MEASUREMENT OF SPEECH PRIVACY OF CLOSED ROOMS USING ASTM E2638 AND SETTING CRITERIA IN TERMS OF SPEECH PRIVACY CLASS

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1. INTRODUCTION

The degree of speech privacy provided by an enclosed room refers to the extent to which conversations occurring inside are protected from overhearing by people outside, in the adjoining building spaces. The new ASTM standard E2638 "Standard Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room" [1] describes a test method suitable for use in enclosed rooms of nearly all sizes. It defines a measure called Speech Privacy Class (SPC) which, for a particular room and a particular listening point, is basically a fixed, physical property of the building. The measurement standard does provide some information on how to interpret and use the SPC value, but does not define criteria for "acceptable" performance.

This paper briefly reviews the new E2638 measurement method, and an approach for setting criteria using SPC.

2. ASTM E2638 MEASUREMENTS

Using a loudspeaker placed at 2 or more positions within the closed room of interest, measurements are made at locations inside the room to determine the average source room levels. (This is unlike open plan privacy measurements according to ASTM E1130 which require a calibrated loudspeaker with a specified directionality, location, and orientation.) For each source position, measurements of received level are also made, at a number of receiver positions outside the room. Unlike sound transmission loss testing (e.g., ASTM E336), the receiver positions are close to the boundaries of the room (0.25 m recommended), and at specific locations of suspected sound leaks (e.g., ducts, doors).

From the measurements, a level difference is calculated for each receiving point: the average receive level (at that point) is deducted from the average source room level to determine *LD(avg)*. Here "*(avg)*" means the one-third-octave band values are arithmetically averaged over the 16 bands from 160 to 5000 Hz. The background level $L_b(avg)$ is also determined at each receiver location. The sum of these two factors is the SPC:

$$\text{SPC} = LD(avg) + L_b(avg) \qquad (1)$$

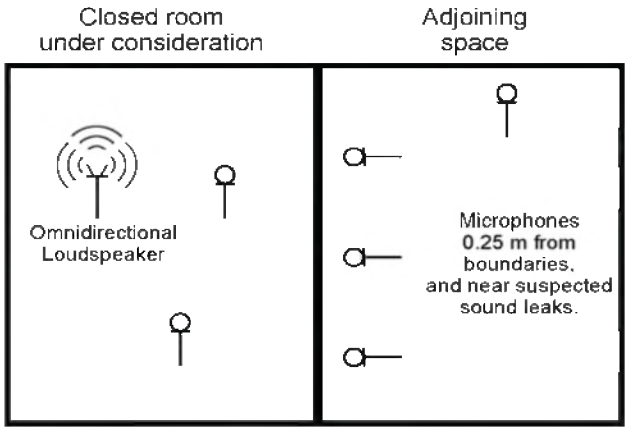

Fig. 1.Schematic indicating loudspeaker and microphone positions for ASTM E2638 measurements.

3. SPEECH PRIVACY CLASS

SPC is the sum of the measured average noise level at the position of a potential eavesdropper outside the room, and the measured level difference between a source room average and the transmitted levels at the same potential eavesdropper location. Increasing either the background noise or the sound insulation will result in a higher degree of privacy, and a correspondingly higher value of SPC. For a given speech level (inside the room), the SPC governs the "speech signal to noise ratio" at the position of a listener, which is related to intelligibility and audibility. Reference [2] defines the relevant signal to noise metric (SNR_{uni32}), and demonstrates the correlation with subjective listening test results of intelligibility and audibility.

The speech levels inside the room, however, are never fixed – they fluctuate as people speak, and can best be described statistically [3]. Viewed this way, the likelihood of transmitted speech being audible or intelligible can be related to the probability of higher-speech levels occurring in the meeting room. The SPC (for the listening position) determines the maximum speech level that is "adequately" protected. The probability of occurrence of higher speech levels is the probability of a speech privacy lapse. Higher values of SPC protect against less likely higher speech levels, and therefore relate to a greater degree of privacy.

Table 1. Descriptions of speech privacy categories, and proposed use for government designated information.

Category	SPC	Description	Proposal for suitable use
Minimal speech privacy	70	Frequently intelligible	
Standard speech privacy	75	Occasionally intelligible, and frequently audible.	Protected B information
Standard speech security	80	Very rarely intelligible, and occasionally audible.	Secret information
High speech security	85	Essentially not intelligible, and very rarely audible.	Top Secret information
Very high speech security	90	Unintelligible and essentially inaudible.	

Frequently : about 1 per 2 minutes
Occasionally: about 1 per 15 minutes
Very rarely: about 4 per 8 hours
Essentially not: about 1 per 16 hours

4. CATEGORIES

The appendix of E2638 includes a table that identifies the frequency with which speech sounds would be audible or intelligible, for various SPC values. This is summarized in the first three columns of Table 1. The descriptions of how frequently speech would be audible or intelligible are based on the statistics of speech levels measured in meeting rooms during meetings.

What the ASTM standard does not do is to indicate what likelihood of speech being audible or intelligible is suitable for end users. One possible proposal was developed recently through consultation with representatives of many federal government departments. The proposal is based on matching the speech privacy criterion to the sensitivity of the information to be discussed in the room. A draft recommendation is listed in the fourth column of Table 1. It indicates that the minimum SPC requirement for a room in which *Protected B* information is to be discussed is 75. For *Secret* information, the SPC should be at least 80, and for *Top Secret*, 85. Obviously users outside of the federal government will have different terminology and possible needs for fewer (or more) categories.

5. PRACTICALITY

In specifying criteria, it is important to be able to estimate whether it is realistic to achieve various SPC values. Measurements conducted in some new government offices indicate ranges of SPC from mid-40s to 90 or so are achievable [4].

6. DISCUSSION

Measurement of speech privacy (or speech security) of enclosed rooms is possible using the new ASTM E2638 standard. Users can use the discussion in the standard to help set criteria and to define useful categories. One proposal is to match the necessary value of SPC to the sensitivity (importance) of the information to be discussed in the room. Measurements in real rooms have demonstrated the feasibility of such an approach. What is still lacking, however, is some real-world validation that occupants' satisfaction with the rooms matches the physical measurements.

REFERENCES

[1] ASTM E2638-10, "Standard test method for objective measurement of the speech privacy provided by a closed room," ASTM International, West Conshohocken, PA (2010).

[2] B.N. Gover and J.S. Bradley, "Measures for assessing architectural speech security (privacy) of closed offices and meeting rooms," *J. Acoust. Soc. Am.* **116**, 3480–3490 (2004).

[3] J.S. Bradley and B.N. Gover, "Speech levels in meeting rooms and the probability of speech privacy problems," *J. Acoust. Soc. Am.* **127**, 815–822 (2010).

[4] C. Fortier, "Speech Privacy Class measurements in Real Office Buildings according to the new ASTM 2638 standard and related STC values," Proceedings of INTER-NOISE 2009.

ACKNOWLEDGEMENTS

This project jointly funded by Public Works and Government Services Canada (PWGSC), the Royal Canadian Mounted Police (RCMP), and the National Research Council Canada (NRC).