
Operation Date Year Month Day

建议复校日期： 2018 年 10 月 26 日
Suggested Recal Date Year Month Day

[illegible]

Register No.: [2012]计量校F002号
Add: Metrology and Quality Inspection Building,Central Section of Longhua Road, Nanshan District,Shenzhen
Tel:0086-755-26941696 0086-755-26941546
Fax:0086-755-26941615 0086-755-26941547
Post Code:518055 http://www.smq.com.cn
E-mail:kfzx@smq.com.cn

深圳市计量质量检测研究院
Shenzhen Academy of Metrology & Quality Inspection
国家高新技术计量站
National Hi-tech Metrology Station

校准报告
CALIBRATION REPORT

校准用主要计量标准装置信息
Main Standard Devices Used

名称 Equipment Name	测量范围 Measuring Range	不确定度/准确度等级/最大允许误差 Uncertainty/Accuracy Class/ Maximum Permissible Error	计量标准考核证书号 Certificate №	有效期至 Due Date

校准用主要标准器信息
Main Standards of Measurement Used

名称 Equipment Name	测量范围 Measuring Range	不确定度/准确度等级/最大允许误差 Uncertainty/Accuracy Class/ Maximum Permissible Error	设备编号 Equipment №	证书号 Certificate №	有效期至 Due Date
振动校准传感器	0.2 Hz ~ 4000 Hz (±1%)	Level 0.5 %, 1 2	SB0424-02	ESad2017-0638	2018-05-14

附加说明
Appended Directions

委托日期： 2017 年 10 月 23 日
Application Date

校准地点： 本院声学振动实验室
Operation Location

环境条件： 温度 23 ℃ 相对湿度 50 %
Operation Environment

符合性及限制使用说明： 所校准项目（或量值）合格
Statement of Compliance and Limitation

Figure C.2

Calibration Certificates – Vibration Calibrator (Pages 1 and 2 of 5)

Date 4 May 2018

Environmental Resources Management

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深圳市计量质量检测研究院
Shenzhen Academy of Metrology & Quality Inspection
国家高新技术计量站
National Hi-tech Metrology Station

校准报告
CALIBRATION REPORT

报告编号：[illegible]
Report N°

第 3 页，共 5 页
Page 3 of 5 Pages

校准结果
Results of Calibration

1 外观检查： 正常

Appearance Check: Pass

2 振动幅值：

Amplitude

2.1 加速度：见表1

Acceleration: See Table 1

表1 Table 1

加速度标称值	加速度实测值	误差	最大允许误差
Nominal SPL	Measured SPL	Error	M.P.E.
(m/s²)	(m/s²)	(%)	(%)
9.8	9.75	+0.5	±3.0

2.2 等效速度：见表2

Equivalent Velocity: See Table 2

表2 Table 2

速度标称值	速度实测值	误差	最大允许误差
Nominal SPL	Measured SPL	Error	M.P.E.
[illegible]	[illegible]	(%)	(%)

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Shenzhen Academy of Metrology & Quality Inspection
国家高新技术计量站
National Hi-tech Metrology Station

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CALIBRATION REPORT

报告编号：[illegible]
Report N°

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校准结果
Results of Calibration

9.8	9.75	+0.5	±3.0

2.3 等效位移：见表3

Equivalent Displacement: See Table 3

表3 Table 3

位移标称值	位移实测值	误差	最大允许误差
Nominal SPL	Measured SPL	Error	M.P.E.
(um)	(um)	(%)	(%)
9.8	9.75	+0.5	±3.0

3 频率：见表4

Frequency: see Table 4

表4 Table 4

频率标称值	频率实测值	误差	最大允许误差
Nominal Freq.	Measured Freq.	Error	M.P.E.
(Hz)	(Hz)	(%)	(%)
159.2	159.2	0.0	±1.0

4 [illegible]

Figure C.3

Calibration Certificates – Vibration Calibrator (Pages 3 and 4 of 5)

Date 4 May 2018

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Shenzhen Academy of Metrology & Quality Inspection
国家高新技术计量站
National Hi-tech Metrology Station

校准报告
CALIBRATION REPORT

校准结果
Results of Calibration

MIC Distortions: See Table 5

表5 Table 5

标称频率 Nominal Freq. (Hz)	标称幅值 Nominal Amplitude (m/s²)	失真度 Distortion (%)	允许范围 Limit (%)
159.2	9.8	0.62	≤5.0

附注(Note):

1) 等效速度和等效位移由参考标准加速度换算得出。

2) 加速度测量结果相对扩展不确定度：U_{rel} = 1.4 %, k = 2

(依据JJF1059.1-2012测量不确定度评定及表示)

Related Expended Uncertainty of Acceleration: U_{rel} = 1.4 %, k = 2

(By JJF1059.1-2012 Evaluation and Expression of Uncertainty in Measurement)

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Annex B

Sample Ground-borne Noise Calculation

Project: KTE Operational Groundborne Noise Assessment

NSR No.: 2

NSR Name: New King's Hotel

NSR Use: Residential

No. of Basement Floors: 0

NSR Floor: 2

	Slant Dist, m	Train Speed, kph	Passby in 1hr
Down Track	13	46	17.1
Up Track	23	67	17.1

Descriptions	Unit	1/3 Octave Band Center Frequency																		
		8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500
Down Track Vibration Calculation																				
FDL	dB re 1N/m$^{0.5}$	46.1	44.1	48.3	50.2	59.6	49.4	48.8	47.6	48.9	45.8	48.8	40.5	42.6	46.9	50.8	47.0	45.7	45.9	
LSR	dB re 1(nm/s)/(N/m$^{0.5}$)	3.1	13.5	13.5	17.6	8.6	7.5	7.2	11.8	13.4	15.8	13.4	18.7	15.8	10.4	19.1	19.6	20.0	21.2	
TOC	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	
TIL	dB	1.5	0.0	0.0	-3.0	-6.0	-5.0	-1.0	1.0	3.0	-7.0	-11.0	-8.0	-10.0	-10.0	-10.5	-10.0	-8.0	-3.0	
TCF	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	
Down Track Vibration Level	dB re 1nm/s	50.7	57.6	61.8	64.8	62.2	51.9	55.0	60.4	65.3	54.6	51.2	51.2	48.4	47.3	59.4	56.6	57.7	64.1	
Up Track Vibration Calculation																				
FDL	dB re 1N/m$^{0.5}$	49.4	47.4	51.6	53.4	62.8	52.6	52.1	50.9	52.1	49.1	52.0	43.8	45.8	50.1	54.1	50.3	49.0	49.1	
LSR	dB re 1(nm/s)/(N/m$^{0.5}$)	0.8	11.2	11.2	15.2	6.2	5.2	4.9	9.4	11.1	13.5	11.1	16.4	13.5	8.1	16.8	17.2	17.7	18.9	
TOC	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	
TIL	dB	1.5	0.0	0.0	-3.0	-6.0	-5.0	-1.0	1.0	3.0	-7.0	-11.0	-8.0	-10.0	-10.0	-10.5	-10.0	-8.0	-3.0	
TCF	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	
Up Track Vibration Level	dB re 1nm/s	51.7	58.6	62.8	65.6	63.0	52.8	56.0	61.3	66.2	55.6	52.1	52.2	49.3	48.2	60.4	57.5	58.7	65.0	
Total of Down Track and Up Track Groundborne Noise Calculation																				
Total Vibration Level Outside Building	dB re 1nm/s	54.2	61.1	65.3	68.2	65.6	55.4	58.5	63.9	68.8	58.2	54.7	54.7	51.9	50.8	62.9	60.1	61.2	67.6	
BCF	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	
BVR - Floor to Floor	dB	-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	-4.0	-4.0	-4.0	-4.0	-4.0	
BVR - Resonance	dB	2.0	3.0	3.8	5.0	6.0	6.0	6.0	6.0	5.8	5.4	5.2	5.0	4.8	4.0	3.0	2.0	1.0	0.7	
CTN	dB	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	
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	
Predicted Noise Level	1/3 Oct (Linear), dB	35.2	43.1	48.1	52.2	50.6	40.4	43.5	48.9	53.6	42.6	38.9	38.7	35.7	33.8	44.9	41.1	41.2	47.3	
Noise Level	1/3 Oct (A-weighted), dBA	-35.2	-27.3	-15.3	-4.5	0.1	-4.3	4.1	14.3	23.4	16.4	16.4	19.6	19.6	20.4	34.0	32.5	34.6	42.5	
Predicted Noise Leq (Double Passby)	dBA	44 dBA																		
Predicted Noise Lmax, slow	dBA	45 dBA																		
Predicted Leq (30min, Night-time)	dBA	36 dBA (Criteria: 45 dBA)																		

Note: Speed correction has been included in the FDL for the operational groundborne noise assessment.

Figure B.1

Sample GBN Calculation based on Q-stock FDL at New King's Hotel of KTE

Date 4 July 2018

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