

October 13, 2011

Ms. Minnie Dhaliwal, Noise Abatement Coordinator
City of Tukwila Department of Community Development
6300 Southcenter Boulevard
Tukwila, WA 98188

Re: Technical Review III
Sound Transit Link Light Rail Tukwila Segment:
Year 2010 Noise and Vibration Compliance Testing Report

Dear Ms. Dhaliwal:

This letter presents our technical review of the vibration portion of the compliance report prepared by Michael Minor & Associates (MM&A) on November 17, 2010 and Sound Transit's Supplement to 2010 results, prepared by Ahmad Fazel on September 6, 2011. The MM&A report presents the second of three annual noise and vibration compliance testing results.

Compliance testing procedures and scope were established in Sound Transit's Compliance Testing Plan dated May 16, 2009 and revised July 2, 2009 (hereafter referred to as the Compliance Testing Plan).

In preparing this letter, BRC Acoustics reviewed the following materials:

- Letter by Mr. Jack Pace of City of Tukwila DCD to Mr. Ahmad Fazel of Sound Transit, dated October 26, 2010;
- Letter by Michael Minor & Associates to James Irish of Sound Transit on November 17, 2010 (referred to hereafter as the 2010 Compliance Testing Report);
- Letter by Ahmad Fazel of Sound Transit to Jack Pace of City of Tukwila DCD titled *Sound Transit's Supplement to 2010 (2nd year) Noise Test Results*, dated September 6, 2011.

In addition, BRC Acoustics conducted supplemental vibration measurements during Sound Transit light-rail pass-bys at a selected receiver location, to follow-up on a concern raised in our previous technical review (dated 1-19-10), stated as follows:

“Comment #V4 (Table of Responses, December 2009)

BRC's concern with the high degree of variability of vibration attenuation with distance was partially answered [by MM&A], but will be further investigated by BRC for the City of Tukwila as part of our up-coming site vibration measurements, which are intended to evaluate the reported vibration conditions as documented in Sound Transit's Compliance Testing Report.”

General Comments Regarding the Scope of the Vibration Annual Review

The 2010 Compliance Testing Report generally follows the vibration evaluation prescriptions of Sound Transit's Compliance Testing Plan dated May 16, 2009. The 2010 report presents vibration measurements at the locations listed in the Compliance Testing Plan, and current results derived from the measurements, as well as applicable criteria for identifying impacts, and proposed noise mitigation measurements.

Baseline Vibration Levels

The data entered in the updated Table 5, page 20, and Attachment B tables of individual vibration levels for passing trains, are consistent with the Monitoring Plan.

At site V2, the measurement location was shifted to the receiving property line, closer to the rail lines, to conform with the Monitoring Plan, which resulted in an increase in the observed vibration levels compared with 2009. BRC Acoustics sampled vibration at this site to confirm the observed vibration increase and to verify the 2010 report's conclusion that the vibration is below the criteria level of 72 VdB.

Allowable Project Vibration Levels

The Federal Transit Administration (FTA) vibration criteria shown in Tables 5 of the 2010 Compliance Testing Report are consistent with the FTA Manual and with Sound Transit's Compliance Testing Plan. The FTA criteria (maximum allowed 72 VdB, rms during train pass-by) are applied consistently to the 4 vibration measurement sites in Table 5.

Vibration Measurements

To confirm the vibration results of the 2010 Compliance Testing Report, BRC Acoustics conducted independent measurements of train pass-bys at receiver location V2 at two different distances from the rail lines. Vibration levels were measured on September 29, 2011 between 1 2 and 3 p.m. and on October 12th between 3 and 4 p.m. The measurements were collected using a Columbia one-axis accelerometer and a Bruel & Kjaer charge amplifier (model 2635). The weather during the measurements was calm and clear, with temperatures in the mid-60s degrees Fahrenheit on 9-29-11 and mid 50s on 10-12-11.

Measurements of vibration were collected at 50 feet from the near rail line at site V2 on 9-29-11 and at approximately 100 feet and 10-12-11. See the location map, Figure 1, on the next page. Average vibration levels at site V2a (50 feet) ranged from 79 to 81 VdB, rms maximum, exceeding the 72 VdB criteria. At V2b, maximum vibration levels ranged from 66 to 68 VdB.

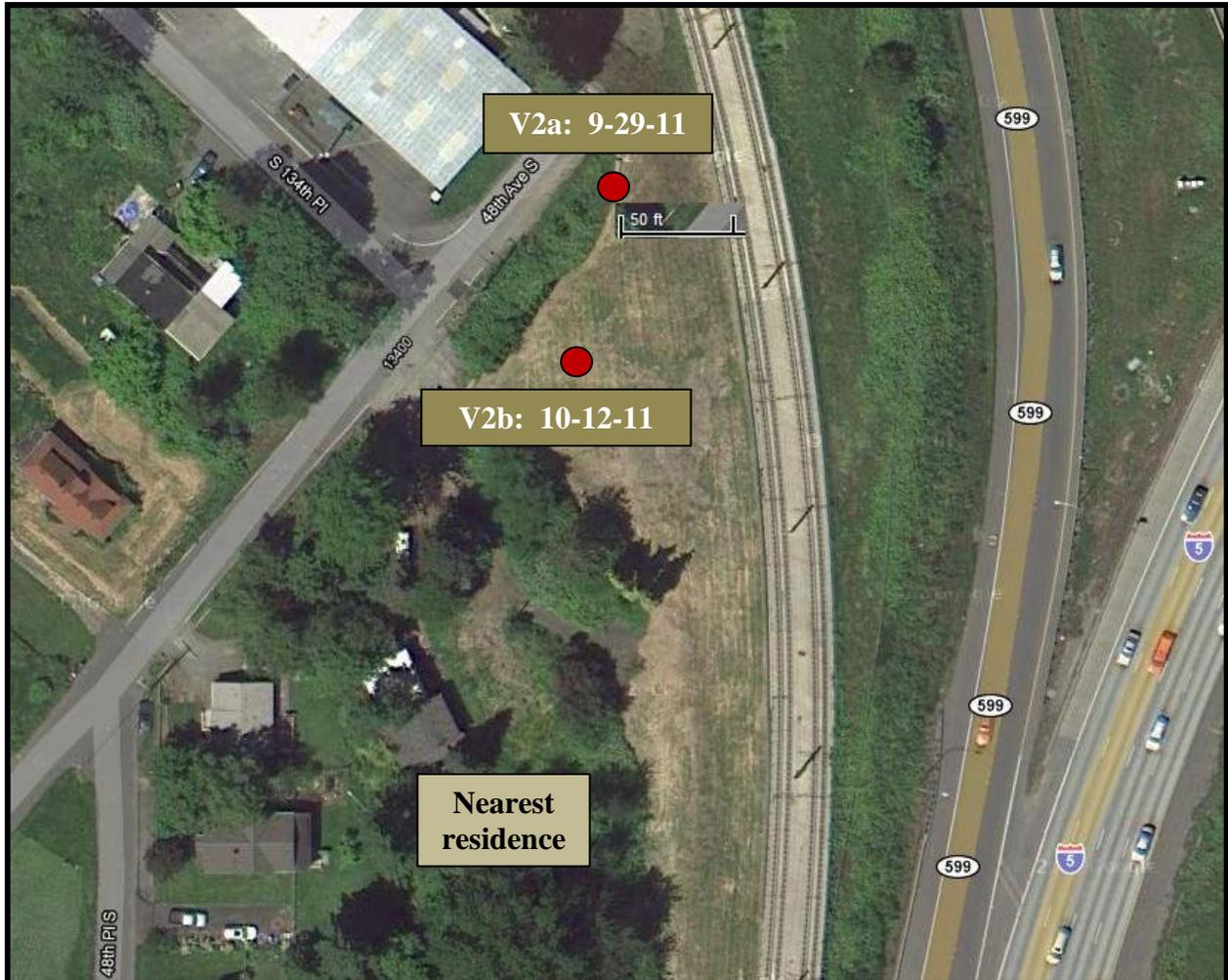


Figure 1: Location of BRC measurements at Site V2

Compliance Verification

Vibration observed by BRC Acoustics for 5 pass-bys at each location (V2a and V2b) confirms the property line measurements at site V2, reported as ranging from 59 to 66 VdB in MM&A 2010 Compliance Testing Report. The MM&A measurements are estimated to be at a location *more than* 100 feet from the near rail line.

The exact location of the property line is not shown in Figure 4 of Appendix C (page 57), but appears to be very close to site V2b. However, there are portions of the nearest property line which are closer to the rail line, and therefore may be exposed to vibration levels exceeding the FTA 72 VdB vibration limit criteria.

Detailed Review of 2010 Compliance Report

1. Variation of train vibration levels is much less in the 2010 Compliance Report compared with 2009 measurements. However, variation of 8 to 9 dB at site V2 is not explained, and may have to do with the exact measurement location. BRC Acoustics observed only a 2 dB variation between near and far rail lines.
 - *BRC Recommendation:* A detailed location should be provided to help resolve this discrepancy, which is important to assess the risk that some property is subjected to vibration exceeding the FTA 72 VdB criterion.
2. Vibration levels increased significantly at Location V2, as reported in Table B-3, and were not adequately explained by a change in the measurement position from the first year measurements. A 10 dB increase from 55 VdB to 65 VdB is very unlikely to be due to a 20 or 30 foot change in position, relative to the position shown on Figure 4 of the May 16, 2009 Compliance Testing report.
 - *BRC Recommendation:* A detailed location should be provided to help resolve this discrepancy, which is important to assess the risk that some property is subjected to vibration exceeding the FTA 72 VdB criterion.
3. BRC Acoustics measured train speeds (using a rough and ready method) at 47 to 52 mph at site V2. The 2010 Compliance report tabulates all trains, whether north or southbound, at 55 mph.
 - *Comment:* The expected speed-dependent vibration levels with a 10 to 15% difference is negligible, and does not contribute to the variation of near & far track vibration levels reported for site V2 in Table B-3.
4. *BRC 2009 Technical Review, dated 11-10-09:*

“The Compliance Testing Plan and the 2009 Compliance Testing Report both show the V3 monitoring site located to the south of the affected residence, across S. 136th Street. The data table for V3 states that the measurements were collected “in front of” the affected residence. Since the residence is within 50 ft of the northbound line, and the train line transitions to an elevated structure south of S. 136th Street, the results can be strongly affected by the exact location of the vibration accelerometer. Provide detail location of the measurements at V3.”

 - *BRC Recommendation:* Provide detailed location, as request in the 2009 Technical Review. A location accurate to ±10 feet on a large scale aerial photo will help resolve uncertainty around the actual vibration exposure. Vibration levels at the nearest residence to location V3 may exceed 72 VdB, since this residence is nearly twice as close to the ST rail lines as the residence at V2.

5. The 2010 Compliance Report (dated 11/17/10) in Table 5 has the Location V2 maximum vibration level as 65 VdB. The table of measurements (B-3) shows several maximums at 66 VdB or slightly higher.
 - *BRC Recommendation:* The Table 5 value of vibration needs to be explained, or corrected.
6. Vibration measurements by BRC Acoustics suggest that property lines at 75 feet or closer to at-grade or retained fill rail locations are likely to have vibration levels above the 72 VdB criteria. Property owners may in the future find value in constructing backyard cottages, as allowed by building codes, like those being introduced in nearby cities. The habitability of supplemental structures can be compromised by vibration levels in the back lot areas which are higher than those at the residence.
 - *BRC recommendation:* Based on the observations in recommendations #1, #2, and #4, above, we believe it is worthwhile for Sound Transit to re-examine the proximity locations for residential vibration exposure, and provide supplemental measurements at *all* locations for residences with property lines less than 75 feet from the near rail line. This may mean identifying supplemental measurement sites in addition to V1, V2, V3, and V4.
7. Test result for Site V2, train #T2: The label under the heading “Track” for train T2 should probably be “NT” (near track).
 - *Comment:* This suspected error is based on the inconsistency of the L_{max} for a “FT” train compared with the 11 other measurements at Location V2.
8. *BRC 2009 Technical Review:* “A reference vibration level should always be specified.” FTA Transit Noise and Vibration Assessment, 2006, p. 7-4. Add a reference level indication to all data tables.
 - *Comment:* Tables of vibration measurements in Appendix B of the 2010 Compliance Report now properly refer to a reference vibration velocity level of “1 μ in/sec.” However, the symbol “mu” or μ for “micro” is difficult to read in the 8 point font of a pdf-formatted document, and is assumed to be the abbreviation for micro (10^{-6}). This could helpfully be clarified with a dash between the “ μ ” and the “in/sec”

Summary

The review by BRC Acoustics and independent vibration measurements confirm that the track vibration mitigation efforts undertaken by Sound Transit have brought vibration levels from light-rail pass-bys well into the range of compliance with FTA 72 VdB criteria. The main concern is with verifying that measurements have been made at the *nearest* property lines, and that all potentially affected residences have been identified.

The Central Link Maintenance Matrix submitted by Sound Transit (Attachment 5 to the letter by Ahmad Fazel) includes provisions for regular maintenance of the rail vehicles (including wheel truing) and the tracks (including track grinding). These procedures aid in reduced vibration from the trains.

Please let us know if you need additional clarification or supplement information.

Sincerely,
BRC Acoustics & Technology Consulting

A handwritten signature in black ink that reads "Dennis Noson". The signature is written in a cursive, flowing style.

Dennis Noson, PhD.
Senior Acoustical Consultant

