Environmental Analysis Report

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Prepared for: Customer XYZ.
Company: Company XYZ

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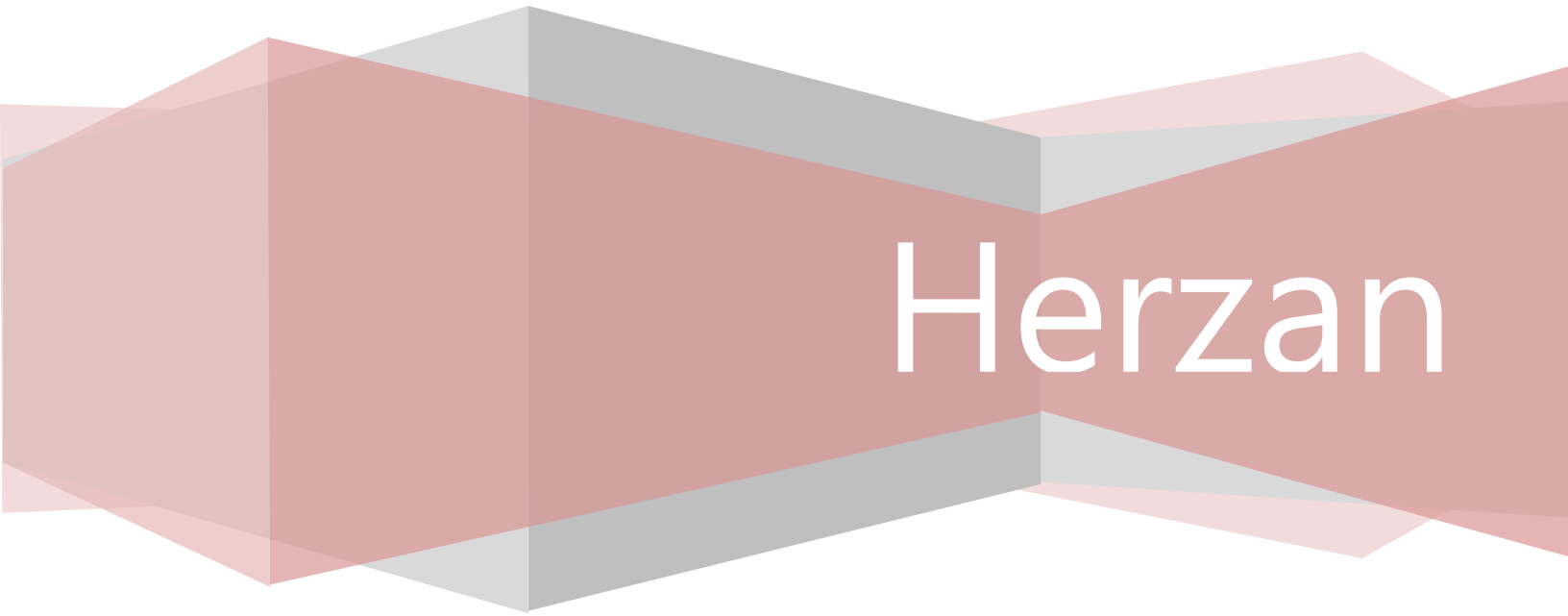

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Test Description

The purpose of conducting a complete environmental analysis is to determine the suitability of a location Company XYZ has set aside for a Carl Zeiss electron microscope. After the data is collected and analyzed, Herzan is to compare the data taken at the Company XYZ location with pre-established environmental specifications required by Carl Zeiss. Herzan will identify what frequencies are of most concern and if there are any viable solutions to bring the environment within specification (if required). Test data for the three forms of environmental noise are presented in the lower frequency range (1 - 200 Hz or 1 – 300 Hz). This frequency range is commonly the most concerned frequency range affecting electron microscopes and the most difficult to bring into specification. Utilizing a narrower frequency range, allowed the sensors to collect more specific environmental data at these lower frequencies.

Vibration tests were conducted on the fourth floor of the new Company XYZ tower. This floor is not directly connected to the fifty-story tower; however, it is placed in a room that is directly attached to the tower. The vibration tests were not taken in the immediate location of where the Carl Zeiss electron microscope is to be installed due to unfavorable floor conditions (carpeting). The reason for taking the vibration measurements in a separate room was due to the vibration sensor requiring firm placement/contact with the floor, which carpeting does not provide. If vibration measurements were taken on the carpet, unclear results would be retrieved as a result. The vibration tests were taken in a room right outside of the prospective location, which had solid stone flooring for optimal coupling of the vibration sensor. The room did have closer access to elevators, which will demonstrate a higher presence of vibrations than what is expected in the prospective lab environment.

The acoustic and EMI tests were performed in the area where the electron microscope is suggested to be installed. Multiple tests were taken with each sensor to ensure a consistent and reliable set of data is retrieved.

The prospective location for the electron microscope currently houses general office shelving and equipment (printers, scanners, faxes, etc.), which will be removed for the installation of the electron microscope. Adjacent to the prospective lab room is a series of file-storage shelves that move intermittently throughout the day, causing an additional source of vibration noise being introduced into the environment. There is also a freight elevator to the north east corner of the floor as well as an access elevator to the south east.

The prospective room has not been completed and is currently open with two reinforced walls. If this location is chosen to house the electron microscope, reinforced concrete walls will be installed to help mitigate any acoustic transference into the room (per recommendation by Carl Zeiss EM Specialist).

Measurement Details

An overview of the measurement locations and scenarios can be found below:

- Company XYZ Building, 4th Floor:
  - Vibration Measurement
    - Triaxial vibration accelerometer was placed on stone flooring near the location of the prospective lab environment
    - Ten groups of measurements were taken in all three axes (X, Y and Z)
      - Each group consists of a set of 10 averages of vibration measurement within the 1 – 200 Hz frequency range.
    - Measurements were measured in velocity (m/s)
  - Acoustic Measurement
    - Acoustic microphone was placed in the exact location where the electron microscope is scheduled to be installed.
    - Ten groups of measurements were taken
      - Each group consists of a set of 10 averages of vibration measurement within the 1 – 200 Hz frequency range.
    - Measurements were measured in Pascals
  - EMI Measurement
    - Triaxial EMI magnetometer (sensor) was placed in the exact location where the electron microscope is scheduled to be installed.
    - Ten groups of measurements were taken in all three axes (X, Y and Z)
      - Each group consists of a set of 10 averages of vibration measurement within the 1 – 300 Hz frequency range.
    - The AC fields of the room were measured during this test
    - Measurements were measured in Tesla.

Site Test Data

Overview

The site where the environmental analysis took place is located at the Company XYZ Building in New York, New York (a recently unveiled 50-story skyscraper, being the tallest in the state). Company XYZ is a leading independent supplier of natural gas and oil

Sources of Noise

In addition to standard ambient laboratory noise sources (i.e. HVAC, walkway traffic, staircases/elevators, etc.), there is a train station 150 to 200 feet away from the prospective laboratory. Any additional noise sources near the measurement location can be provided by Customer XYZ who performed the measurements.

Site Test Data Comparison

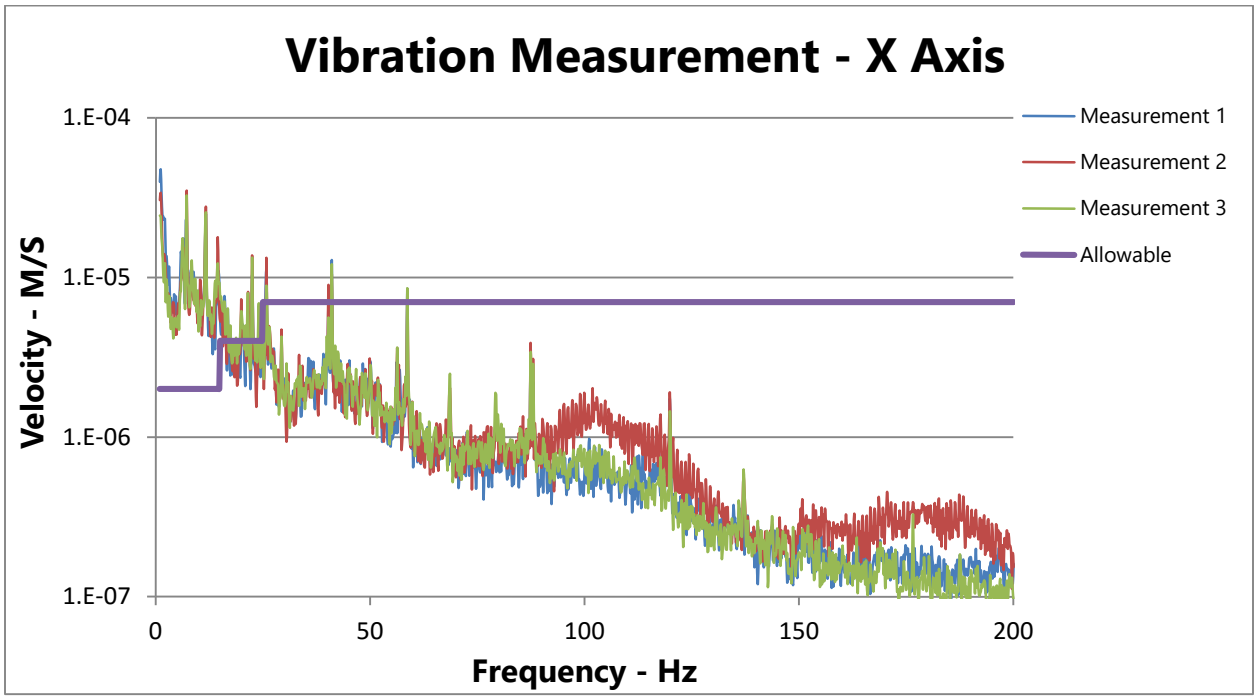
To provide clear analysis of how the environmental noise at the Company XYZ site compares with the established Carl Zeiss environmental specifications, the following criterion were used:

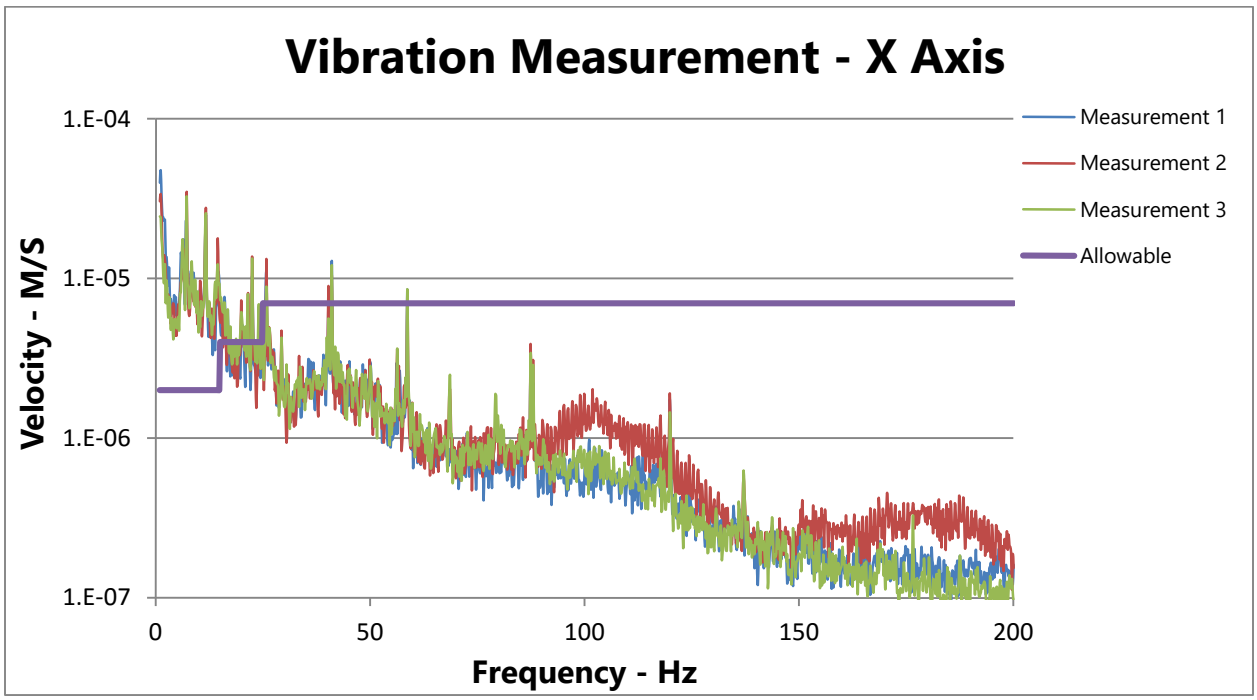
- Vibration Noise Specification for Carl Zeiss Sigma HD Scanning Electron Microscope
  - Less than 6 um/sec rms from 0-30 Hz
  - Less than 12 um/sec rms from 30 Hz
  - These values are for all three measurement directions: X, Y and Z

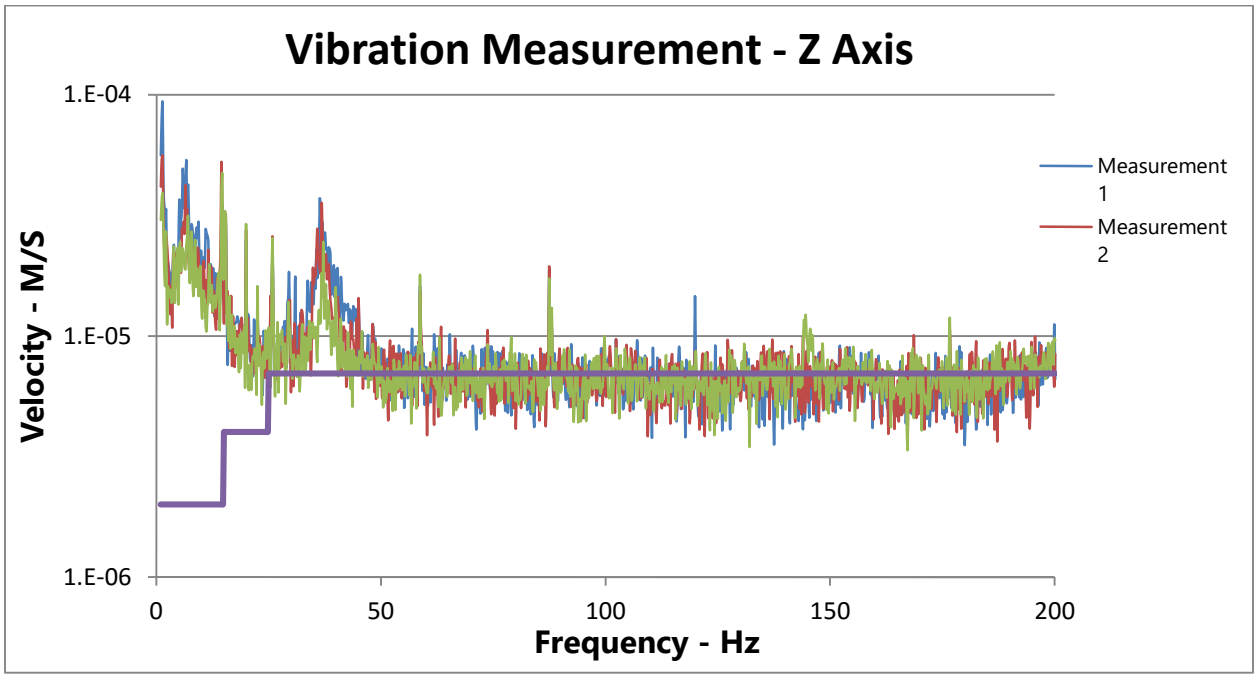
- Acoustic Noise Specification for Carl Zeiss Sigma HD Scanning Electron Microscope
  - Less than 53 dB for frequencies up to 200 Hz
  - Less than 42 dB for frequencies from 200 to 300 Hz
  - Less than 50 dB for frequencies higher than 300 Hz

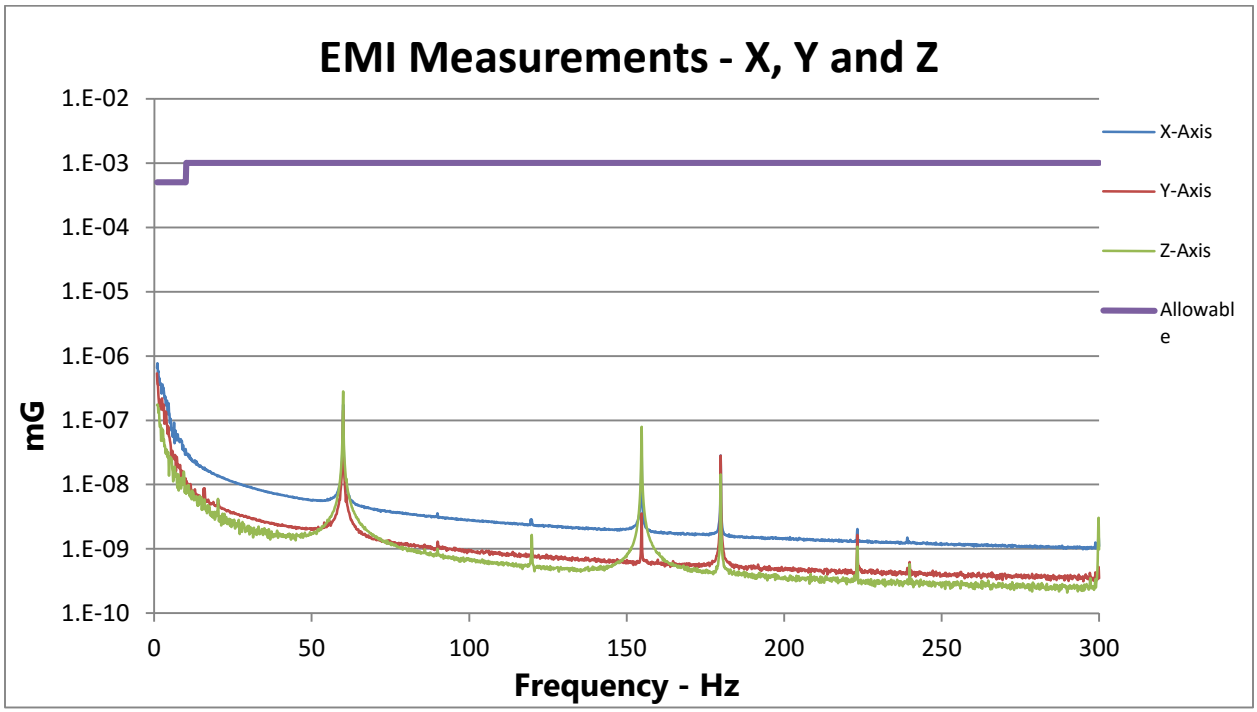
- EMI Noise Specification for Carl Zeiss Sigma HD Scanning Electron Microscope
  - Less than 3 mG peak to peak at 50 and 60 Hz

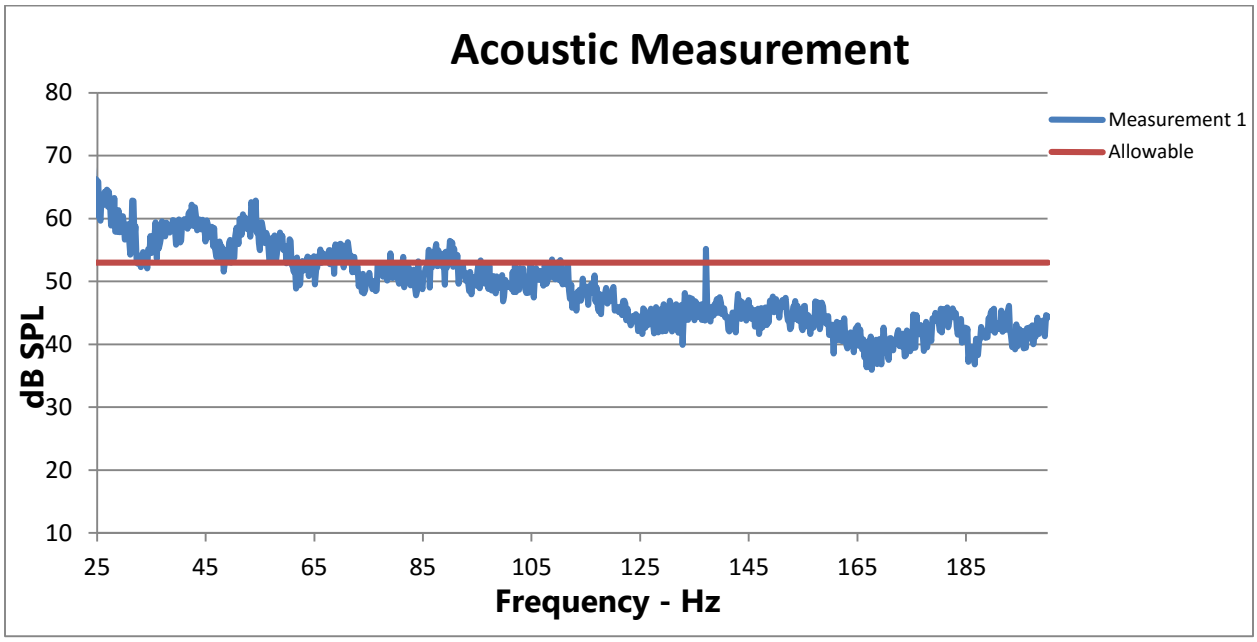
Provided below are graphs of the three environmental noise levels present at the prospective lab facility. All graphs (minus the acoustic test) include three separate measurements to demonstrate consistent data. Acoustic testing does not include three individual measurements as the differences between the testing were nominal and hardly distinguishable with one another.


Vibration Measurement - X Axis
Velocity - M/S
1.E-04
1.E-05
1.E-06
1.E-07
0
50
100
150
200
Frequency - Hz
Measurement 1
Measurement 2
Measurement 3
Allowable


Vibration Measurement - X Axis
Velocity - M/S
1.E-04
1.E-05
1.E-06
1.E-07
0
50
100
150
200
Frequency - Hz
Measurement 1
Measurement 2
Measurement 3
Allowable


Vibration Measurement - Z Axis
1.E-04
1.E-05
1.E-06
Velocity - M/S
0
50
100
150
200
Frequency - Hz
Measurement 1
Measurement 2


EMI Measurements - X, Y and Z
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
mG
0
50
100
150
200
250
300
Frequency - Hz
X-Axis
Y-Axis
Z-Axis
Allowable



Observations and Analysis

Observations

Vibration Noise

The vibration levels in all three measurement directions exceed the allowable vibration specification established by Carl Zeiss in the 1 – 20 Hz frequency range. The primary frequency bandwidth that is of most concern is relatively consistent between all three measurement directions—1 - 20 Hz. The Z axis demonstrated the highest level of vibration excitations, being nearly out of specification throughout the entire frequency bandwidth.

The primary vibration amplitudes in the X-Axis exist at: 7.2, 11.7 and 14.4 Hz; the primary vibration amplitudes in the Y-Axis exist at: 3.7 and 14.4 Hz; the primary vibration amplitudes in the Z-Axis exist at: 6, 14 and 36 Hz.

Acoustic Noise

The acoustic levels within the room did not meet the allowable acoustic noise specification established by Carl Zeiss for the Sigma HD SEM. The primary frequency bandwidth that did not pass the allowable specification is: 25 Hz – 60 Hz. Beyond 60 Hz, majority of the acoustic noise meets the allowable specification, minus one incidence at 135 Hz.

EMI Noise

The data collected indicates the levels of EMI noise are well under the allowable specifications established by Carl Zeiss for their line of Sigma HD SEMs.

Analysis

Vibration Noise

The vibration measurements were taken in an outside room adjacent to the prospective lab environment on a solid stone floor. The measurements were not taken directly in the location of the prospective lab environment due to the floor currently consisting of carpet material. This carpet material prohibits any relevant data from being collected by a vibration sensor as the sensor requires firm bonding to the supported surface.

The data collected is to be used as a benchmark for vibration levels on the floor, however, it is suggested lower levels of vibration noise will be present in the prospective lab environment due to the distance away from the access elevators and other noise sources. Since access to the immediate location of the prospective lab was not available, the data collected was considered for analysis

An active vibration isolation system, such as the AVI Series (i.e. AVI-400) will be able to significantly reduce any ground vibrations near the maximum vibration amplitudes. The sensitive frequencies on the fourth floor of the Company XYZ building are within the primary bandwidth, which the AVI platform performs steep vibration attenuation. The AVI Series will be able to provide steep attenuation at the sensitive frequencies across all three axes (including all six degrees of freedom).

Acoustic Noise

Acoustic noise measured within the environment indicates a higher level of acoustic noise present than what is allowed for the Sigma HD SEM. The data, however, is not representative of the environment the Carl Zeiss microscope will be placed in due to the lack of isolation (no

surrounding walls) and high levels of external acoustic noise transference (employees). It has been suggested that concrete walls will be installed to encapsulate the room, adding to an enormous benefit to the acoustic noise present in the room. With a solid walled structure, the acoustic noise present in the room will be significantly improved.

EMI Noise

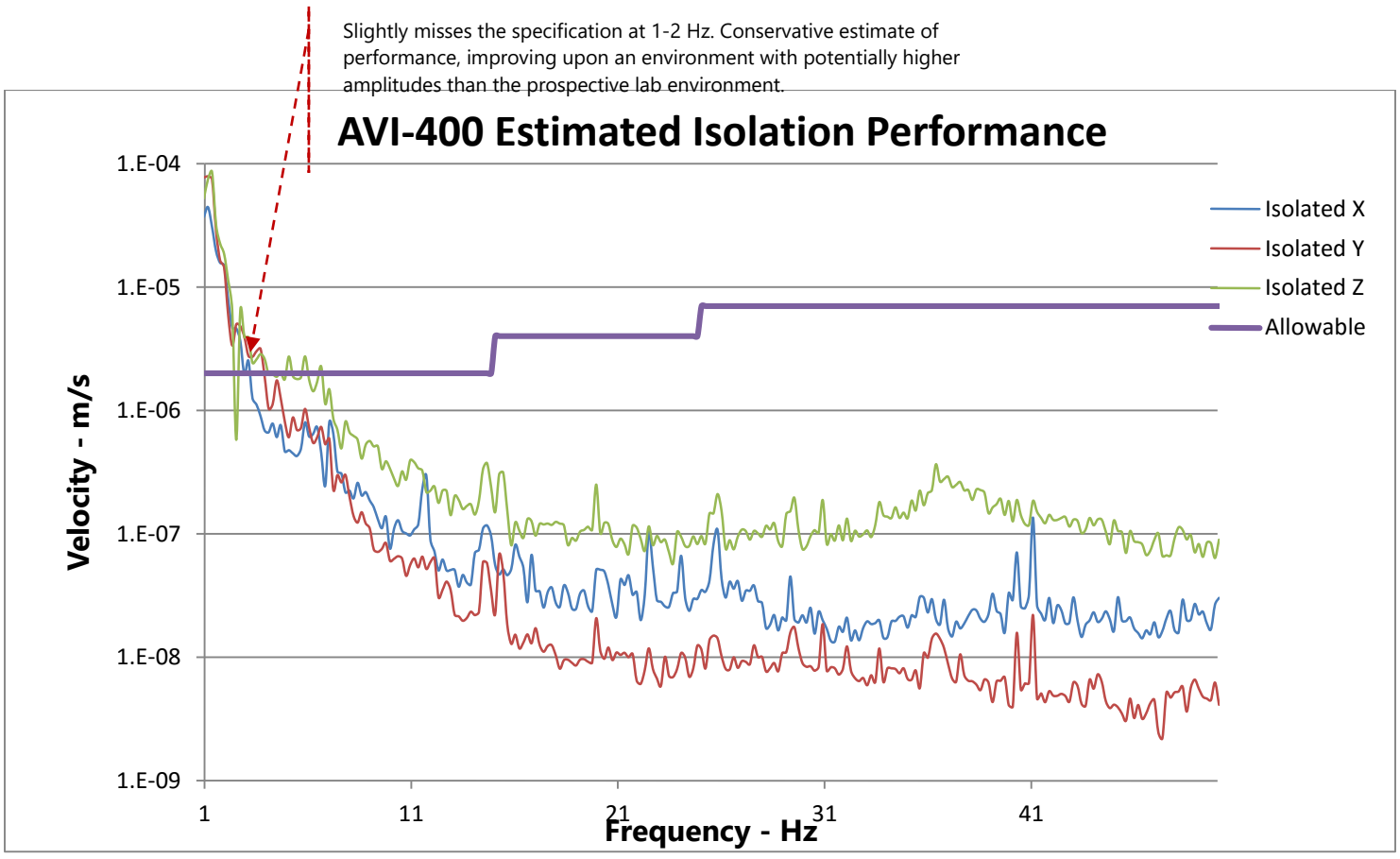
EMI noise within the environment will not cause issue for the Carl Zeiss instrument. The levels of EMI noise within the environment are on an order of magnitude less than the allowable specification, making the location pass for the EMI specification.

Recommendations

- Isolating Vibration Noise
    - Based upon the measured vibration noise in the prospective lab environment and how it compares with the established Carl Zeiss electron microscope specification for vibration noise; it is recommended to implement an active vibration isolation support platform (AVI Series) to attenuate vibrations within the lab environment.
        - To provide the Carl Zeiss electron microscope with the most vibration free platform, it is recommended to supply an active vibration isolation system to mitigate the low frequency noise from entering the instrument.
        - Active vibration isolation systems must be able to properly isolate vibrations across all six degrees of freedom and utilize piezoelectric sensory technology that is capable of achieving vibration isolation beginning at 1 Hz.
    - **AVI Series** sold by Herzan
        - Herzan is confident that its active vibration isolation solution (AVI Series) will be capable of significantly reducing the vibrations from affecting the Carl Zeiss electron microscope.
        - The performance of the AVI Series has been capable of providing high levels of vibration attenuation across a broad frequency spectrum in any environment.
        - The AVI Series can achieve 90% vibration attenuation at 5.5 Hz and 99% vibration attenuation at 10 Hz and beyond.

- The AVI Series has become a standard solution for large scale instruments, with minimal set up/installation time and no increase in footprint (saving valuable lab space).
    - More information can be found here: http://www.herzan.com/products/active-vibration-control/avi-series.html

A graph representing the improved performance when using the AVI-400 of the Sigma HD's experienced vibrations can be found below (1 – 50 Hz; frequencies not meeting specification prior to AVI platform isolation performance):



- Isolating Acoustic Noise
    - Based upon the measured acoustic noise in the prospective lab environment and how it compares with the established Carl Zeiss electron microscope specification for acoustic noise; it is recommended to enclose the room with dense walls (of

concrete or sound deadening material). Doing so will significantly improve upon the acoustical characteristics of the room and increase the opportunity for the room to meet the allowable specification standard established by Carl Zeiss.
    - If improvement of the walls does not bring the environment within specification, an acoustic isolating enclosure or surround is suggested. Herzan supplies modular/paneled acoustic enclosure systems that will surround the Carl Zeiss Sigma HD and provide significant acoustic dampening (if needed).

- Isolating EMI Noise
    - There are no recommendations to isolate EMI as the EMI levels meet specifications.

Appendices

Test Instrumentation

- VA-3 Triaxial Vibration Accelerometer
- Herzan WaveCatcher Analyzer
- Bartington Triaxial EMI Magnetometer (Sensor)
- PCB Electronics Acoustic Microphone

Units

- Vibration measurements are expressed in m/s, which is a unit of velocity
- Acoustic measurements are expressed in pascals
- EMI measurements are expressed in Tesla
- All measured units were converted to Carl Zeiss specified units for clear comparison in the graphs.