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Standard Test Method for Measurement and Reporting of Masking Sound Levels Using A-Weighted and One-Third-Octave-Band Sound Pressure Levels¹

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INTRODUCTION

This test method is one of a set of standards relating to the acoustical performance of components or systems in open and closed office settings. 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, acoustical ceiling systems; and speech privacy in open and closed spaces.

1. Scope

1.1 This test method specifies the procedure used to measure the masking sound in terms of A-weighted and one-third-octave-band sound pressure levels.

1.2 The results of this test method can be used to determine if and where the masking sound meets (or does not meet) a particular specification.

1.3 This test method does not evaluate the overall acoustical environment. It is intended only to measure and report the masking sound levels.

1.4 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

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

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This test method is under the jurisdiction of ASTM Committee E33 on Building and Environmental Acoustics and is the direct responsibility of Subcommittee E33.02 on Speech Privacy.

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2. Referenced Documents

2.1 *ASTM Standards*:²

C634 Terminology Relating to Building and Environmental Acoustics

E1374 Guide for Office Acoustics and Applicable ASTM Standards

2.2 *IEC Standards*:³

IEC 61260:1 Electroacoustics - Octave-band and fractional-octave-band filters - Part 1: Specifications

IEC 61672:1 Electroacoustics - Sound Level meters - Part 1: Specifications

NOTE 1—The IEC standards are often adopted by national standards organizations as national standards sometimes with additional unique national standards numbers assigned.

3. Terminology

3.1 Terms used in this standard are defined either in Terminology C634 or within this standard. The definitions of terms explicitly given within this standard take precedence over definitions given in Terminology C634. The definitions within Terminology C634 and this standard take precedence over any other definitions of defined terms found in any other documents, including other documents referenced in this standard.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, <http://www.iec.ch>.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *masking sound, n*—sound that reduces the intelligibility of speech and the distraction of activity noise.

3.2.1.1 *Discussion*—Masking sound is produced and controlled most effectively by an electronic sound masking system.

3.2.2 *sound masking system, n*—electronic equipment and loudspeakers used to generate, distribute, and control masking sound throughout a treated area.

4. Summary of Test Method

4.1 The conformity of the masking sound to a specified curve and level is determined by measuring the A-weighted sound level and the one-third-octave-band sound pressure levels at sufficiently representative locations with a sound level meter and comparing these values to specified levels.

5. Significance and Use

5.1 Acoustical performance is dependent on many factors (see Guide E1374 for a discussion on general office acoustical considerations). One of these factors is the masking sound. The masking spectrum shape and level must conform within specified tolerances throughout the treated area. The measurement and recording of these parameters are addressed in this test method.

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

6. Test Space

6.1 The test space shall include the entire area of the building served by the masking system.

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 All interior furnishings shall be in place.

6.5 The test 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 and the sound masking system combined, or

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

7.1.3 The sound due to the HVAC system alone.

7.2 For the case described in 7.1.1, the test procedures shall be conducted with the sound masking system and all other background sound sources operational. The HVAC system shall be operated at its normal daytime condition.

7.3 For the case described in 7.1.2, the test procedures shall be conducted with the sound masking system only. Noise generated by other background sound sources shall be at least 10 dB below the masking signal in all respective one-third-octave-bands. The HVAC system shall be shut off and any remaining sounds that may interfere with the measurements shall be noted in the report.

7.4 If the intent is to measure the sound generated only by the HVAC system and other building sources, the HVAC system and other sound sources shall be operated at their normal daytime conditions.

7.5 Sound masking features such as adaptive level adjustment or programmable timer shall be deactivated and set to the specified base levels during measurements.

NOTE 2—Testing the HVAC system alone will typically occur in order to verify the need for electronic sound masking and conversely, to determine the areas within a facility where the HVAC levels may already exceed ideal masking sound levels.

NOTE 3—When the masking system is measured without the HVAC as per 7.1.2, the subsequent restoration of the HVAC may result in combined ambient noise levels that are unacceptable to the occupants.

8. Test Instrumentation and Microphone Positioning

8.1 Instrumentation Specification:

8.1.1 The sound level meter or analyzer shall be an integrating-averaging type with appropriate microphone that conforms to class 1, IEC 61672:1-2013 requirements.

8.1.2 The measurement system shall include one-third-octave-band filters that conform to IEC 61260:1-2014 for class 1.

8.1.3 Test data may be acquired on-site or recorded for later analysis. The combined frequency response and other characteristics of the measurement system and recording device shall meet the class 1 requirements of IEC 61672:1-2013.

8.2 Microphone Orientation and Positioning:

8.2.1 The measurement system will typically include a 12.7 mm ($\frac{1}{2}$ in.) microphone which will have either a free-field or random incidence inherent directivity response and the system may include electronic circuitry allowing the microphone to simulate either directivity response. Results above around 5000 Hz can be influenced by the microphone directivity response, the degree of diffusivity of the sound field, and the orientation of the microphone if the field is not highly diffuse. These concerns can be avoided by use of a 6.4 mm ($\frac{1}{4}$ in.) microphone. For indoor measurements, it is often assumed that the field is diffusive, and a random incidence response microphone or setting is preferred with the orientation insignificant. Use of a free-field microphone in such fields will result in slightly low readings at higher frequencies. Large open plan spaces may not be diffuse. Especially if it is clear to the ear that the dominant sound is from above, it is preferable in such spaces to use either a free-field response with the microphone pointed upward, or a random-incidence response with the microphone pointed at about 45° above the horizontal. The microphone directivity response and orientation shall be provided in the report.

8.2.2 The center of the microphone sweep position(s) shall be at ear-height for the average seated person which is 1.2 m (4 ft) above the floor.

8.2.3 The microphone sweep position(s) shall be selected if possible so that all measurements are at least 1 m (3.3 ft) from any reflective surfaces such as walls, columns, desks, or office furniture. In the event that this criterion cannot be met with the specified sweep diameter, measurements may be as close as 0.5 m (1.6 ft) from surfaces. If the distance between reflecting

surfaces is less than 2 m (6.6 ft), reduce the diameter of the sweep to maintain a minimum distance from surfaces of 0.5 m (1.6 ft).

8.2.4 In enclosed offices, the default center of the sweep shall be as close as practical to the seated location of the primary occupant while maintaining the requirements of 8.2.3.

NOTE 4—Given the tight tolerances that are often specified in modern sound masking systems, reproducibility of acceptable measurement values between commissioning and verification agents can be a challenge. One option to reduce measurement equipment discrepancies is for the commissioning and verification agents to be present on site simultaneously working from a single measurement device.

9. Procedure

9.1 Measurement of Masking Sound:

9.1.1 Measure the sound pressure levels in the specified range of one-third-octave-bands and the A-weighted sound level at each measurement location in the test area using the scanning microphone method. In each one-third-octave-band, sweep the microphone around a circle of approximately 1 m (3.3 ft) radius centered on the measurement location starting at the designated height per 8.2.2 less 0.15 m (6 in.) while spiraling upwards by 0.3 m, and complete at least 2 integer revolutions. The A-weighted sound level shall also be measured in this manner.

9.1.2 The average sound pressure level and spectrum at each measurement location shall be measured over a period of at least 15 s.

9.1.3 At a minimum, measurements shall be taken as follows:

9.1.3.1 5000 ft² of test space overall, or less:

(1) Minimum of 5 open plan measurement positions, which must include at least one measurement on each floor level, and at least one measurement in each area of the test space where different sound masking A-weighted levels, or different spectra, have been specified.

(2) All closed offices if 5 or less.

(3) Minimum of 50 % of closed offices if more than 10.

(4) Five measurement positions if 6 to 10 closed offices.

9.1.3.2 Above 5000 ft² of test space overall:

(1) One measurement per 1000 ft² open area which must include at least one measurement on each floor level, and at least one measurement in each area of the test space where different sound masking A-weighted levels, or different spectra, have been specified.

(2) 50 % of closed offices up to 100.

(3) Minimum 50 closed offices up to 200.

(4) Minimum 25 % of closed offices if more than 200.

9.1.4 Individual open plan area measurements outside of defined tolerances can have up to three additional measurements taken within the vicinity of the initial measurement location to determine arithmetic mean. Each additional measurement shall be taken within the confines of the defined 1000 ft² test area. The arithmetic mean of the combined measurements is used to determine compliance to the specification for that individual test area.

9.1.5 Measurement locations within each 1000 ft² test area can be randomly chosen and should focus on the seated

position of an occupant wherever possible whilst meeting the requirements of 8.2.3.

9.1.6 Individual enclosed office test area measurements outside of defined tolerances can have up to three additional measurements taken within the room to determine arithmetic mean. The arithmetic mean of the combined measurements is used to determine compliance to the specification for that particular room.

9.1.7 Measurement locations inside enclosed offices should be the seated position of the primary occupant wherever possible, whilst meeting the requirements of 8.2.3.

9.1.7.1 In certain instances, the frequencies outside of the specified range will adversely affect the overall dBA level and cause it to be higher than specified even when the third-octave levels of the masking curve are within specified tolerances. In these instances, the calculated dBA from the specified third-octave measurements shall be used to determine conformity.

NOTE 5—Due to potential variations in masking spectrum uniformity across a space caused by architectural/furniture non-uniformity, it may be expected that when randomly selecting measurement locations, a single position may be outside of tightly specified tolerances, particularly in 1/3 octave at lower frequencies. In instances where an individual measurement does not meet the specified levels within the defined tolerances an average of multiple positions can be used to demonstrate compliance.

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 measure the sound provided by combining HVAC with a sound masking system or the HVAC system alone or the sound masking system alone.

10.1.3 A brief description of the loudspeakers, including installation and mounting details such as mounting height, spacing, orientation, and locations.

10.1.4 A brief description of the sound masking system including the means of generation and distribution of the sound, the electronic equipment, and operating details.

10.1.5 A brief description of the (HVAC) air handling system or other sound sources that contribute to the base building ambient 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, 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, the microphone response (free-field or random incidence) and orientation of the microphone relative to the ceiling.

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