

ASHRAE Recommended Procedure for Measuring Background Sound Pressure Level in a Room (Draft #9)

Introduction and Scope

This procedure is recommended by ASHRAE for the measurement of background HVAC system noise in rooms. Two methods are presented: a survey method intended to provide a quick and easy evaluation, and an engineering method to provide a more accurate assessment of the background noise level. **Unless stated otherwise, the survey method is the default method associated with this procedure.** The survey method is generally adequate for the initial building commissioning process **or** when the measured sound level is greater than or less than the design criterion by 3 dB or more. The engineering method is recommended whenever a more accurate assessment of the background noise level is required. It is intended that this procedure be used whenever evaluating the noise with a specified criteria rating system (dBA, NC, RC, or NCB).

Instrumentation

The measurements shall be made using instrumentation equivalent to an integrating sound level meter equipped with octave or 1/3-octave band filters and an omnidirectional condenser microphone. The instrumentation shall meet Type 1 specifications (~~for the engineering method~~) or Type 2 specifications (~~for the survey method~~) as defined in the latest versions of ANSI S1.4, ANSI S1.11, and ANSI S1.43. If the applicable noise criterion requires frequency analysis, the instrumentation **should** utilize parallel filters, where all frequency bands are processed simultaneously. Instrumentation that utilizes serial filters (where the meter cycles through the various frequency bands one at a time) is not permitted ~~permitted~~. The time constant for the rms detector shall be set to FAST response (125 ms) for all measurements.

Use a handheld, Type 1 portable acoustic **calibrator** to calibrate the instrumentation before and after each measurement session. Both the meter (including the microphone) and the portable acoustic calibrator shall be periodically calibrated by an independent testing agency that is traceable to the National Bureau of Standards. The calibration date for the Type 1 measurement system shall not be more than one year prior to the test date.

Measurement Conditions

The measurements should, if possible, be conducted with the room vacated by its normal occupants. If this is not possible, the test report shall indicate the occupancy of the room and a general description of what the occupants were doing during the measurements. In addition, all non-HVAC related sound-producing equipment (computers, radios, vacuum cleaners, etc.) should be turned off (if possible) for the duration of the measurements. Noise from outdoor sources (e.g. aircraft, street traffic, lawn mowers, etc.) should also be minimized by closing

windows and doors and/or scheduling the tests during time periods when these sounds are at a minimum.

The operating condition of the HVAC equipment or system serving the room during the measurement shall be determined and reported. If possible, the measurements shall be conducted with the system operating at full capacity (e.g. during maximum cooling for a VAV system). Measurements at two or three different operating conditions (e.g., maximum cooling, maximum heating, full economizer, etc.) are strongly encouraged, but not required. In all cases the HVAC system shall be operating in a known steady-state condition during the measurements. **If noise measurements are conducted with the system running in an unknown condition, the report shall clearly state this fact and the results of the test cannot be used to show compliance with the project requirements.**

Measurement Volume

All measurements shall be made within a measurement volume that is defined as all points greater than 1 meter from any room boundary (wall, floor, and ceiling), but not greater than 2 meters above the floor). In rooms with multiple floor levels (e.g. a balcony in a theater) each level shall be considered a separate room. The microphone shall be positioned so that at no time is it closer than ½ meter from any object in the room (e.g., furniture). If possible, all doors in the room shall be closed during the measurements to minimize the potential for interfering noise from other sources. In small or narrow rooms where the width of the room is less than 2.5 meters, the measurement volume may include all points more than 0.5 meter from the room boundaries.

Measurement Procedure

Noise measurements may be taken at any specific point or region within the room as long as it is carefully defined and reported. If the measurement results are intended to apply to the entire room in general (e.g., for commissioning), then measurements shall be taken at several stationary microphone locations in the measurement volume. The microphone may be hand-held or mounted on a tripod.

Number of Measurements

Survey Method

For the survey method, measure the noise at a point in the vicinity of where one would logically expect to find the ears of the occupant (e.g., near the seated position in front of the desk in a private office). If the room is such that there will be many occupants or there is no single defined area for the occupant (e.g., a school classroom), measure at the listener's location that is

closest to the dominant source of noise in the room (e.g., the HVAC unit). More than one measurement point may be measured (if desired). Record the time average (Leq) sound pressure level for each measurement point.

Engineering Method

If the floor area of the room is less than 20 square meters, measure the entire measurement volume using 4 fixed microphone locations uniformly distributed over the measurement volume. No microphone location shall be less than 1 meter from another microphone location. All microphone locations shall be at potential ear locations for the room occupants. If the floor area of the measurement volume is more than 20 sq. meters, divide the room into two or more sub-volumes and conduct four separate measurements in each sub-volume. If the room is large enough, the floor area in each sub-volume may be greater than 20 sq. meters, but not more than 40 sq. meters. None of the measurement sub-volumes shall overlap. For each sub-volume, record the average (Leq) sound pressure level at each measurement point. If the measurement volume is so small that the 1 meter microphone spacing cannot be achieved, then reduce the microphone spacing accordingly, and include the minimum microphone spacing in the test report. Do not reduce the number of microphone positions. Record the time average (Leq) sound pressure level for each measurement point.

Ambient Noise

Engineering Method or Survey Method

Measure the ambient noise levels in the room (with the HVAC system turned off) using the same measurement procedure defined above. The ambient noise levels should be measured immediately before or after (preferably both) the HVAC noise measurements. Record the time average (Leq) sound pressure level at each measurement location.

Ambient Noise Correction

In this context ambient noise is defined as any noise other than that generated by the HVAC system. Correction for ambient noise is not required by this standard, but may be used as defined below. If the average (Leq) background noise level is more than 6 dB below the HVAC noise level in any octave band (measured either before or after the HVAC system noise measurements), then the ambient adjusted HVAC noise level in that octave band is computed via the following equation:

$$L_{p \text{ (ambient adjusted)}} = 10 \log [10^{(L_{\text{phvac}}/10)} - 10^{(L_{\text{pambient}}/10)}]$$

where:

L_{phvac} is the sound pressure level with the HVAC system operating, and

$L_{pambient}$ is the sound pressure level with the HVAC system off.

The ambient noise adjustment is also allowed if the ambient noise level (measured both before and after the HVAC measurements) is between 3 and 6 dB below the HVAC noise level in any frequency band. **When making this adjustment, there will be two different ambient noise measurements (one before and one after the HVAC measurements). Of the two ambient noise readings, the lowest ambient noise level must be used in the above equation.** The ambient noise correction is not allowed when the ambient noise is within 3 dB of the measured HVAC system noise.

Criteria Evaluation

The measured average (L_{eq}) sound pressure level (ambient corrected, if allowed) in each measurement volume shall be used for evaluation against the desired room criteria. Do not evaluate the instantaneous maximum (L_{max}) sound pressure level against the specified criteria, unless the noise criteria specifically states that the instantaneous maximum sound pressure level must meet the criteria. If so, the time constant of the rms detector (e.g., fast or slow response) shall also be specified. In large rooms (with a measurement volume floor area greater than 20 sq. meters) the noise criteria rating value shall be independently evaluated for each measurement point. A measurement tolerance of plus or minus 2 dB (in both the measured overall and octave band levels) may be used to show compliance with the noise criteria.

Report

Engineering Method and Survey Method

The report shall include the measurement location, date, time of day, name of the person(s) conducting the measurements, identification of the acoustic instrumentation used, and a general description of the room including room name or number, approximate floor area, approximate room volume (not measurement volume), and a general description of the surface treatments and the room occupancy. A general description of the HVAC system (including operating conditions and room temperature at the time of the measurements) shall also be reported. In terms of the raw data, report the average (L_{eq}) sound pressure levels (before any ambient noise correction) for each measurement location. The measured noise criteria rating for each room measurement location shall be reported along with the ambient-corrected sound pressure levels.

Statement of Precision and Bias

To be determined via round robin tests.