

APPENDIX A: SAMPLE S&V SPECIFICATION – LONG FORM

(This recommended S&V specification is available from www.nebb.org)

SECTION 15xxx (23xxx) – SOUND AND VIBRATION TESTING **PART 1 – GENERAL**

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

This Section includes measurement and reporting of sound and vibration levels.

1.3 DEFINITIONS

(To be added as per Section x of the Current Revision S&V Procedural Standard)

1.4 SUBMITTALS

In accordance with Contract Documents.

1.5 QUALITY ASSURANCE

- A. S&V Firm Qualifications: Engage a NEBB Certified Sound & Vibration Firm.
- B. Certification of S&V Reports: Review field data reports to validate accuracy of data and to prepare certified S&V reports. The Certified Report shall be prepared in accordance with the requirements of Part 3, Section 3.4 and the latest edition of the *NEBB S&V Procedural Standard for Measurement of Sound and Vibration*.
- C. S&V Report Forms shall include, at a minimum, all information required in Part 3, Section 3.5 and the latest edition of the *NEBB S&V Procedural Standard for Measurement of Sound and Vibration*.
- D. Instrumentation Type, Quantity, Accuracy and Calibration shall meet the requirements of the latest edition of the *NEBB S&V Procedural Standard for Measurement of Sound and Vibration*.
- E. Field calibration prior to instrument use shall meet the requirements of the latest edition of the *NEBB S&V Procedural Standard for Measurement of Sound and Vibration*.

1.6 PROJECT CONDITIONS

- A. Vibration testing shall be performed after HVAC Test and Balance of air and water systems have been satisfactorily completed, and with all systems operating at normal conditions. Vibration testing shall be completed and reported prior to sound testing.
- B. Sound testing shall be performed after HVAC Test and Balance of air and water systems have been satisfactorily completed, with all systems operating at normal conditions, and with all spaces completed and finished for occupancy. All other building mechanical and electrical systems must be operational that may affect sound readings.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with the Project requirements and to discover conditions in the system design that may preclude proper S&V testing of systems and equipment.
- B. Verify that the mechanical contractor performed, completed and provided written documentation that a field inspection of all vibration isolators and that all vibration isolators have been installed and adjusted properly. Vibration isolator compliance includes,
 - 1. Verify that all isolators are installed in accordance with manufacturer's recommendations.
 - 2. Verify that piping, duct, and conduit penetrations through mechanical equipment room envelope are sealed, and if required, rigid contact with building structure does not exist.
 - 3. Steel isolation bases must be inspected for cracked welds, excessive bending or twisting of steel members.
 - 4. Concrete isolation bases must be examined for cracked concrete. Isolator retainer brackets must be checked for looseness. The concrete base must be flat and true in plane.
 - 5. Elastomeric isolators must be examined for cracks in the rubber and for loose bonds between the rubber and steel plates or other steel components. Adequate clearance must be provided between bolts and the side of the bolt holes to prevent short circuiting.
 - 6. Steel spring isolators must be examined for loose or missing bolts, nuts or lock washers. Check for spring overloading or underloading, completely collapsed spring coils, and cocked springs. Note if rubber or glass fiber pad between the bottom plate of the steel spring and the concrete slab or supporting structure is present.
 - 7. Housed steel springs must be examined for proper centering of the springs, clearance between the cast housing and rubber snubber, and the steel spring for tilted or cocked springs.
 - 8. When the specifications require that the isolators be bolted to the concrete slab or other supporting structure, the bolts may be isolated by means of rubber bushings and rubber washers.
 - 9. Inspect isolators with restraint devices to make sure that all shims have been removed and supportive nuts have been properly adjusted to allow for free floating of the isolated system.
 - 10. Seismic restraints shall not prevent the proper functioning of vibration isolation system.

11. Pneumatic isolators must be inspected for overload or underload by checking the air pressure gauge against manufacturer's submittals or catalog. The pneumatic isolator system should include the isolator, strainer, oil separator, height regulator, and air pressure gauge. Inspect the vicinity of the isolator. Note if the isolator is exposed to damage from vehicle or other traffic.
12. Carefully inspect the space under all isolated bases to assure that these spaces are clean and free of debris to prevent short-circuiting.
13. Check to ensure that all shipping bolts associated with spring isolators have been removed.
14. Inspect all flexible piping, hoses, and expansion joints as to type, length and location as called for by the specifications. Examine flexible hose for excessive elongation.
15. Inspect all electrical and control connections to ensure that they do not restrain the movement of the vibration isolated equipment.
16. Inspect all fabric connections between fans and ductwork to ensure that a fabric "bellows" exists when the fans are operating.
17. Each piece of vibration isolated machinery must be free of any structural tie or rigid connection that may "short circuit" the isolation system. All limit stops, shipping bolts, and leveling bolts on all isolators must be inspected to ensure that they are not "short circuiting" the isolation system.
18. Hanger isolators should be free of misalignment and over / underloading. Under no circumstances the isolator rod should be allowed to make rigid contact with the hanger housing.

C. Report deficiencies as discovered to the appropriate parties.

3.2 PROCEDURES FOR VIBRATION MEASUREMENTS

- A. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
 1. Turn off equipment in the building that might interfere with testing.
 2. Restrict people from occupying areas where human activity may affect accuracy of measurements. Measurements should be performed when exterior vibration sources (trains, roadway 1065 traffic, adjacent construction activities, etc.) are at a minimum level.
- B. Attach and secure the vibration transducer in accordance with the latest edition of the *NEBB S&V Procedural Standard for Measurement of Sound and Vibration*.
- C. Measure and record, on all pumps and fans over 3 Hp, and all chillers and compressors over 5HP, vibration levels in at least 1 Hz increments over a minimum frequency range of 5 to 200 Hz or as specified by contract documents.
- D. Measure and record acceleration and/or velocity and/or displacement readings on equipment, bearing and equipment base in the vertical, horizontal and axial planes, where measurements can be performed safely. Record vibration acceleration and/or velocity and/or displacement; in the vertical, radial horizontal and axial axes (with respect to the equipment axis of rotation), or as per contract specifications.

1. Pumps:
 - a. Pump Bearing: Drive end and opposite end.
 - b. Motor bearing: Drive and opposite end.one each isolator.
 - c. Building: Floor adjacent to pump/motor, within 6” of one isolator, vertical axis only.
2. Fans and HVAC Equipment with Fans:
 - a. Fan Bearing: Drive end and opposite end.
 - b. Motor Bearing: Drive and opposite end.
 - c. Equipment Base: Top and side, within 6” of one isolator.
 - d. Building: Floor adjacent to pump/motor, within 6” of one isolator, vertical axis only.
3. Chillers and HVAC Equipment with Compressors:
 - a. Compressor Bearing: Drive end and opposite end.
 - b. Motor Bearing: Drive end and opposite end.
 - c. Equipment Base: Top and side, within 6” of one isolator.
 - d. Building: Floor adjacent to pump/motor, within 6” of one isolator, vertical axis only.

3.3 PROCEDURES FOR SOUND LEVEL MEASUREMENTS

- A. Close windows and doors to the space.
- B. Perform measurements when the space is not occupied, or when the occupant noise levels from other spaces in the building and outside are at a minimum, or do not affect sound readings.
- C. Clear the space of temporary sound sources so unrelated disturbances will not be measured. Turn off all sound sources (personal computers, printers, fax machines, etc.) in the space that may affect sound readings.
- D. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.
- E. Take sound measurements at a height approximately 48 inches above the floor and at least 36 inches from a wall, column, or any other large surface capable of altering the measurements.
- F. Take sound measurements in dB (linear or flat), with the fast time constant, in the octave bands from 31.5 to 8000 Hz.
- G. Take sound measurements with the HVAC systems off to establish the background levels and take sound measurements with the HVAC systems operating. Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.
- H. Perform sound testing in all occupied space horizontally and vertically adjacent to all mechanical equipment rooms and all mechanical chases.

- I. Perform sound testing at 10% of locations on the project for each type of the following spaces. For each space type tested, select a measurement location that has the greatest anticipated sound level. If testing multiple locations for each space type, select at least one location that is near and at least one location that is remote from the predominant sound source.
 1. Private office.
 2. Open office area.
 3. Conference room.
 4. Auditorium/large meeting room/lecture hall.
 5. Classroom/training room.
 6. Patient room/exam room.
 7. Sound or vibration sensitive laboratory.
 8. Hotel room/apartment.
 9. Library open space.
 10. Public areas (such as, lobbies, hallways, break rooms).
- J. Perform sound testing in all spaces with design criterion of NC or RC 25 or less
- K. Sound Measurement Reports: Record sound measurements on appropriate test forms, indicating the decibel levels measured in for both “background” and “HVAC system operating” readings. Record each tested location on a separate NC or RC chart. Record the following on the forms.
 1. Date and time of test.
 2. Equipment operational parameters - speed / frequency at time of measurements.
 3. Indoor measurements - space location within building including floor level and room / space number

3.4 FINAL REPORT

- A. The final report shall be in accordance with the requirements of the current edition of the NEBB *Procedural Standard for Measurement of Sound and Vibration*. The final certified report shall include, but not limited to the following:
 1. Report Title page indicating: “Certified Sound and Vibration Report”; Project Name, names of the project Architect, Engineer, HVAC Contractor and NEBB Certified S&V Firm with names, addresses and telephone numbers.
 2. Report Certification Page indicating the Project name, Certifying NEBB Qualified Supervisor’s name, Firm name, Certification number, Expiration date, Certifying NEBB Qualified Supervisor’s NEBB Stamp (signed & dated). The Certification page shall also contain the required certification statement.
 3. Table of contents with the total number of pages defined for each section of the report. Number each page in the report.
 4. Report Summary / Remarks including a narrative description of system set-up conditions, results and deficiencies.
 5. Instrument Calibration page indicating a list of the instruments to be used to verify the reported data. The page shall contain the name/type of each instrument, the manufacturer, model number, serial number, calibration date and dates of use.
 6. Data sheets on Sound and Vibration measurements as described below.
 7. Other information relative to equipment performance at time of testing that is deemed appropriate by the NEBB Certified S&V Firm.

- B. Vibration Measurement Report Forms: For each measurement location, record vibration measurements on appropriate test forms, indicating the following information:
1. Date of test.
 2. Equipment designation, location, motor horsepower and equipment operational parameters (speed/ frequency) at time of measurements.
 3. Measured acceleration (in units of g's, inches/sec², meters/sec², or units requested by the engineer of record), and/or, measured velocity (in units of inches/sec, meters/sec or units requested by the engineer of record) and/or, measured displacement (in units of inches, mils, millimeters, or units requested by the engineer of record).
- C. Sound Measurement Report Forms: Record sound measurements on appropriate test forms, indicating the decibel levels measured in for both "background" and "building system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms.
1. Date and time of test.
 2. Equipment operational parameters – speed / frequency at time of measurements.
 3. Indoor measurements – space location within the building including floor level and room space number.
 4. Outdoor measurements – location identifier such as location relative to equipment, building, or property line.
 5. Indicate where measurements meet or exceed design criteria.