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Standard Guide for Open Office Acoustics and Applicable ASTM Standards[1]

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ε[1] NOTE—Keywords were added editorially in March 1998.

INTRODUCTION

There are no full height partitions in an open-plan office to block sound transmission between adjacent work stations. Instead, partial height barriers, a sound absorbing ceiling and absorption on vertical surfaces are used to provide sound attenuation between individuals. These, in combination with work station layout and appropriate levels of broad band masking sound are used to obtain acceptable degrees of acoustical privacy.

1. Scope

1.1 This guide discusses the acoustical principles and interactions that affect the acoustical environment and acoustical privacy in the open office. In this context, it describes the application and use of the series of ASTM standards that apply to the open office.

1.2 The values stated in inch-pound units are to be regarded as standard. The SI units in parentheses are provided for information only.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 1041 Guide for Measurement of Masking Sound in Open Offices[2]

E 1110 Classification for Determination of Articulation Class[2]

E 1111 Test Method for Measuring Interzone Attenuation of Ceiling Systems[2]

E 1130 Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index[2]

E 1179 Specification for Sound Sources Used for Testing Open Office Components and Systems[2]

E 1375 Test Method for Measuring the Interzone Attenuation of Furniture Panels Used as Acoustical Barriers[2]

E 1376 Test Method for Measuring the Interzone Attenuation of Sound Reflected by Wall Finishes and Furniture Panels[2]

E 1414 Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling and Plenum[2]

3. Summary of Guide

3.1 *Acoustical Privacy*—The attenuation of sound between neighboring work stations in an open-plan office is typically much less than that potentially available between closed-plan offices. Nevertheless, a degree of acoustical privacy can be achieved if component selection and interaction are understood. A successful open plan office is the result of careful coordination of the several components, ceiling, wall treatments, furniture and furnishings, heating, ventilating and air-conditioning system, and masking sound system. (See Section 7.)

3.1.1 This guide delineates the role and interaction of the several components and the application of the relevant ASTM Standards.

4. Significance and Use

4.1 This guide is intended for the use of architects, engineers, office managers, and others interested in designing, specifying, or operating open offices.

4.2 It is not intended to be applied to other than office environments, for example, open plan schools.

4.3 While this guide attempts to clarify the many interacting variables that influence office privacy, it is not intended to supplant the experience and judgment of experts in the field of acoustics. Competent technical advice should be sought for success in the design of open offices, including comparisons of test results carried out according to ASTM standards.

5. General Open Office Acoustical Considerations

5.1 *Introduction—Attenuation with Distance*—In almost any enclosed space, there is some reduction of sound level with

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

distance. In many typical spaces, this decrease of sound level with distance is affected by sound reflections from the ceiling, the walls, and floor. In the open plan office the goal is to maximize this loss with distance in order to improve acoustical privacy. This requires a highly absorbent ceiling, some absorption on the floor, and careful treatment of nearby vertical surfaces. The ideal is to approach the conditions of the outdoors, where there are no reflecting surfaces.

5.2 Attaining acoustical privacy between work stations, open or closed plan, is determined by the degree to which the intruding sounds from adjacent work stations exceed the ambient sound levels at the listener's ear.

5.3 The sound pressure levels arriving at the listener's ear from sources in adjacent work stations depend on the following:

5.3.1 The sound source amplitude, directivity, and orientation.

5.3.2 The total attenuation of the sound due to a combination of distance and shielding by intervening barriers.

5.3.3 The reinforcement of the direct sound due to reflections from office surfaces such as the ceiling, furniture panels, light fixtures, walls, and windows.

5.3.4 The level of ambient sound at the listener's ear. This will often be generated and controlled by a sound masking sound system, but in certain positions and frequency ranges, heating, ventilating, and air conditioning equipment (HVAC) may contribute significantly to the ambient sound level.

5.4 The attributes in 5.3.1 through 5.3.4 apply regardless of the source of the intruding sound. In the open plan, both office equipment and speech are the dominant intruding sources. In many cases, the provision for acceptable speech privacy is the major concern.

5.5 Office layout should be designed to avoid obvious noise intrusion possibilities. Individual work stations should be positioned relative to columns, walls, and each other to avoid uninterrupted sound paths between contiguous work stations. Occupant orientation is also important, because there is a significant difference between the sound level when a talker faces a listener versus the talker facing away from the listener, of the order of 9 dB.

5.6 *Loud Noises*— Distractions caused by raised voices or loud office equipment usually cannot be controlled by normal open office constructions. It is recommended that some closed plan spaces be provided to contain such loud equipment or enclose noise sensitive spaces such as conference rooms.

5.7 *Problem Noise Sources*—Computers, business machines, copiers, typewriters, and other noise generating devices should be located in isolated (enclosed) rooms or areas to minimize their noise intrusion into the work station. Where this is impractical, care should be exercised in eliminating or minimizing the noise generation aspects. Telephones and "speaker phones" are a frequent problem. The former should be equipped with flashing lights, rather than ringers (audible annunciators). Large typing pools or word processing centers can generate A-weighted sound levels up to 80 dB. These activities should be contained in special work areas affording adequate noise isolation from the surrounding open plan spaces.

5.8 *Undivided Workspaces*—Acoustical comfort may be improved in undivided workspaces such as "bull-pen" offices, drafting rooms, and typing pools by the addition of acoustical absorption to horizontal and vertical surfaces, but no such treatment alone will provide speech privacy.

5.9 ASTM test methods exist for testing *components* and *systems* for open plan offices. These include measuring the attenuation between work stations by the ceiling path (see Test Method E 1111), the effect of barriers such as furniture panels (see Test Method E 1375), the effect of flanking or reflections from vertical surfaces (see Test Method E 1376), measurement of masking sound in the open office (see Guide E 1041), and the determination of the articulation class (see Classification E 1110), that is a single number rating of system component performance. Articulation class does not account for the effect of masking sound.

5.10 *Objective Determination of Speech Privacy*—Test Method E 1130 describes a method of objectively measuring the speech privacy in open plan offices. It is based on a determination of the articulation index.

5.10.1 *Articulation Index*—The articulation index (AI) is a computational method for predicting the intelligibility of speech for groups of talkers and listeners. The AI is a weighted fraction representing, for a given speech frequency band and noise condition, the effective proportion of the standard speech signal that is available at the listener's ear for conveying speech intelligibility.

5.10.1.1 The articulation index ranges from 0.00 to 1.00, with 0.00 representing zero intelligibility and 1.00 complete intelligibility.

5.10.1.2 Speech privacy may be described as *confidential* when speech may be detected but not understood.

5.10.1.3 Speech privacy may be described as *normal* or *non-intrusive* when effort is required to understand the intruding speech. Normal speech privacy may also be described as the absence of distraction.

5.10.1.4 Confidential speech privacy occurs at an AI of 0.05 or less. Speech becomes more readily understood with AI values greater than 0.20; at values greater than 0.40 there is essentially no privacy.

NOTE 1—Additional research is needed to verify the relation between the AI and the subjective judgement of *normal* privacy in the open plan. (See the appendix of Test Method E 1130.)

6. Components of the Open Plan Acoustical Environment

6.1 *Ceilings*:

6.1.1 The sound absorbing characteristics required of the ceiling plane for open plan systems are different than those for private offices or conference rooms. In open plan spaces, sound from the source not controlled by part-height space dividers travels toward the ceiling plane, where part can be reflected back into the adjacent work space. To minimize the reflected sound, the ceiling must absorb most of it. In private offices or conference rooms, some lesser absorption or greater reflection may be desirable.

6.1.2 The sound barrier characteristics of the ceiling plane helps provide spatially uniform masking sound from loudspeakers located in the ceiling plenum. If the sound barrier performance is low or variable, it may lead to the perceptions