HGC ENGINEERING

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September 28, 2023

VIA E-MAIL TO: gpennino@cityparkhomes.ca

Giancarlo Pennino
City Park Homes
950 Nashville Road
Kleinburg, Ontario
L0L 1C0

Re: Vibration Feasibility Study, Proposed Residential Development
Queen Street South and Britannia Road, Mississauga, Ontario
HGC Engineering Project No. 02200853

Dear Giancarlo,

Introduction

HGC Engineering was retained by City Park Homes to conduct a rail vibration feasibility study for a proposed residential development to be located at the southwest corner of Queen Street South and Britannia Road in the City of Mississauga, Ontario. The noise study for this development was completed by HGC Engineering titled *"Noise Feasibility Study, Proposed Residential Development, Queen Street South & Britannia Road West, Mississauga, Ontario"* dated June 22, 2023 (Noise Study). This vibration study has been prepared for submission as part of the approval process by the city. It follows the guidelines of the Ministry of the Environment, Conservation and Parks (MECP) and Canadian Pacific Railway (CP) with regard to the impact of ground-borne vibration from freight and passenger trains.

Ground-borne vibration measurements were performed at the location of the nearest proposed building façade to the railway right-of-way, and the location of the nearest proposed dwelling unit to the railway right-of-way. Measured vibration levels were found to momentarily exceed the criteria during some of the train pass-bys. Nonetheless, acceptable vibration levels are expected to be achieved once the foundations for the building are in place. When architectural and structural drawings are available for the building, they should be reviewed to confirm the natural attenuation from the foundation and confirm the construction. A vibration warning clause should be included in the property and tenancy agreements of the units to inform the future owners and tenants of the possible momentary vibration perceptibility during rail pass-bys.

Description of the Site

A key plan showing the location of the proposed site is indicted in Figure 1. The development is located to the west of Queen Street and south of Britannia Road, in Mississauga, Ontario. The proposed site plan prepared by G+C Architects dated January 20, 2023, is attached as Figure 2. The proposed development will consist of one new 8-storey residential building with a parking garage. The vibration measurement locations are also shown on Figure 2 for reference.

The primary source of vibration is rail traffic on the CP Galt railway corridor located directly southwest of the site, adjacent to the proposed parking garage and approximately 25 m southwest of the closest proposed dwelling unit. The rail line is used by both freight and passenger trains and is considered a principal main line. The surrounding lands are primarily existing residences with some light commercial uses. The CP railway yard is located to the northwest of the site.

Criteria Ground-borne Vibration from Rail Traffic

CP provides guidance and vibration criteria for residential developments adjacent to their railway right-of-way. CP guidelines require measurements of ground-borne vibration when a residential development is to be located within 75 m of a rail line, as is the case for this development. The CP main line requirements are attached. The Railway Association of Canada/Federation of Canadian Municipalities "Report Research Phase 3: Proximity Guidelines and Best Practices" dated November 2006 and Guidelines for New Development in Proximity to Railway Operations dated May 2013 were also reviewed.

Vibration is typically measured in terms of oscillatory velocity or acceleration. The CP limits for acceptable ground-borne vibration are an overall RMS velocity of 0.14 mm/s (-17 dB re 1 mm/s) between the frequencies of 4 and 200 Hz.

CP limits for acceptable ground-borne vibration are also presented as a curve of maximum allowable vibratory acceleration levels, in units of decibels relative to the acceleration due to gravity (dB re 1g), versus one-third octave band frequency. The CP spectral criteria have been overlaid on the graphs of measured vibration for easy reference.

Assessment of Ground-borne Vibration from Rail Traffic

HGC Engineering personnel visited the site on September 11 and 14, 2023, in order to conduct vibration measurements. Measurements of ground-borne rail vibration were conducted at two locations, along the southwest property line of the site and approximately 25 m from the southwest property line, as indicated by [V1] and [V2] in Figure 2. The vibration measurements were conducted using a Svantek SV977 Sound and Vibration Meter outfitted with a Wilcoxon Research type 793V velocity transducer that was correctly field calibrated before and after the measurements.

Ground-borne vibration was measured for train pass-bys between September 11th and 14th. The vibration level plots of five representative pass-bys are attached as Figures 3 to 12. Table 1 shows the maximum overall RMS vibration velocity measurements during each of these five train pass-bys.

Table 1: Peak Vibration Measurements of Train Pass-bys

Train Pass-by	Measured Vibration Level (mm/s)		Criteria (mm/s)
	[V1]	[V2]	
1 (Freight)	0.52	0.22	0.14
2 (Freight)	0.19	0.09	
3 (Freight)	0.23	0.14	
4 (Passenger)	0.07	0.04	
5 (Passenger)	0.09	0.05	

The upper curves, Figures 3a to 12a, show RMS vibration velocity as a function of time for each train pass-by. Vibration levels were found to momentarily exceed the CP limit of 0.14 mm/s during three of the five train pass-bys at location [V1], and during one train pass-by at location [V2]. The maximum vibration exceeded 0.2 mm/s during only two pass-bys at location [V1] and during only one pass-by at location [V2].

The lower curves, Figures 3b to 12b, show the maximum measured acceleration as a spectrum of level in dB re g versus one-third octave frequency compared to the CP criteria curve. These figures show that the highest levels, relative to the criteria, occurred between the frequencies of 20 Hz and 40 Hz.

Vibration isolation of the building structure by supporting the building above the foundation walls on resilient rubber pads is not considered appropriate for this development. These systems typically have a natural frequency in the range of 10 to 12 Hz and would amplify ground-borne vibration at these frequencies. In this case, such a system would not be appropriate as higher levels of vibration were noted in the low frequency range, which could be amplified in the structure by the presence of rubber pads. As such, vibration mitigation through the use of resilient pads or springs is not recommended.

The mass of the building structure will provide a certain degree of vibration attenuation. Heavier foundations generally provide greater attenuation than lighter weight foundations. US Federal Transit Administration (FTA) guidelines predict a reduction of vibration felt in buildings due to heavier foundation systems, similar to the anticipated foundation of the proposed 8-storey residential building, that is expected to be sufficient to achieve the required criteria. At this time, the architectural and structural drawings for the building are not available. Once available, the architectural and structural drawings should be reviewed to consider the beneficial attenuation of the proposed foundations.

As shown in Table 1, the peak vibration levels at the nearest residential dwelling unit were significantly lower than the levels measured at the property line where the parking garage begins. The separation distance of the residential units from the rail line and the building structure of the parking garage should provide further attenuation of the vibration levels perceived in the proposed residential units.

The following vibration warning clause should be included in the property and tenancy agreements of the dwelling units in addition to the warning clauses outlined in the Noise Study to inform the future owners and tenants of the potential that vibration may be perceptible .

Type F:

> Purchasers/tenants are advised that due to the proximity of this dwelling to the nearby railway tracks, vibration from rail pass-bys may be perceptible within this unit.

Summary

The measured levels of ground-borne vibration were found to momentarily exceed the CP vibration limits at the location of the nearest building façade and the nearest proposed dwelling unit of the proposed development during some of the train pass-bys. Nonetheless, based on the guidance provided by the FTA, acceptable vibration levels are expected to be achieved once the foundations for the building are in place. When architectural and structural drawings are available for the building, they should be reviewed to confirm the natural attenuation from the foundation and confirm the construction. A vibration warning clause should be included in the property and tenancy agreements of the units to inform the future owners and tenants of the possible momentary vibration excesses during rail pass-bys.

We trust this information is sufficient for your present purposes. Please do not hesitate to contact us if you have any questions or concerns.

Yours truly,
Howe Gastmeier Chapnik Limited

Andrew Rogers, BASc

Attached: Figures 1 – 12, CP Main Line Requirements

Mandy Chan, PEng

Limitations

This document was prepared solely for the addressed party and titled project or named part thereof, and should not be relied upon or used for any other project without obtaining prior written authorization from HGC Engineering. HGC Engineering accepts no responsibility or liability for any consequence of this document being used for a purpose other than for which it was commissioned. Any person or party using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm their agreement to indemnify HGC Engineering for all loss or damage resulting therefrom. HGC Engineering accepts no responsibility or liability for this document to any person or party other than the party by whom it was commissioned.

Any conclusions and/or recommendations herein reflect the judgment of HGC Engineering based on information available at the time of preparation, and were developed in good faith on information provided by others, as noted in the report, which has been assumed to be factual and accurate. Changed conditions or information occurring or becoming known after the date of this report could affect the results and conclusions presented.

Figure 1: Key Plan

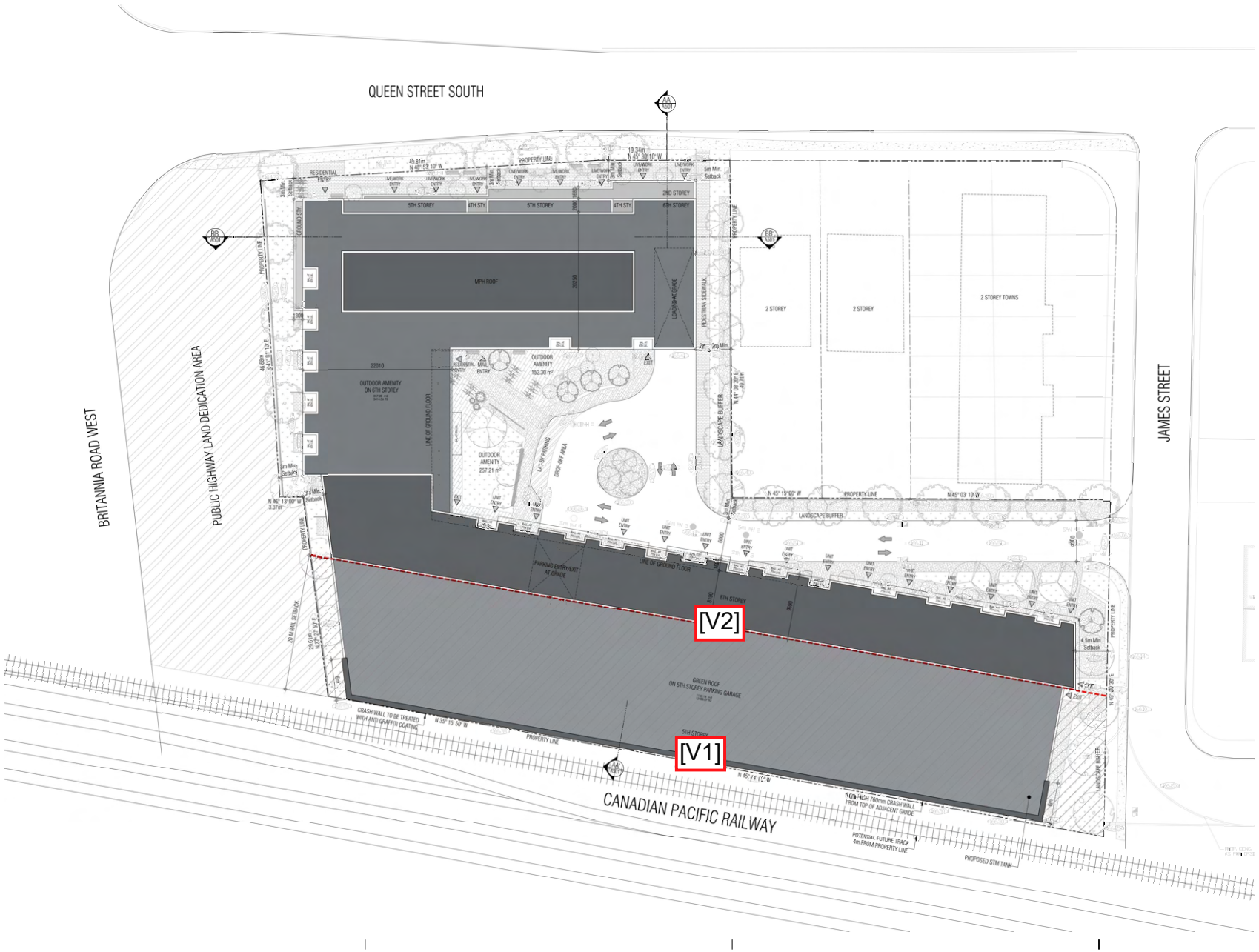


Figure 2 - Proposed Site Plan Showing Vibration Measurement Locations

Figure 3a: Pass-by 1 (PL)
Measured Vibratory Velocity Level

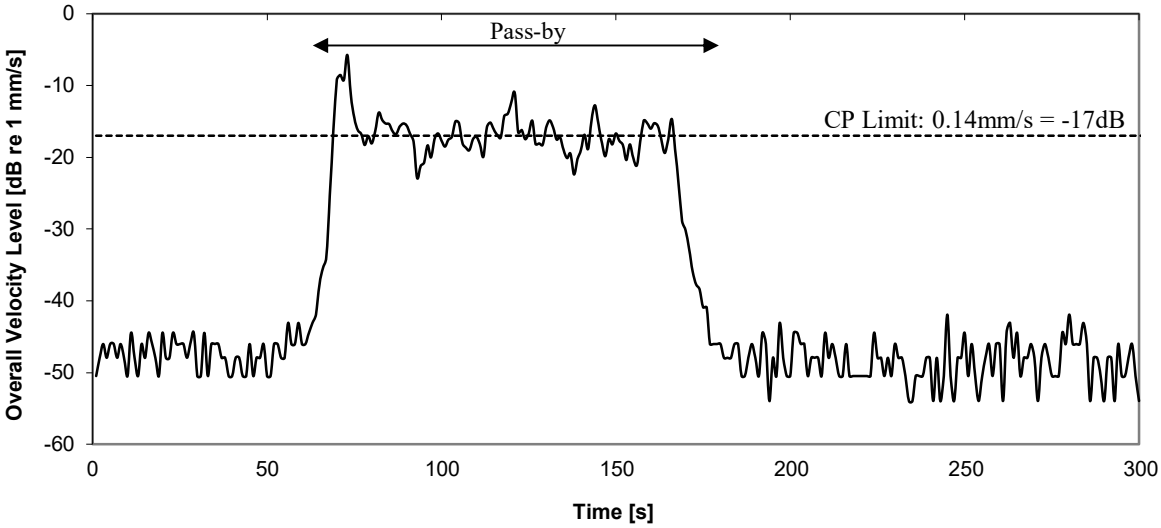


Figure 3b: Pass-by 1 (PL)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

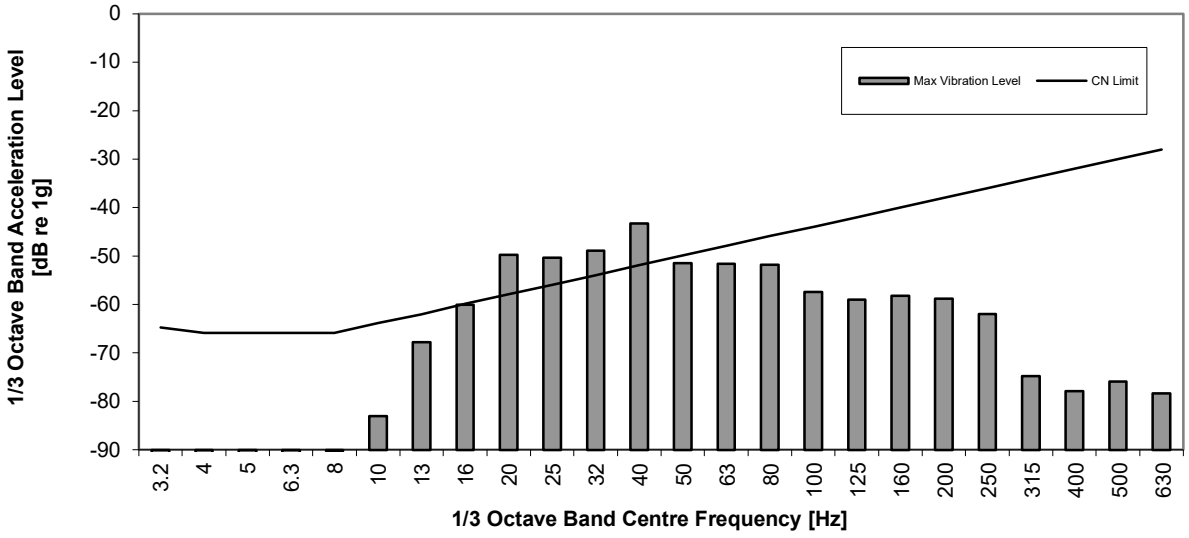


Figure 4a: Pass-by 1 (20 m)
Measured Vibratory Velocity Level

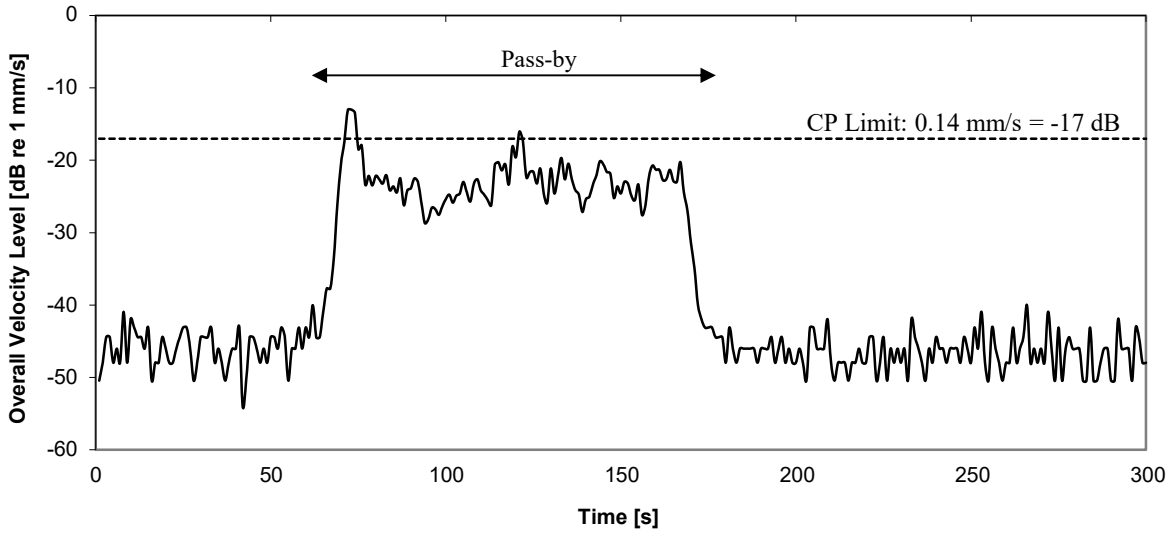


Figure 4b: Pass-by 1 (20 m)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

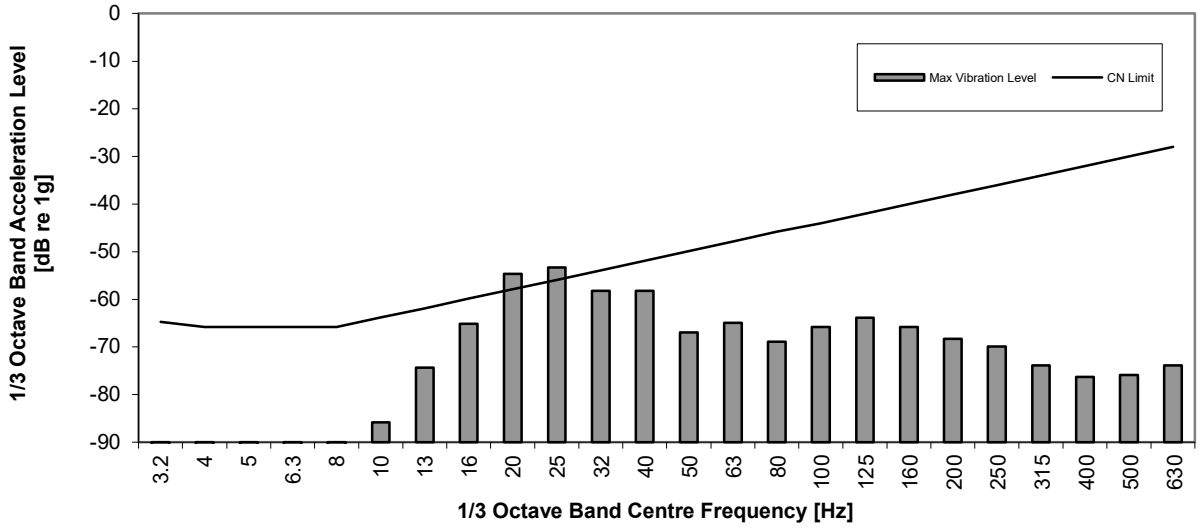


Figure 5a: Pass-by 2 (PL)
Measured Vibratory Velocity Level

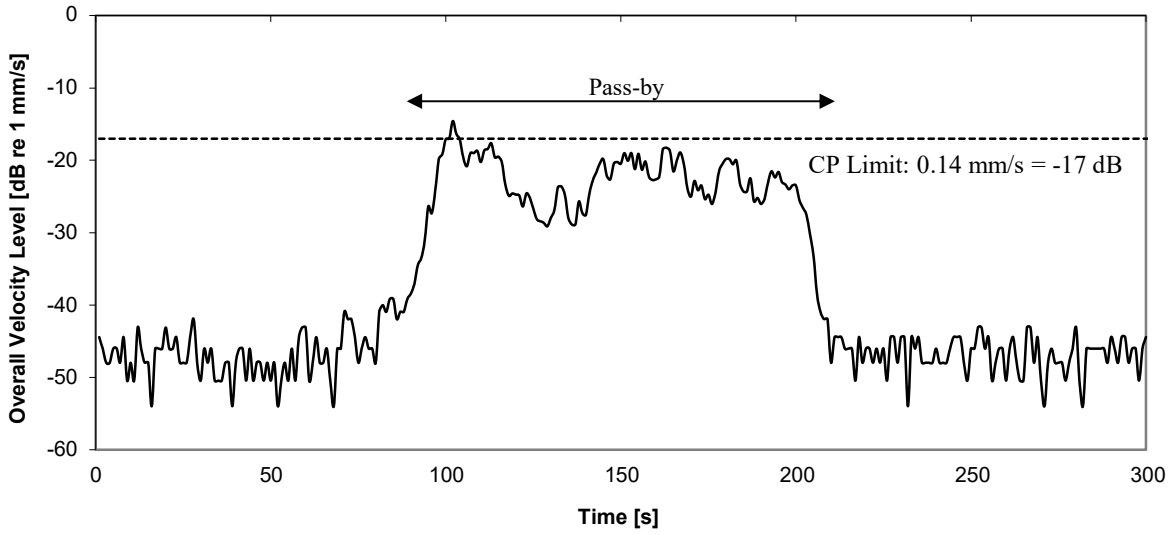


Figure 5b: Pass-by 2 (PL)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

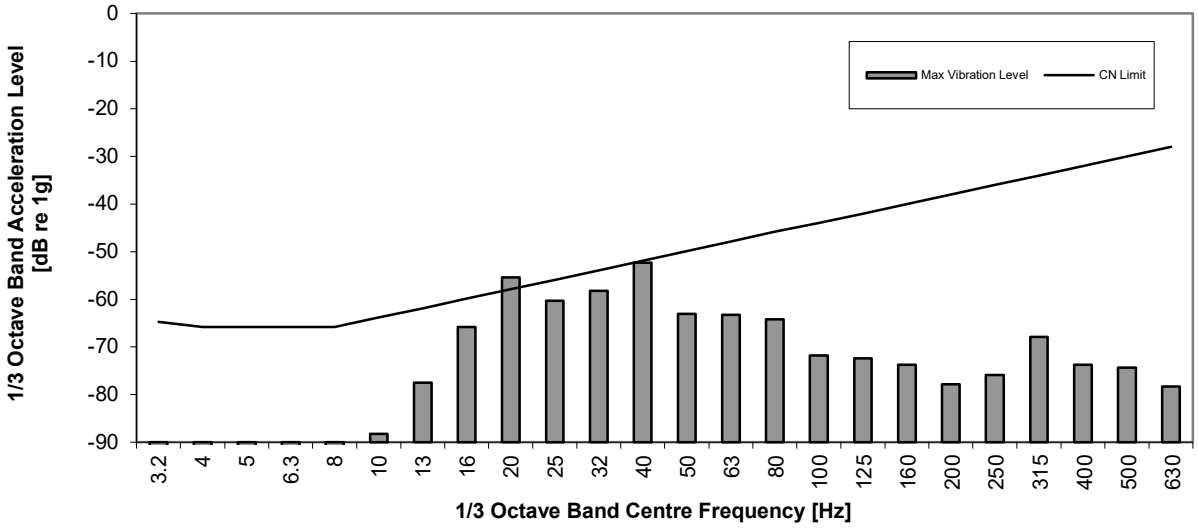


Figure 6a: Pass-by 2 (20 m)
Measured Vibratory Velocity Level

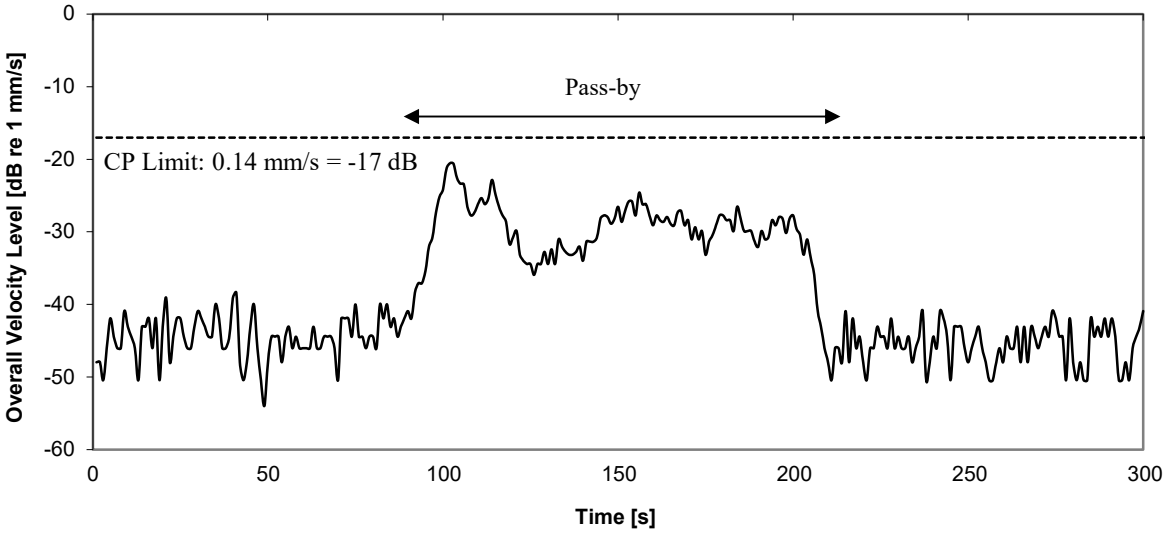


Figure 6b: Pass-by 2 (20 m)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

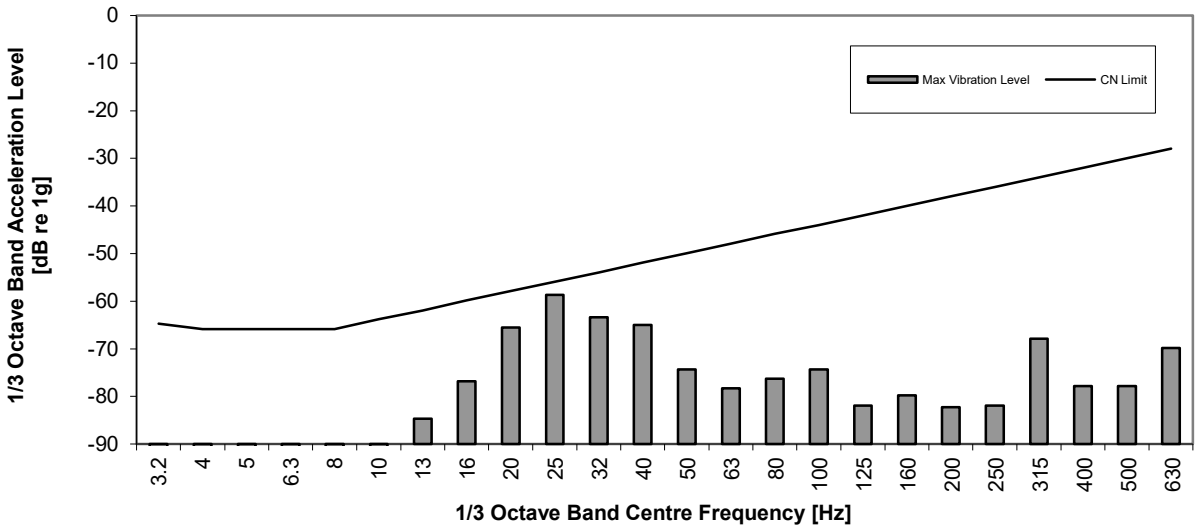


Figure 7a: Pass-by 3 (PL)
Measured Vibratory Velocity Level

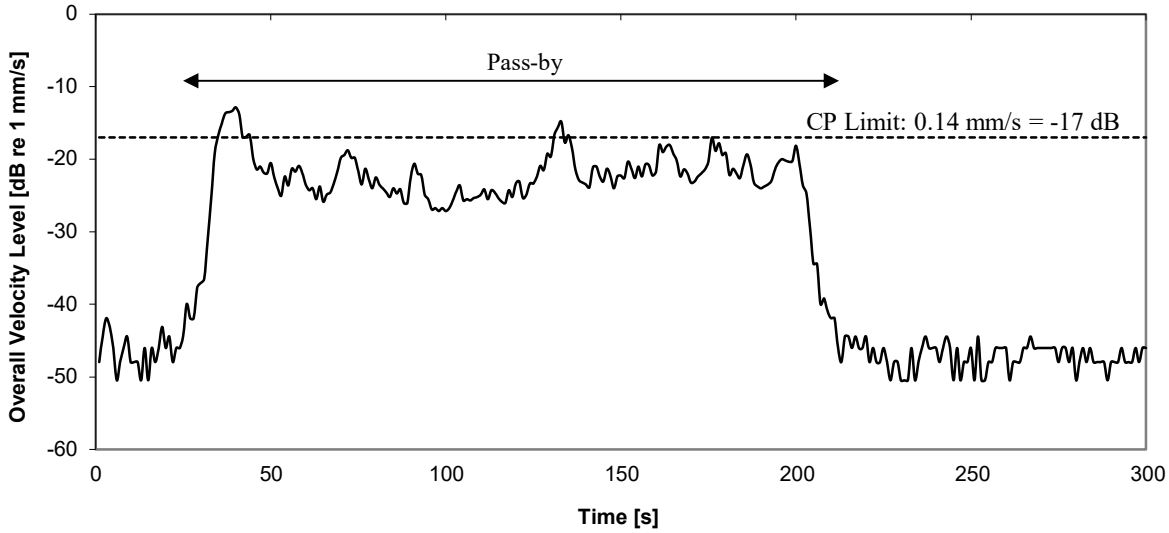


Figure 7b: Pass-by 3 (PL)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

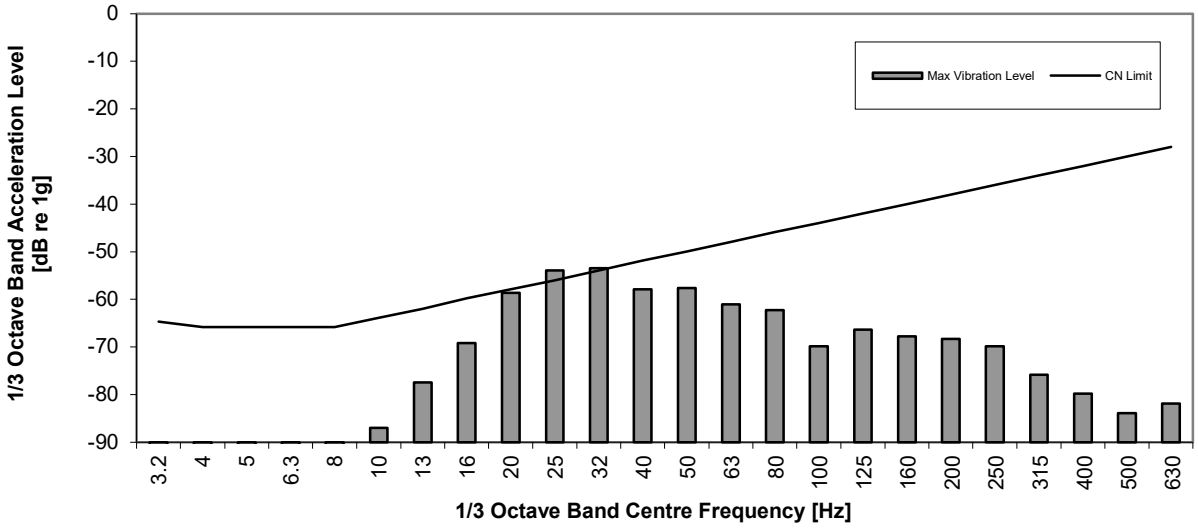


Figure 8a: Pass-by 3 (20 m)
Measured Vibratory Velocity Level

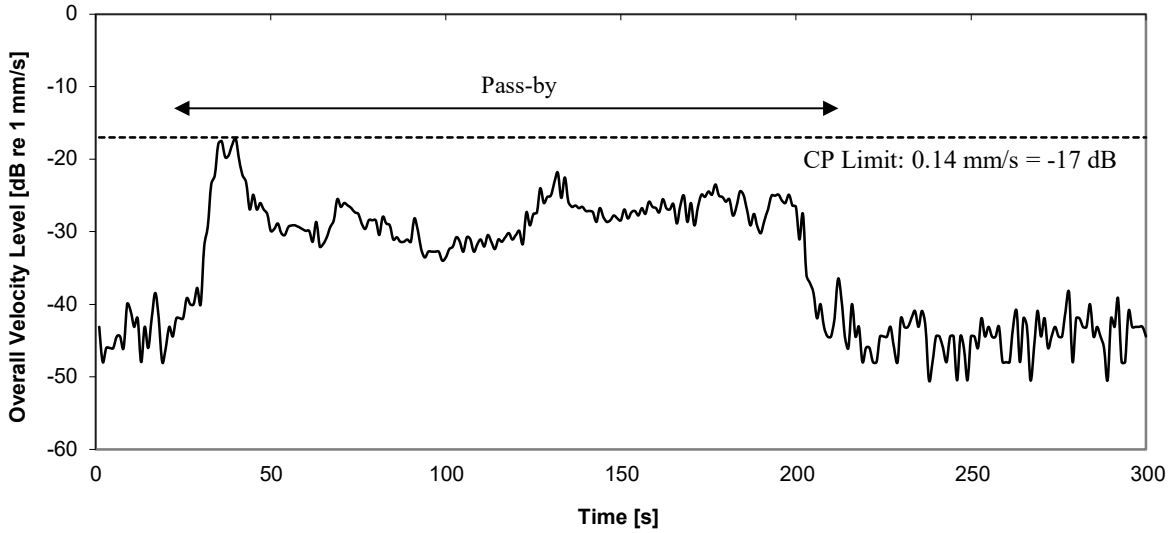


Figure 8b: Pass-by 3 (20 m)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

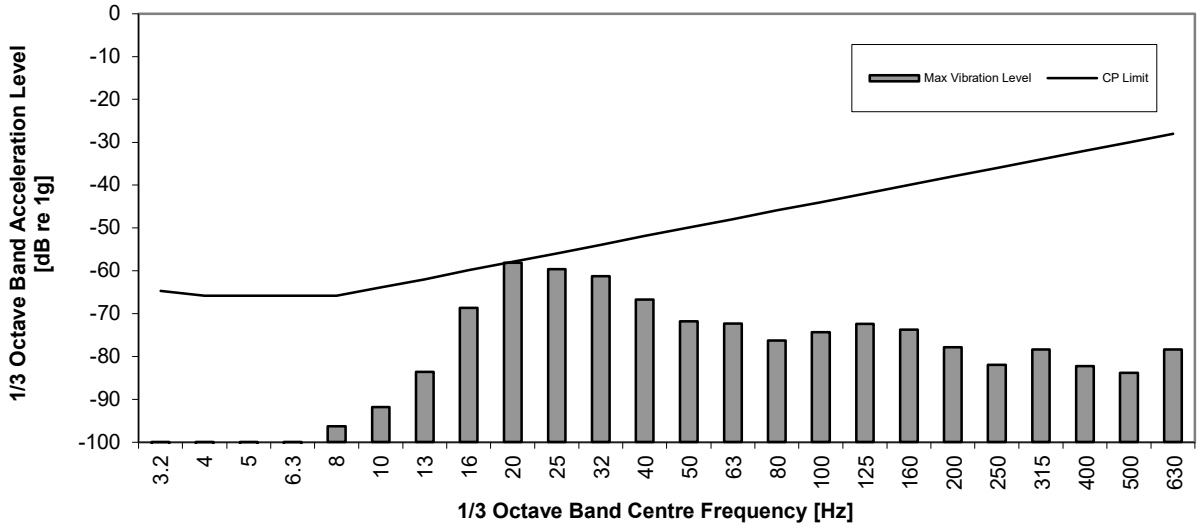


Figure 9a: Pass-by 4 (PL)
Measured Vibratory Velocity Level

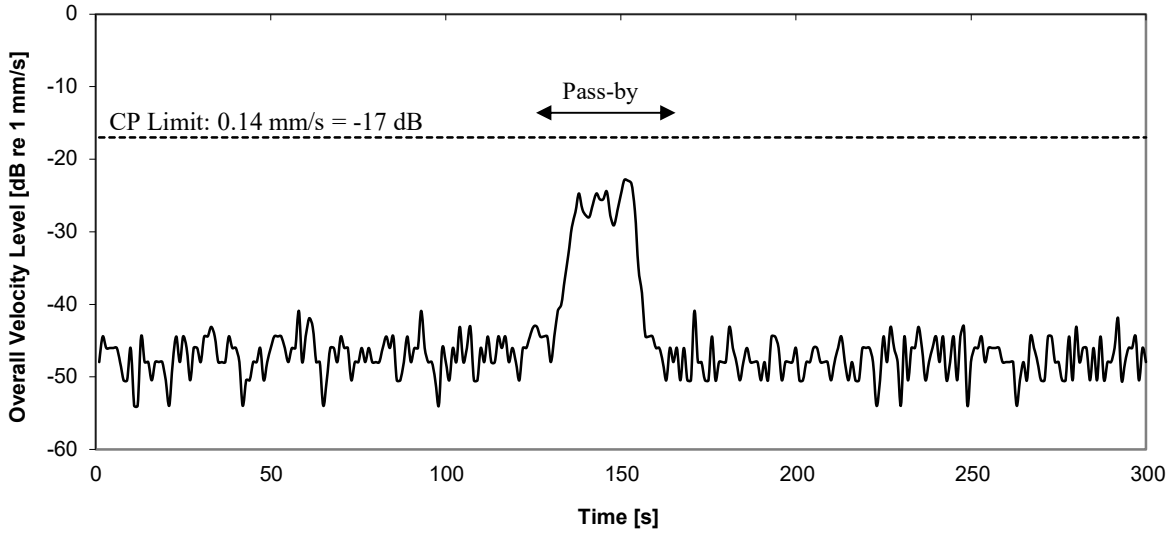


Figure 9b: Pass-by 4 (PL)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

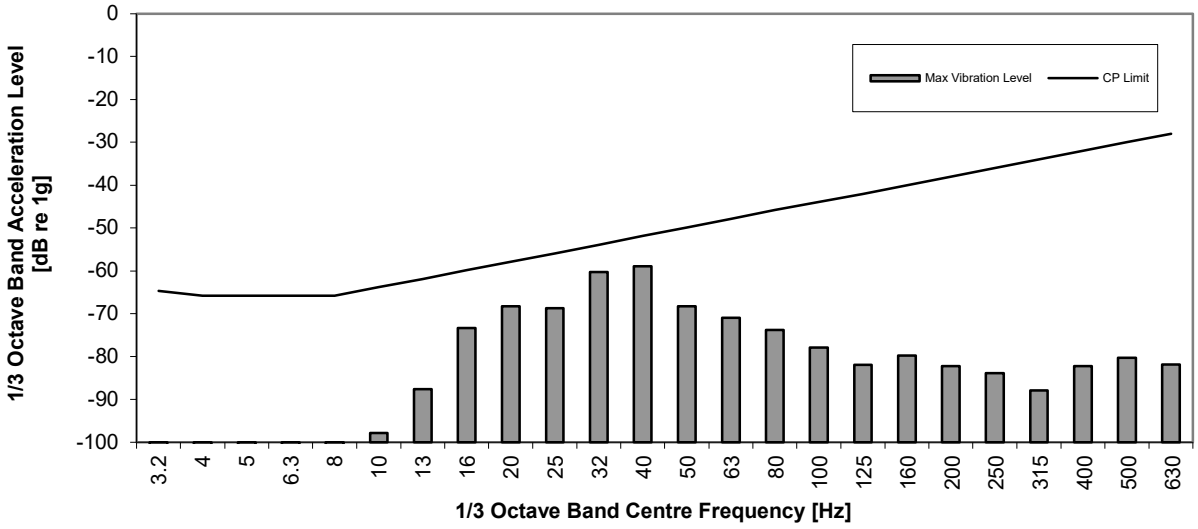


Figure 10a: Pass-by 4 (20 m)
Measured Vibratory Velocity Level

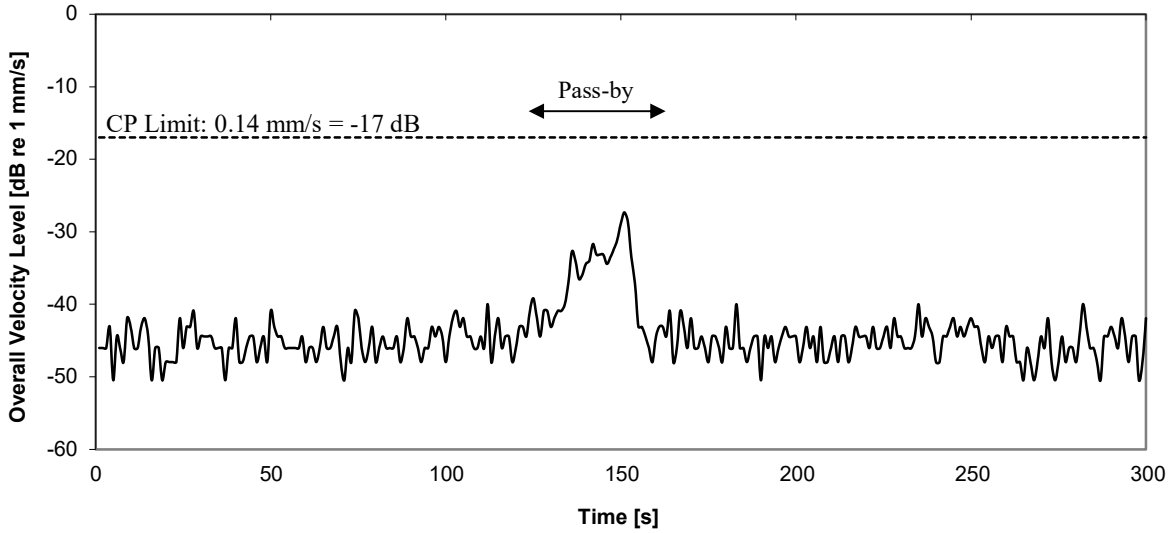


Figure 10b: Pass-by 4 (20 m)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

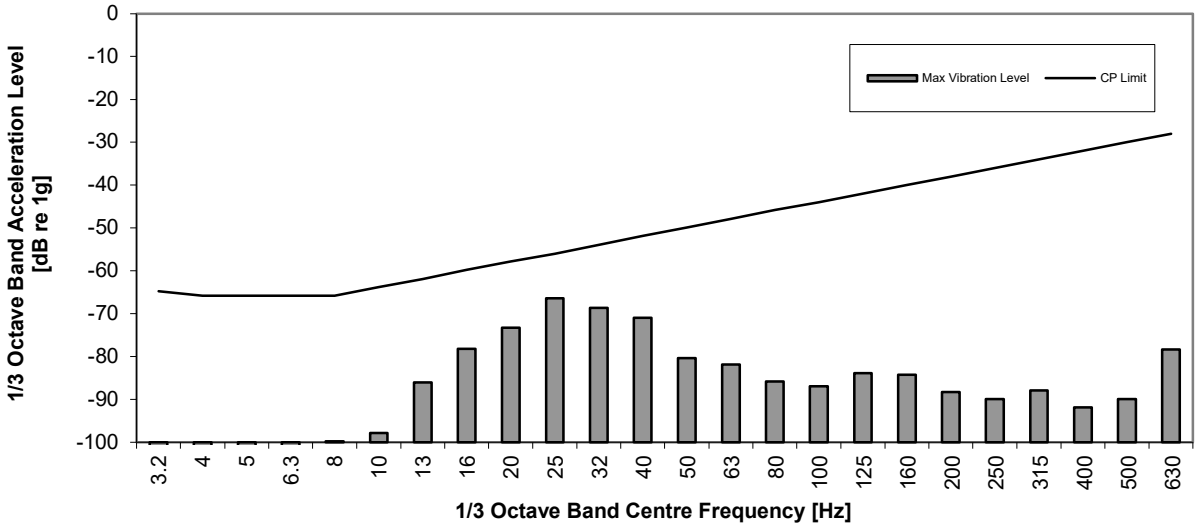


Figure 11a: Pass-by 5 (PL)
Measured Vibratory Velocity Level

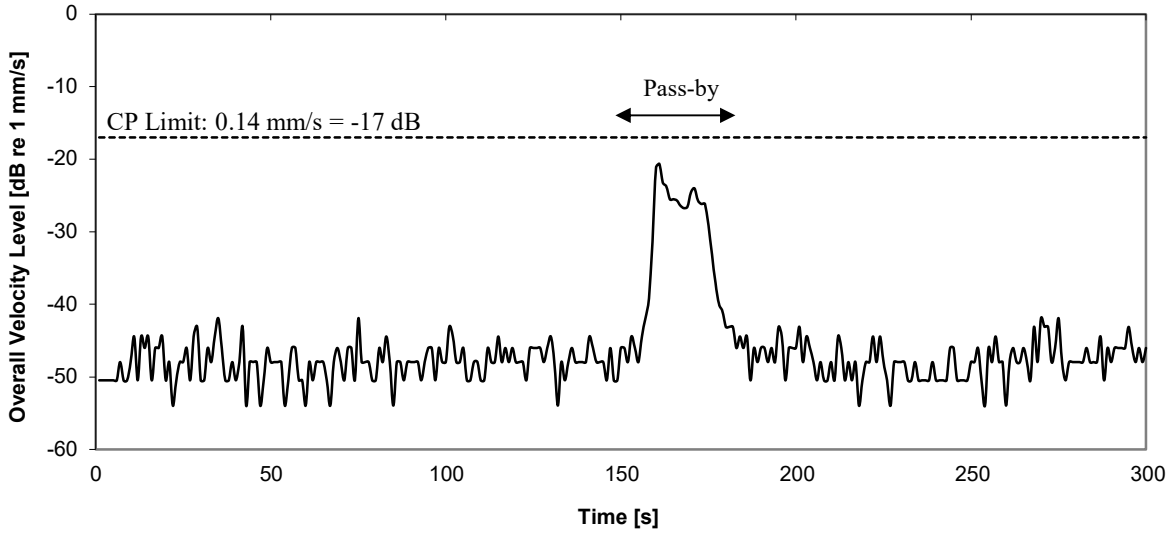


Figure 11b: Pass-by 5 (PL)
Acceleration Spectrum @ Peak Level (1 sec. Duration)

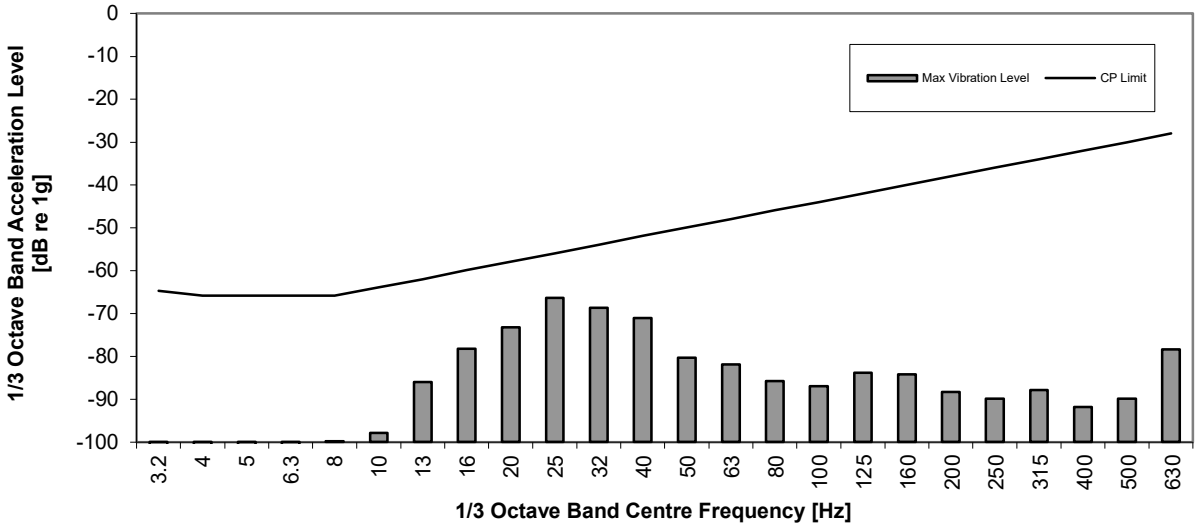


Figure 12a: Pass-by 5 (20 m)
Measured Vibratory Velocity Level

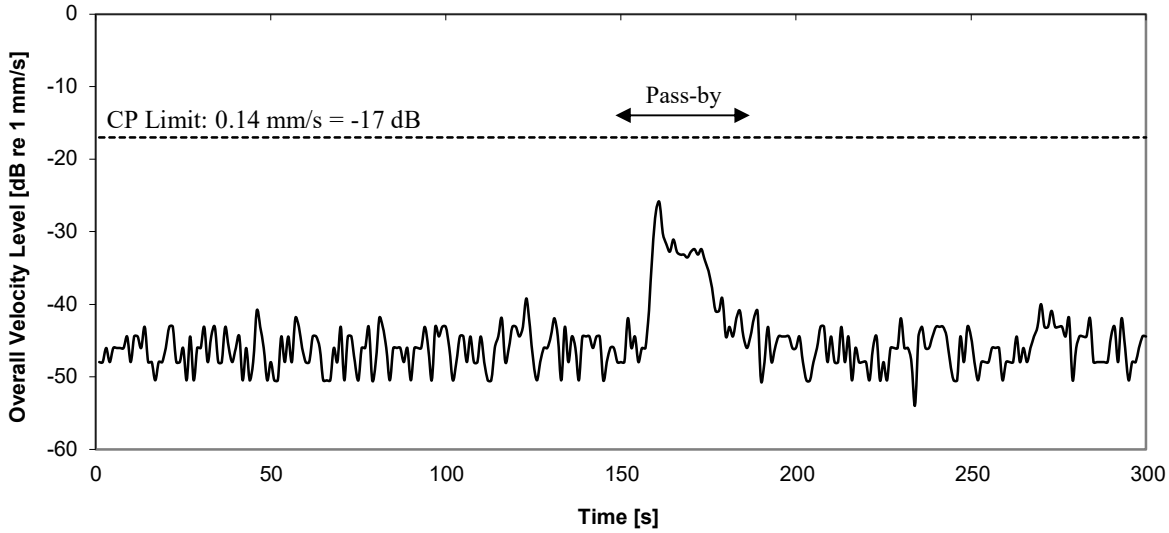
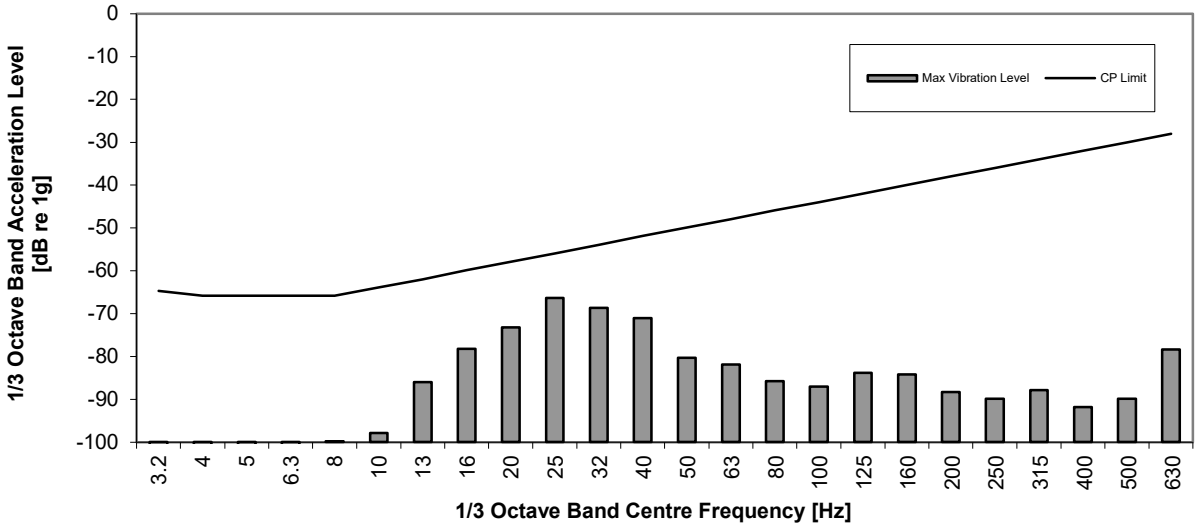


Figure 12b: Pass-by 5 (20 m)
Acceleration Spectrum @ Peak Level (1 sec. Duration)



CANADIAN PACIFIC RAILWAY

PRINCIPAL MAIN LINE REQUIREMENTS

1. Berm, or combination berm and noise attenuation fence, having extensions or returns at the ends, to be erected on adjoining property, parallel to the railway right-of-way with construction according to the following:

   a) Minimum total height 5.5 metres above top-of-rail;
   b) Berm minimum height 2.5 metres and side slopes not steeper than 2.5 to 1.
   c) Fence, or wall, to be constructed without openings and of a durable material weighing not less than 20 kg. per square metre (4 lb/sq.ft.) of surface area.

   No part of the berm/noise barrier is to be constructed on railway property.

   A clause should be inserted in all offers of purchase and sale or lease, and be registered on title or included in the lease for each dwelling affected by any noise and vibration attenuation measures, advising that any berm, fencing, or vibration isolation features implemented are not to be tampered with or altered, and further that the owner shall have the sole responsibility for and shall maintain these features.

   Dwellings must be constructed such that the interior noise levels meet the criteria of the appropriate Ministry. A noise study should be carried out by a professional noise consultant to determine what impact, if any, railway noise would have on residents of proposed subdivisions and to recommend mitigation measures, if required. The Railway may consider other measures recommended by the study.

2. Setback of dwellings from the railway right-of-way to be a minimum of 30 metres. While no dwelling should be closer to the right-of-way than the specified setback, an unoccupied building, such as a garage, may be built closer. The 2.5 metre high earth berm adjacent to the right-of-way must be provided in all instances.

3. Ground vibration transmission to be estimated through site tests. If in excess of the acceptable levels, all dwellings within 75 metres of the nearest track should be protected. The measures employed may be:

   a) Support the building on rubber pads between the foundation and the occupied structure so that the maximum vertical natural frequency of the structure on the pads is 12 Hz;
   b) Insulate the building from the vibration originating at the railway tracks by an intervening discontinuity or by installing adequate insulation outside the building, protected from the compaction that would reduce its effectiveness so that vibration in the building became unacceptable; or
   c) Other suitable measures that will retain their effectiveness over time.

4. A clause should be inserted in all offers of purchase and sale or lease and in the title deed or lease of each dwelling within 300m of the railway right-of-way, warning prospective purchasers or tenants of the existence of the Railway's operating right-of-way; the possibility of alterations including the possibility that the Railway may expand its operations, which expansion may affect the living environment of the residents notwithstanding the inclusion of noise and vibration attenuating measures in the design of the subdivision and individual units, and that the Railway will not be responsible for complaints or claims arising from the use of its facilities and/or operations.

5. Any proposed alterations to the existing drainage pattern affecting railway property must receive prior concurrence from the Railway, and be substantiated by a drainage report to be reviewed by the Railway.

6. A 1.83 metre high chain link security fence be constructed and maintained along the common property line of the Railway and the development by the developer at his expense, and the developer is made aware of the necessity of including a covenant running with the lands, in all deeds, obliging the purchasers of the land to maintain the fence in a satisfactory condition at their expense.

7. Any proposed utilities under or over railway property to serve the development must be approved prior to their installation and be covered by the Railway's standard agreement.