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Standard Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels[1]

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INTRODUCTION

This test method is one of a set of standards for evaluating the acoustical performance of components or systems in an open office. The other standards in this set deal with the measurement of the sound attenuation between work stations provided by partial height space dividers, vertical surfaces, and acoustical ceiling systems; speech privacy; and the evaluation of masking sound.

1. Scope

1.1 This test method specifies the procedures that can be used to evaluate the spatial and temporal uniformity of masking sound in open offices using A-weighted sound levels. It also specifies the procedure for evaluating the masking sound spectrum and level using one-third octave band sound pressure levels.

1.2 The results of this test method can be used to determine if the masking sound meets a particular specification for spatial and temporal uniformity if that specification is written in terms of A-weighted sound levels and if the masking sound meets a particular spectrum shape and level in the office area.

1.3 This test method must not be used to evaluate the acoustical environment in an office space. It is intended only to evaluate the masking sound in an office. This test method, for instance, does not evaluate the low frequency *rumble* noise found in some offices.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 634 Terminology Relating to Environmental Acoustics[2]

E 1374 Guide for Open Office Acoustics and Applicable Standards[2]

2.2 *ANSI Standards:*[3]

S1.11 Specification for Octave-Band and Fractional-Octave Band Analog and Digital Filters

S1.4 Specification for Sound Level Meters

3. Terminology

3.1 *Definitions*—The acoustical terminology used in this test method is consistent with the definitions in Terminology C 634.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *masking sound*—sound within an office that reduces the intelligibility of intruding speech and the distraction from activity noise. Masking sound may be produced by a masking sound system, heating, ventilating, and air conditioning (HVAC) sources, or other sources.

3.2.2 *masking sound system*—the electronic equipment and loudspeakers used to generate, distribute, and produce masking sound throughout an office space.

3.2.3 *spatial uniformity*—a condition where the sound pressure levels throughout a defined space do not vary significantly from the arithmetic mean sound pressure level. The amount of allowable variation is specified by others such as a consultant, designer, or owner.

3.2.4 *temporal uniformity*—at a given position, a condition where the average sound pressure level measured over a short time interval does not differ significantly from the average sound pressure level measured over a long time interval. The

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[2] *Annual Book of ASTM Standards,* Vol 04.06.

[3] Available from American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.

amount of allowable variation is specified by others such as a consultant, designer, or owner.

4. Summary of Test Method

4.1 The spatial uniformity of the masking sound in an open office is determined by measuring the A-weighted average sound level with a sound level meter or real time analyzer at several locations and comparing these values to the arithmetic mean sound level or to a specified level. The temporal uniformity of the masking sound is determined by measuring the A-weighted sound levels over an extended period of time at one or more locations. The masking sound spectrum and level is determined by measuring the one-third octave band sound pressure levels at one or more locations.

5. Significance and Use

5.1 Speech privacy in an open office is dependent on many factors (see Guide E 1374 for a discussion on open office acoustical considerations). One of these factors is the masking sound in the office. Without masking sound in the open office, confidential speech privacy is not possible at normal voice levels. The four critical acoustical parameters of masking sound are its spatial uniformity, temporal uniformity, spectrum shape, and level. The measurement and determination of these parameters are addressed in this test method.

5.2 The results from this test method can be used to determine if the masking sound meets a particular specification.

6. Test Space

6.1 The test space shall include the entire office area served by the masking system, or as otherwise specified.

6.2 The ceiling system of the test space shall be completely finished, including light fixtures and air diffusers.

6.3 The floor covering and all wall finishes shall be completely installed prior to testing.

6.4 To provide the most meaningful information concerning the ability of the masking sound to provide consistent privacy, it is preferable to test with interior furnishings in place since furniture may influence the distribution of masking sound within the space. However, this test method may also be used for unfurnished spaces.

6.5 The office space shall be unoccupied during the tests.

7. Test Signal

7.1 The test signal used for this evaluation may be any of the following:

7.1.1 The sound due to the HVAC system, the masking sound system, and any other noise sources,

7.1.2 The sound due to the masking sound system alone, or

7.1.3 The sound due to the HVAC system alone.

7.2 If the intent is to evaluate the performance of the combination of sounds from the masking sound system, sound sources associated with the HVAC system and other equipment, then the test procedures shall be carried out with the masking sound system adjusted as intended to be used in the occupied space. The HVAC system should be operated at its noisiest and quietest settings or conditions.

7.3 If the intent is to evaluate the performance of the masking sound system alone, then the background sound pressure levels shall be at least 10 dB lower than the sound pressure levels of the masking sound signal. For the measurement of temporal or spatial uniformity, this may require that the sound pressure levels of the masking sound system be temporarily raised above the design level to provide the proper signal to noise ratio. Care should be taken not to overdrive the masking sound system, which may cause distortion.

7.4 If the intent is to evaluate the performance of the masking sound generated only by the HVAC system and other building sources, the HVAC system and other sound sources shall be operated at their noisiest and quietest settings or conditions.

8. Test Instrumentation

8.1 A sound level meter or analyzer shall be used that conforms to, or is better than, ANSI S1.4 for a Type 1 meter that has one-third octave band filters.

8.1.1 The overall frequency response of the filters for each test band shall conform to ANSI S1.11 for Order 3 or higher, Type 1 or better.

8.2 Test data may be acquired on-site or tape recorded for later analysis. The tape recorder shall have a frequency response of ±1 dB from 80 to 10 000 Hz.

8.3 A microphone with a frequency response of ±2 dB from 80 to 10 000 Hz shall be used. The microphone shall be oriented with respect to the ceiling in the office per the manufacturer's recommendation for the type of microphone being used.

8.3.1 The microphone position(s) should be at ear-height for the average seated person which is 1.2 m (4 ft) above the floor.

8.3.2 The microphone position(s) should be at least 1 m (3.3 ft) from any vertical surfaces such as walls, columns, desks, or office furniture. In the event that this criterion cannot be met, the selected location shall be as far as possible from the closest surface and the location shall be described in the report.

9. Procedure

9.1 Four different acoustical parameters must be measured in order to evaluate masking sound. These parameters are the masking sound spectrum, sound level, spatial uniformity, and temporal uniformity. The masking sound spectrum and level must be measured first to determine compliance with a specified spectrum. A test procedure is specified for determining each of these parameters.

NOTE 1—**Caution:** Some computer monitors employ fly-back transformers that produce high sound levels around 16 000 Hz or higher. Such sources, which might not be heard and are outside the masking sound frequency range, may provide misleading A-weighted readings. Care should be taken to minimize this problem by avoiding operating terminals, turning them off, or band limiting the A-weighting reading.

9.2 *Measurement of Masking Sound Spectrum and Level*:

9.2.1 Measure the masking sound pressure levels at each one-third octave band center frequency from 100 to 8,000 Hz at three or more locations in the office test area. The measurement (microphone) locations shall not be closer than 2 m (6.5 ft) from each other.

9.2.2 The one-third octave band sound pressure levels at the selected locations shall be measured over a time period of at least 4 s.

9.3 *Measurement of Spatial Uniformity*:

9.3.1 Measure over an interval of at least 4 s the A-weighted sound level of the masking sound. The number and location of measurement positions is determined by a walk-through listening test conducted in the office test area. Measurements shall be made at locations where both a change in masking sound is detected and at locations where no change in the masking sound is detected. No less than five measurement locations shall be selected with at least 50 % of the locations being where no change in the masking sound is detected.

9.3.2 For furnished spaces, the measurement locations shall be chosen to represent typical listening positions within the open office environment and shall also include the effects of items (such as light fixtures, diffusers, large ducts in the plenum, etc.) that may affect masking sound distribution. The provisions of 8.3.1 and 8.3.2 should be met. The number of locations at each type of work station shall be representative of the mix of each type of work station that is found in the overall floor space under evaluation.

9.3.3 The population maximum, minimum, mean, and standard deviation of the average values measured in 9.3.1 shall be determined.

9.4 *Measurement of Temporal Uniformity*:

9.4.1 The temporal uniformity of the masking sound is determined by measuring the A-weighted sound levels over a 1-min interval at one or more locations in the open office.

9.4.2 The maximum, minimum, and averaged A-weighted sound levels encountered during the 1-min interval shall be noted. The measured values shall be either obtained using the *slow* response on the sound level meter or may be obtained from the sound pressure levels averaged over 1-s intervals by the meter.

10. Report

10.1 In order to allow comparisons of data obtained at different installations using this test method, the report shall include the following items:

10.1.1 A statement, if true in every respect, that tests were conducted in accordance with the provisions outlined in this test method. Any exceptions to this test method shall be noted.

10.1.2 A statement explaining whether the testing was intended to evaluate the masking sound provided by all sound sources or only a masking sound system.

10.1.3 A brief description of the loudspeaker or sound radiator, including installation and mounting details such as mounting height, spacing, orientation, and locations.

10.1.4 A brief description of the masking sound system including the means of generation and distribution of the sound, the electronic equipment, and operating details including any adjustments to the masking sound system needed to comply with 7.3.

10.1.5 A brief description of the air handling system or other ambient sound sources that contribute to the masking sound.

10.1.6 A brief description of the test space including pertinent features (for example, ceiling material, suspension grid, light fixtures, ceiling diffusers, ceiling height, structural system above or below the ceiling system, plenum depth, plenum duct work, wall and floor finishes, and any interior furnishings).

10.1.7 A complete description of the test signal (see 7.1).

10.1.8 A description of the instrumentation used to acquire acoustical data including manufacturer, type and model, and date of the last calibration.

10.1.9 A complete description of all microphone locations selected for measurements, preferably shown on a floor plan of the space.

10.1.10 A statement identifying the location and data that was taken at microphone locations closer than 1 m (3.3 ft) from a vertical surface.

10.1.11 A listing of the measured maximum, minimum, and mean A-weighted sound levels, rounded to the nearest decibel, for each location evaluated for temporal uniformity.

10.1.12 A listing of the population maximum, minimum, mean, and standard deviation of the A-weighted sound levels rounded to the nearest decibel, measured for the evaluation of spatial distribution.

10.1.13 A listing and a graph of the average one-third octave band sound pressure levels of the masking sound.

11. Precision and Bias

11.1 The precision of the A-weighted sound levels and the one-third octave band sound pressure levels measured in an open office environment has been determined to be ±2 dB when the measurements are made by different operators using different instruments.

11.2 The procedures in this test method have no bias because the values of spatial uniformity, temporal uniformity, and masking sound spectrum are defined only in terms of this test method for the particular office space evaluated.

12. Keywords

12.1 A-weighted; masking sound; one-third octave band; one-third octave band sound pressure levels; open offices