3.0 University Place

VIBRATION MONITORING REPORT

May 25, 2023

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May 25, 2023

Scott Mazo
Founder & CEO
University Place Associates
30 N. 41st Street
Philadelphia, PA 19104

Re: 3.0 University Place
Vibration Monitoring Report

Dear Scott:

Metropolitan Acoustics conducted vibration testing on four floors of 3.0 University Place located at the corner of 41st and Market Streets in Philadelphia, PA on March 16 through March 21, 2023 and May 4 through May 8, 2023. This is a new building that is located along the SEPTA Market-Frankford subway line. The building shell is complete and fit-out construction work is underway on the first and second floors. This report summarizes our vibration testing procedures and results with comparison to the project design criteria.

Please let us know if you have any questions regarding this information.

Best regards,

metropolitan acoustics, llc

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TERMINOLOGY

Acceleration is typically measured and reported as a multiple of the acceleration due to Earth's gravity (*g*). One *g* is approximately equal to 9.8 m/s² and is one of the most common units for vibration measurements using accelerometers in buildings. Acceleration describes the variation of velocity over time. Root-mean-square (RMS) amplitude is used to describe the "smoothed" vibration amplitude of acceleration and velocity.

The Vibration Criteria (VC) curves were developed as generic vibration criteria for vibration-sensitive equipment for use in the semiconductor, medical, and biopharmaceutical industries, but have found application in a wide variety of technological applications. These criteria take the form of a set of one-third octave band RMS velocity spectra and apply to vibration measured in the vertical and two horizontal axes.

EXISTING CONDITIONS

3.0 University Place is a new building constructed at the corner of 41st and Market Streets. The building is tailored toward life science tenants, and therefore, testing to establish the baseline vibration levels on each floor was requested. Figure 1 shows the location of the building.

Figure 1. Aerial view of site; 3.0 University Place in red

VIBRATION CRITERIA

The VC curves are presented in Figure 2; in general, life science tenants require ambient vibration levels of VC-A or VC-B, although some tenants may require more stringent criteria based on the type of imaging instrumentation they use.

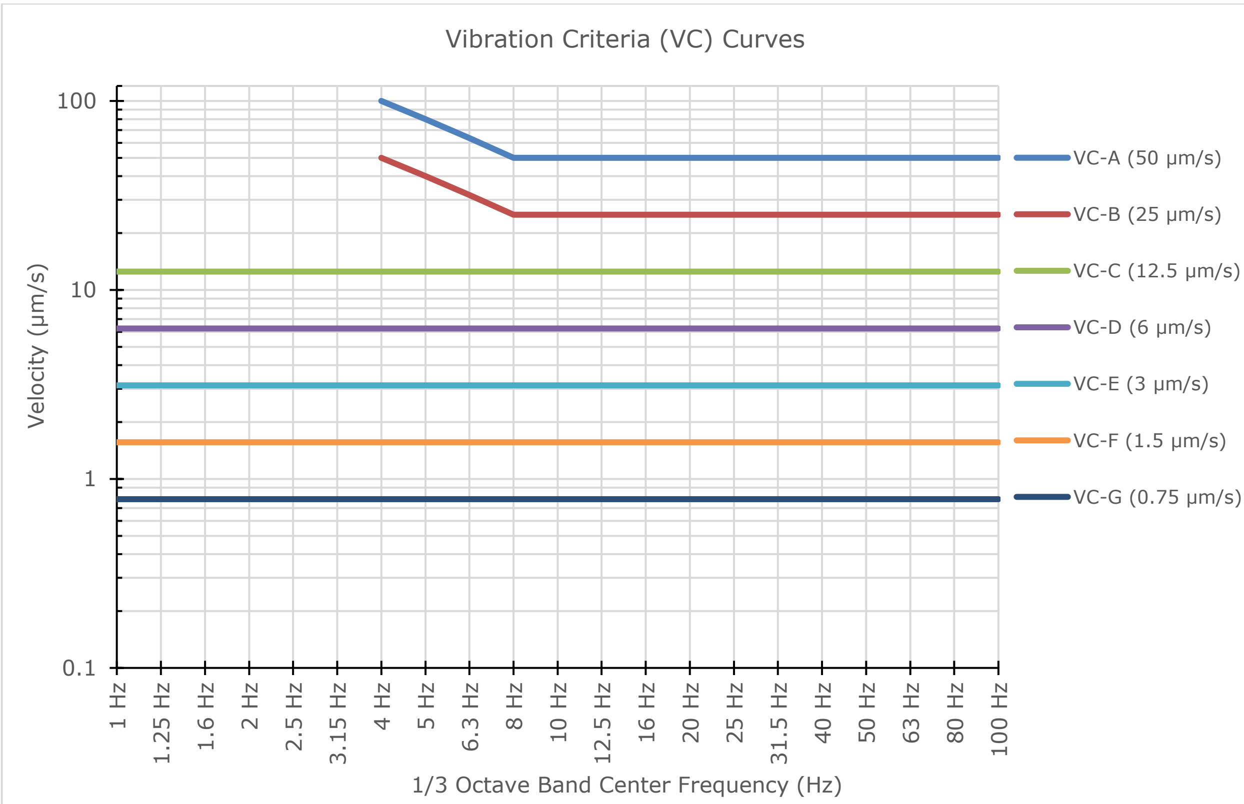

Figure 2. VC Curves

Table 1 includes information on the VC curves and the suitability of each for various applications.

Table 1. Vibration Criteria Curves, Detail Sizes, and Applications		
Vibration Criterion	*Detail Size (µm)*	*Application*
VC-A	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	3	Appropriate for inspection and lithography (including steppers) to 3 µm line widths.
VC-C	1 - 3	Appropriate standard for optical microscopes to 1000X, inspection and lithography inspection equipment (including moderately sensitive electron microscopes) to 1 µm detail size, TFT-LCD stepper/scanner processes.
VC-D	0.1 - 0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems.

Survey Procedures

Vibration levels were measured on the 5th and 8th floors between March 16 and March 21, 2023; and on the 1st and 2nd floors between May 4 and May 8, 2023. The delay between the surveys was due to heavy construction on the 1st and 2nd floors in March; there was nowhere safe to place the sensors on these floors during this period. In May, the base building was completed, and although some fit-out construction work was occurring on the 1st floor, we were able to install on both the 1st and 2nd floors.

Five vibration measurement nodes were installed on each floor, vibration data was collected for at least 24 consecutive hours, and the nodes were relocated to another floor to collect data at five positions for another 24 hours. At the conclusion of the measurements, we removed the equipment from the site. Twenty measurement positions were monitored over the measurement period: five locations on each of the 1st, 2nd, 5th, and 8th floors. At each location, either three single-axis accelerometers were placed on a mounting cube (hereafter referred to as a triaxial node) to obtain data in three orthogonal axes, or a single-axis accelerometer (hereafter referred to as a single-axis node) was directly mounted to the floor slab; each node was adhered to the floor slab using hot glue. Accelerometers were Model 393B05 manufactured by PCB Piezotronics.

Two triaxial nodes and three single-axis nodes were used. Each node was placed at or near the center of slab bays of interest; the location of each node was chosen to give a sense of how different areas of the building react to ambient vibration. The triaxial nodes include X (north-south), Y (east-west), and Z (vertical). All single-axis nodes were configured in the Z direction. Generally, we expect the Z axis to present the highest level of vibration and exhibit the most fluctuation between each structural bay; lateral axes should be consistent across the floor slabs. Figure 3 through 5 show the position of the nodes on the floors. Figure 6 and 7 show the existing conditions of the building at the time of the testing.

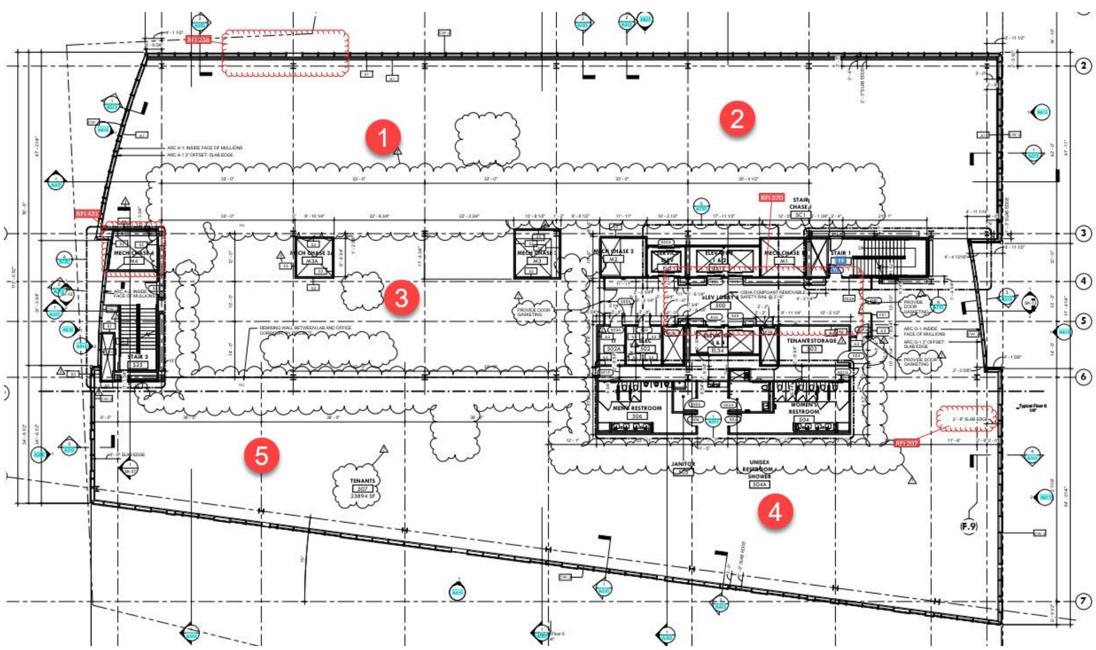

Figure 3. Node positions in red, 5th and 8th floors - 3/16/2023 to 3/21/2023

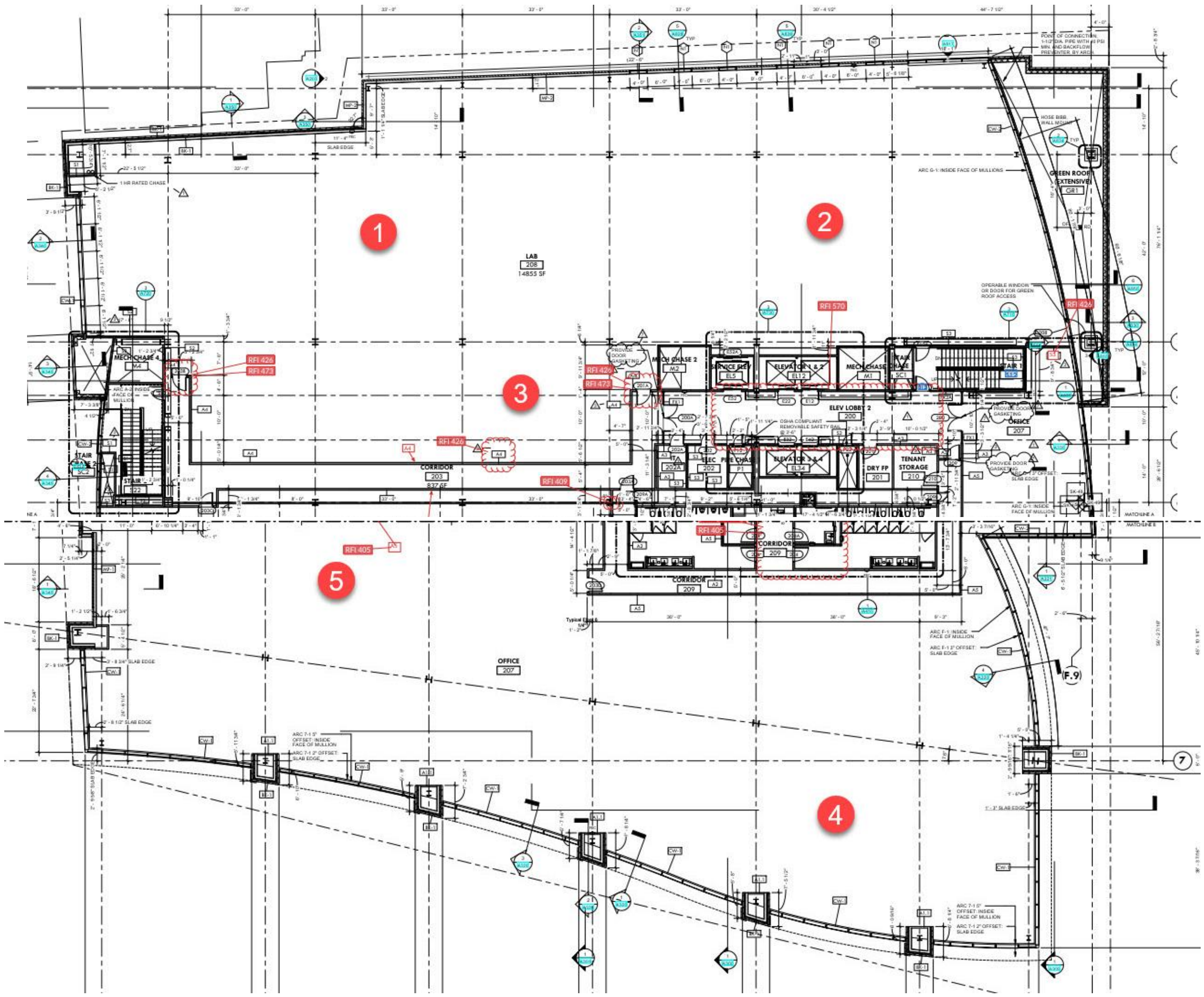

Figure 4. Node positions, 2nd floor - 5/4/2023 to 5/5/2023

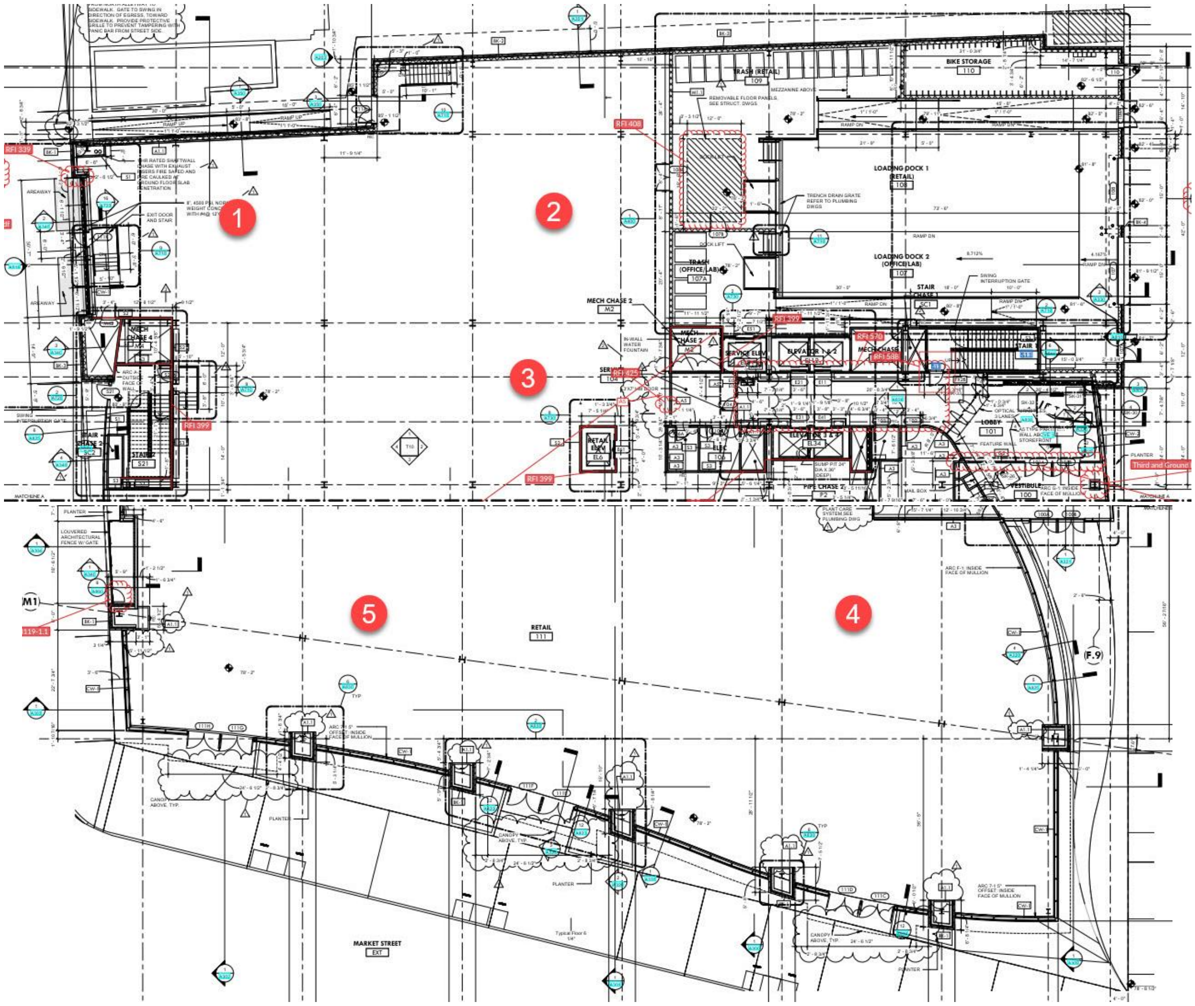

Figure 5. Node positions, 1st floor - 5/5/2023 to 5/8/2023

Figure 6. Existing conditions during testing

Figure 7. Existing conditions during testing

SenSV is our hardware and software platform that was used to aggregate the data from the sensors, process the data, and compare it to VC curves. The system was set with a sampling rate of 1024 Hz and raw time domain acceleration data was stored on a local hard drive for post-processing. SenSV applied Fourier transforms to the time-domain data to obtain frequency-domain data, converted the data to velocity, binned the data in one-third octave bands from 1 Hz to 100 Hz, then calculated the RMS velocity amplitudes over 30 second intervals.

Survey Results

Since this was an active construction site during some of the measurement time periods, we did not include data between the hours of 7:00 a.m. to 3:00 p.m. during the weekdays in our analysis to obtain more realistic values of the ambient floor slab vibration levels from exterior vibration sources. Table 2 summarizes our measurements along each orthogonal axis on each floor; data collected by each of the nodes are compiled and displayed per axis for each floor. The data for each classification is presented as the percentage of the measurement period for which the floor slab did not exceed the given criteria. For example, for the Z-axis on the 1st floor, the slab was below VC-A and VC-B for 100.0% of the entire measurement period, below VC-C for 97.8% of the time, and below VC-D 88.3% of the measurement period. The sensors used are accurate down to VC-D, so no data below that is reported. We considered any percentage above 99.0% to meet a given curve, and overall classifications show the lowest criteria that the slab met in each axis.

Table 2. Measured Vibration Levels, All Nodes
3.0 University Place, 3/16/2023 – 3/21/2023 and 5/4/2023 – 5/8/2023

Floor	*Axis*	*VC-A*	*VC-B*	*VC-C*	*VC-D*	*Overall Classification*
1	X	100.0	100.0	99.8	98.0	VC-C
	Y	100.0	100.0	100.0	99.8	VC-D
	Z	100.0	100.0	97.8	88.3	VC-B
2	X	100.0	100.0	100.0	100.0	VC-D
	Y	100.0	100.0	100.0	100.0	VC-D
	Z	100.0	99.9	99.2	97.0	VC-C
5	X	100.0	100.0	100.0	99.9	VC-D
	Y	100.0	100.0	99.9	98.3	VC-C
	Z	100.0	100.0	100.0	99.5	VC-D
8	X	100.0	100.0	99.4	94.1	VC-C
	Y	100.0	100.0	92.6	73.4	VC-B
	Z	100.0	99.8	94.5	79.5	VC-B

Interestingly, the vibration levels on the upper floors, both 5th and 8th, were higher in the Y-axis than in both the X- and Z-axes. We believe this was due to the wind moving the building in the east-west direction. As one moves up higher in a building, the more the building will move laterally when the wind blows. We looked up historical weather data for the days that we were monitoring on the 5th and 8th floors (March 16-21) and saw that the wind speeds were consistently between 15-25 mph and prevalent from west to east, parallel to the Y-axis. Additionally, Market Street is a notoriously windy street, and it is common to have strong winds blowing from west to east on that corridor.