THE EFFECT OF ANCILLARY VOLUME ON SOUND TRANSMISSION MEASUREMENTS USING ASTM STANDARD TEST METHOD E336

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1. INTRODUCTION

The ASTM Standard E336-05 provides methods to assess the airborne sound isolation between a source and receiving room. In certain field situations, the determination of what constitutes the source or receiving room and its volume may not be obvious. An example is a living room (principal volume) connected to a kitchen (ancillary volume) through an opening in the wall separating the two, and the party wall under test is a surface of the living room (principal volume). Some judgment may be required to define the volume and where the sound field of the "room" should be measured. The Standard requires that the ancillary volume be disregarded if the average sound pressure level in the ancillary volume is 6 or more decibels below the average level in the principal portion of the source or receiving room to which it is coupled at all measurement frequencies. Otherwise, the ancillary volume shall be included as part of the measurement space. This paper investigates the suitability of this criterion.

2. MEASUREMENTS AND RESULTS

The basic premise was the Apparent Transmission Loss (ATL) should be invariant of the coupled ancillary volume. Thus, the appropriate measurement procedure is the one that best approximates the (reference) ATL measured when there was no coupled ancillary volume. To evaluate this and arrive at the recommended measurement procedure, different field scenarios were simulated using the four-room Flanking Transmission Facility at the NRC/IRC. (See sketches of Figures 1-3). The volume of the rooms ranged from about 35 to 50 m^3. In Figures 1-3 the ATL was computed for both directions between room pairs AC and BD using sound field measurements of the principal volume only. The wall between C and D (lower horizontally separated rooms) was systematically opened up from 0%, 8%, 17%, 36% to 100% to increase the coupling to the ancillary volume. Absorption was added to one of the lower rooms to simulate heavy furnishings.

Ancillary Volume Coupled to Source Room has only minimal effect on the ATL and this is largely independent of the size of the opening between the source and ancillary volumes. Although Figure 1 shows the case with an absorptive source room (worst case), similar results were observed when either ancillary or principal source volume was highly absorptive (reverberation time, RT, ~ 0.4 s) or when both were not (RT > 1.0 s).

Ancillary Volume Coupled to Receiving Room will result in an overestimation of the ATL if receive room measurements are made only in the principal volume. The results shown in Figure 2 are typical of when both receive and coupled ancillary volumes are not highly absorptive. By comparing Figures 2 and 3, one can see the overestimation is greater when the principal volume is highly absorptive. It should be noted that effect is considerably less when the ancillary volume is highly absorptive relative to the receive room principal volume. For all cases considered the overestimation increased with opening size.

3. DISCUSSION AND CONCLUSIONS

The practical approach is to select the direction of measurement such that the ancillary volume, if present, is coupled to the source room. However, when the receive room is coupled to the ancillary volume a criterion is required to minimize the effect of an ancillary volume.

Figures 4 and 5 show when there is an ancillary volume coupled to the receive room, the difference in the ATL with and without (reference) an ancillary volume, is a function of two parameters. First is space-average level difference between the principal and ancillary volumes. Second is whether sound field measurements include the ancillary volume. There is a data point for each one-third octave in the range 125-4kHz. The figures show that there is practically no ATL overestimation for two conditions, 1.) small level difference between the coupled volumes and the sound field averaged over both and the combined volume is used in calculations, 2.) large level difference between the coupled volumes and the sound field in principal volume is used in the calculations. For intermediate conditions, the overestimation is appreciable and should be minimized. For the room volumes and reverberation times considered here, the regression lines suggest, when the difference in space average level between the principal and ancillary volumes is greater than about 4 dB estimates of ATL should be obtained using sound field measurements restricted to the principal volume. However, when difference is less than 4 dB both principal and ancillary volumes must be used.

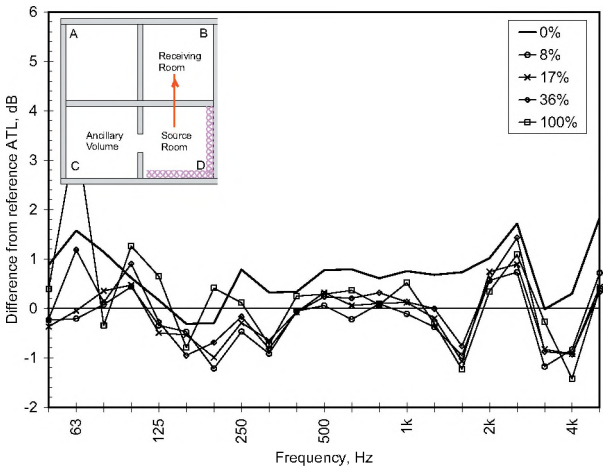

Figure 1: Effect of an ancillary volume and percent opening when coupled to a heavily furnished source room

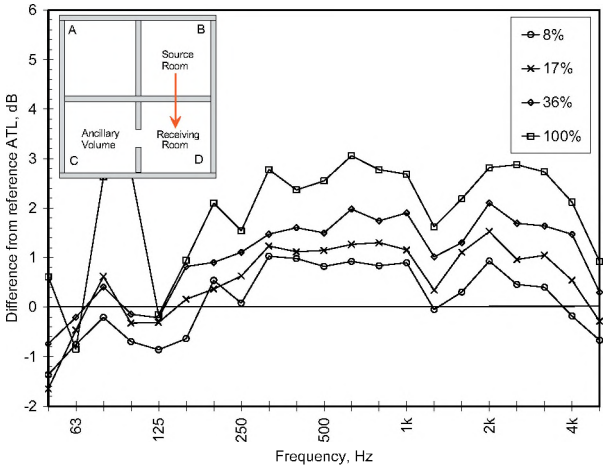

Figure 2: Effect of an ancillary volume and percent opening when coupled to a receive room.

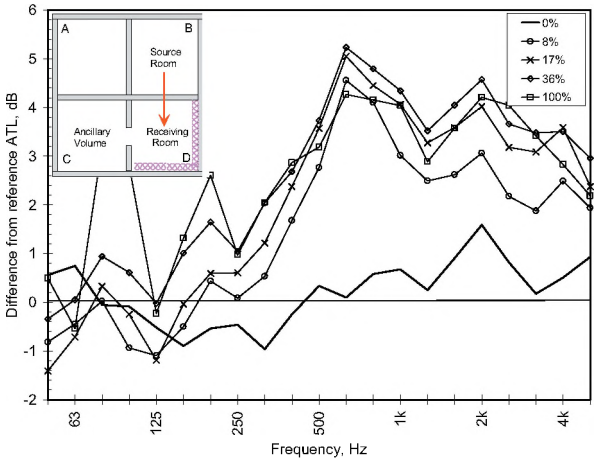

Figure 3: Effect of an ancillary volume and percent opening when coupled to a highly absorptive receive room.

In both cases, the room volume used in the calculation is consistent with the space where the sound fields were measured. Since there is a tendency to overestimate the ATL, an alternate procedure would be to compute the ATL twice – first using measurements made in the principal volume, and second using measurements in the combined volumes – and take the lower of the two values. For rooms typical of most apartments (volume 35-50 m^3 and reverberation times 0.4 – 1.0 s), this small systematic study has shown the E336 criterion is not optimal, but is close.

The authors wish to thank Don MacMillan and Brian Fitzpatrick for their help in this study.

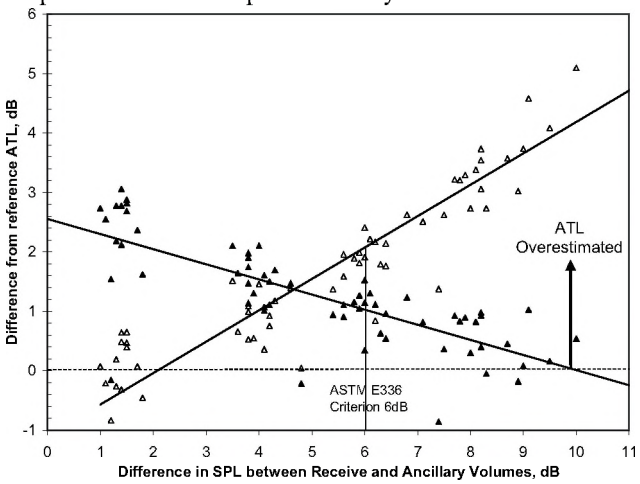

Figure 4: ATL errors when an ancillary volume is coupled to receiving room. Open symbols are estimates obtained from measurements in both the ancillary and receive volumes. Closed symbols are estimates obtained from measurements in the principal receive volume. There is a data point for each one-third octave band in the range 125 – 4kHz.

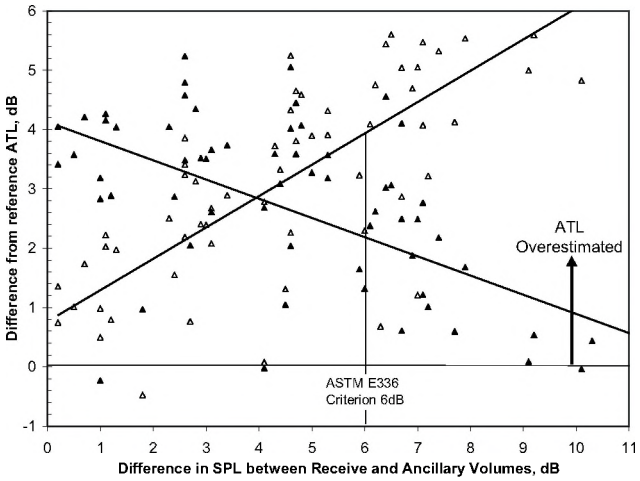

Figure 5: ATL errors when an ancillary volume is coupled to a heavily furnished receiving room. Open symbols are estimates obtained from measurements in both the ancillary and receive volumes. Closed symbols are estimates obtained from measurements in the principal receive volume. There is a data point for each one third octave band in the range 125 – 4k Hz.