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Standardizing the Evaluation of Noise Attenuation (Sound Transmission Class) for Gap Closures to Include Gordon Incorporated Mullion Mate and Window Mate Assemblies

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Purpose

The purpose of this paper is to articulate the research efforts completed to standardize the evaluation of the sound dampening characteristics of architectural gap closure assemblies similar to the Mullion Mate and Window Mate assemblies manufactured by Gordon, Inc. This standardization provides:

I. End users with a clear idea of what to expect with respect to noise attenuation (Sound Transmission Class) when trying to perform an “in-situ” evaluation of architectural gap closures
II. A standard methodology for comparing Sound Transmission Class performance between other gap closure options.

Background

There is a lack of specific test protocols for the type of architectural gap closures used to block the space between partition walls and window mullions, or partition walls and glass curtain walls. As a result, these assemblies are tested using the "Standard Test Method for Laboratory Measurements of Airborne Sound Transmission Loss of Building Partitions and Elements" described in ASTM E90-09(2016). This method of testing ignores real life configuration of the assemblies. Instead, ASTM E90-09(2016) determines the Sound Transmission Loss through the assembly itself along a test wall with a predetermined area and predetermined construction type for a specific Sound Transmission Class (STC). In real life applications these assemblies are used on a variety of conditions where the wall area and the wall sound absorption properties are unknown. The ASTM E90-09(2016) provides a comparison number between assemblies by itself, but not on the field configurations.

The results obtained by using ASTM E90-09(2016) are the specimen STC and the Composite STC. The specimen STC is the gap closure STC by itself assuming the tested wall STC is much higher than the gap closure STC. The composite STC is calculated using the Transmission Loss (TL) of the test wall, the area of the wall, the area of the gap closure and the TL of the gap closure. The composite STC provides the Sound Transmission Loss on the wall gap closure combination in the lab setting. In actual construction settings, the gap closure STC is as determined in the lab, but modified by the construction of the wall and gap closure end condition. This may differ from the lab setting thereby providing confusing expectations. The composite STC is critical when estimating the sound transmission loss from room to room.

Due to the lack of standardization of test protocols for true field applications, there is no method to compare composite STC results between other gap closure options. The adoption of this standardization evaluation method will provide a methodology to compare such systems.

Methodology

In order to perform an Airborne Sound Transmission Loss of architectural gap closures simulating a true field installed assembly, it is necessary to create a reference system that takes in consideration the following:

- Partition wall areas adjacent to the gap closure
- Boundaries of the gap closure
- Whether it is a window mullion (tube) or a glass pane
- STC of the partition walls
- Ceiling materials
- Any additional element surrounding the gap closure that contributes to the sound propagation or absorption.

In order to achieve a rationalized understanding on how these elements present in the typical room or divided space affect the sound attenuation from room to room, we performed a series of independent lab testing using ASTM E90-09(2016) with distinct setups where the gap closures manufactured by Gordon, Inc., Mullion Mate 30, Window Mate 30, Mullion Mate 40 PLUS and Window Mate 40 PLUS, were tested on walls with different STCs and configurations mimicking true field installation boundaries. By performing these different tests, we are able to correlate results and have an educated approximation of the expected room to room sound attenuation values which will vary due to the influence of the total wall area on the composite STC as well as the influence of the gap closure boundaries.

Procedure for Lab Testing

The purpose of the testing is to determine the STC factors for Gordon, Inc. Mullion Mate and Window Mate products in a simulated real life application. The specimens are to be tested using ASTM E 90-09(2016)/ASTM E413-16 in the stated configurations below. Specimens will be tested using a 35 STC wall and a 65 STC wall.

The following configurations were tested using a 35 STC wall and Gordon Inc.'s Mullion Mate 30 and Window Mate 30:

1. Test the 35 STC wall by itself, to achieve baseline shown in Figure 1.
2. Test the 35 STC wall with the configuration shown in Figure 2, gap closure in direct contact with glass
3. Test the STC 35 wall with the configuration shown in Figure 3, gap closure in direct contact with the window mullion (tube) and the window mullion (tube) in direct contact with glass.

Note: The glass strip to be 0.25 inch thick and extend a minimum of 1" beyond each side of the STC wall. The window mullion (tube) has a wall thickness of 0.125 inches.

Figure 1: Section View of 35 STC Wall

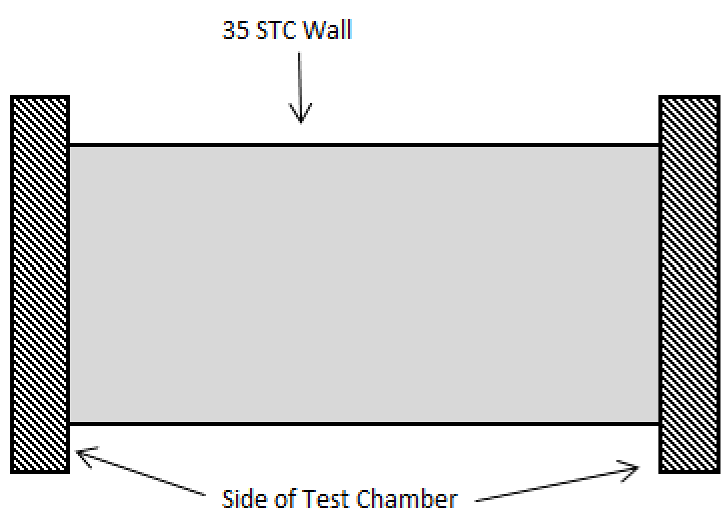


Figure 2: Section View of 35 STC Wall with Glass and Window Mate 30

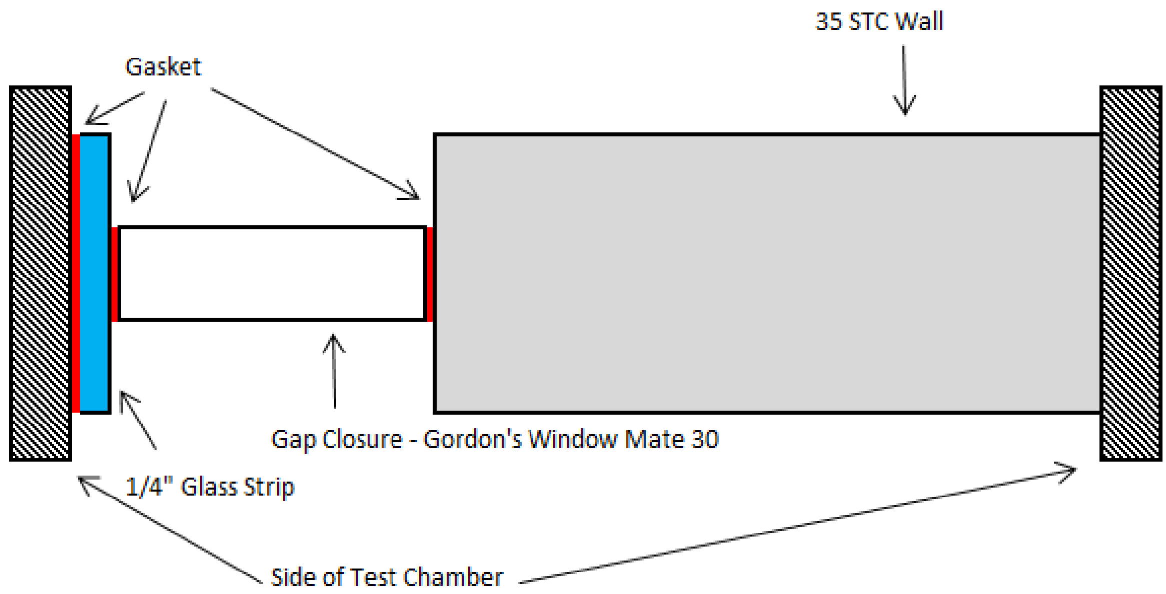
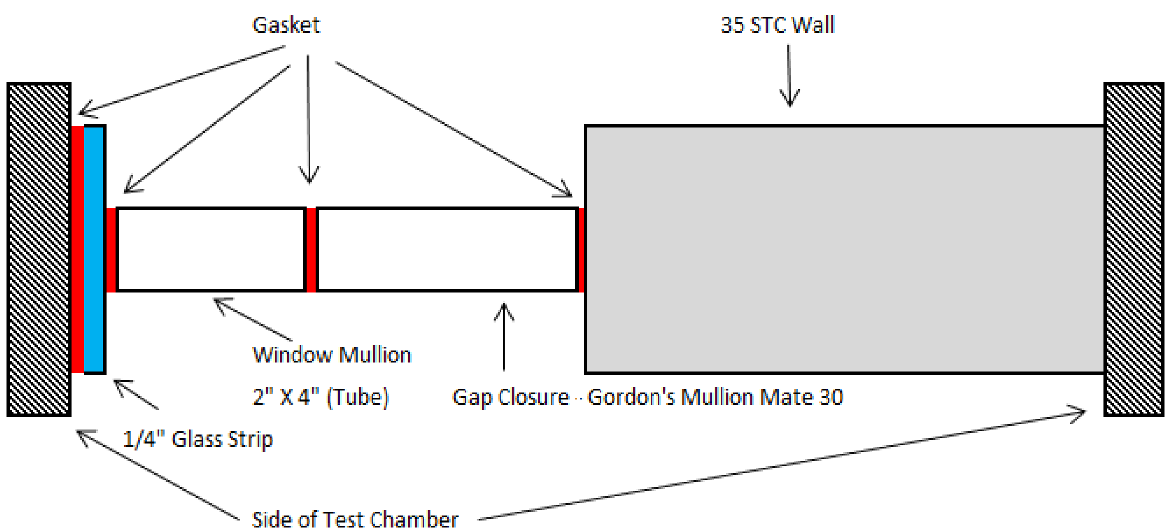


Figure 3: Section View of 35 STC Wall with Glass, Window Mullion, and Mullion Mate 30



On a second round of testing, the process repeats, but using a wall with STC 65 and Gordon Inc.'s Mullion Mate 40 PLUS and Window Mate 40 PLUS:

1. Test the 65 STC wall by itself, to achieve a baseline shown in Figure 4.
2. Test the 65 STC wall with the configuration shown in Figure 5, gap closure in direct contact with glass.
3. Test the STC 65 wall with the configuration shown in Figure 6, gap closure in direct contact with the window mullion (tube) and the window mullion (tube) in direct contact with glass.

Note: The glass strip to be 0.25 inch thick and extend a minimum of 1" beyond each side of the STC wall. The window mullion (tube) has a wall thickness of 0.125 inches.

Figure 4: Section View of 65 STC Wall

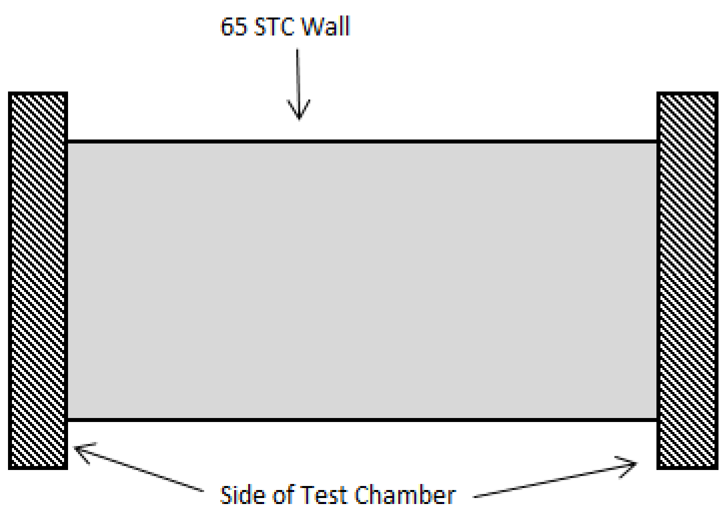


Figure 5: Section View of 65 STC Wall with Glass and Window Mate 40 PLUS

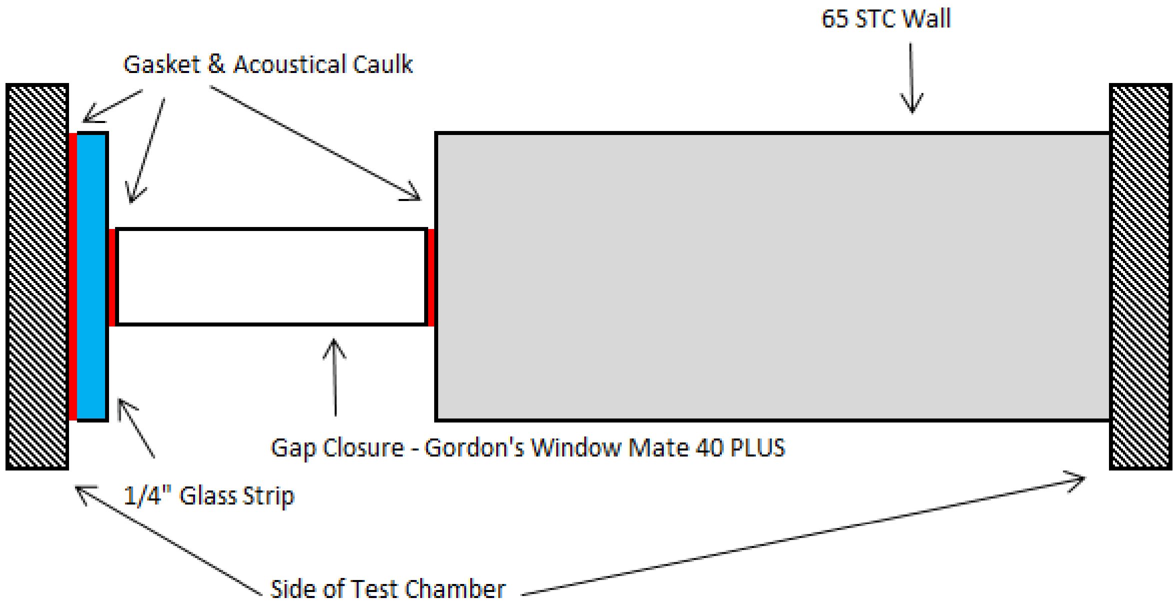


Figure 6: Section View of 65 STC Wall with Glass, Window Mullion, and Mullion Mate 40 PLUS

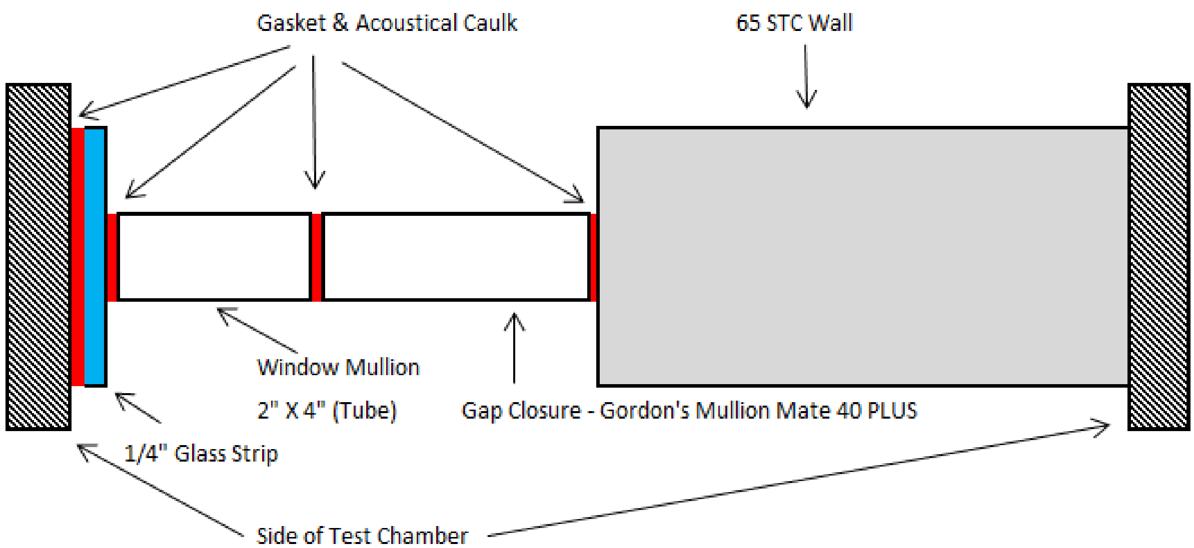
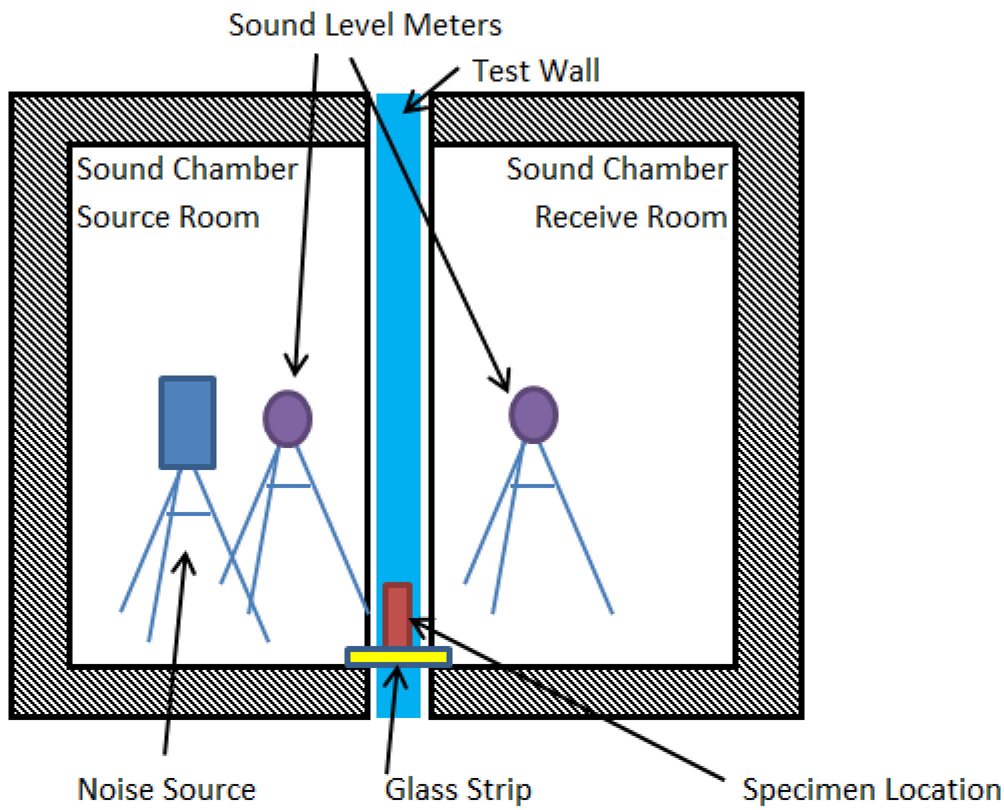


Figure 7 shows how the gap closure was located in relation to the space of the Lab test room/chamber.

Figure 7: Gap Closure Specimen Location



Note: Microphone positions are detailed in Annex A2.2 in ASTM E90-09 (2016).

Results

The Composite STC of each configuration described above was recorded and shown in Tables 1 and 2. The graphical results depicting the Transmission Loss (TL) at each frequency compared to the STC contour is shown in Figures 8-10 and 12-14.

Table 1: Composite STC Results with 35 STC Wall

CONSTRUCTION	COMPOSITE STC
WALL (BASELINE)	36
WALL + Window Mate 30 + GLASS	37
WALL + Mullion Mate 30 + MULLION + GLASS	35

Figure 8: Transmission Loss versus Frequency for 35 STC Wall

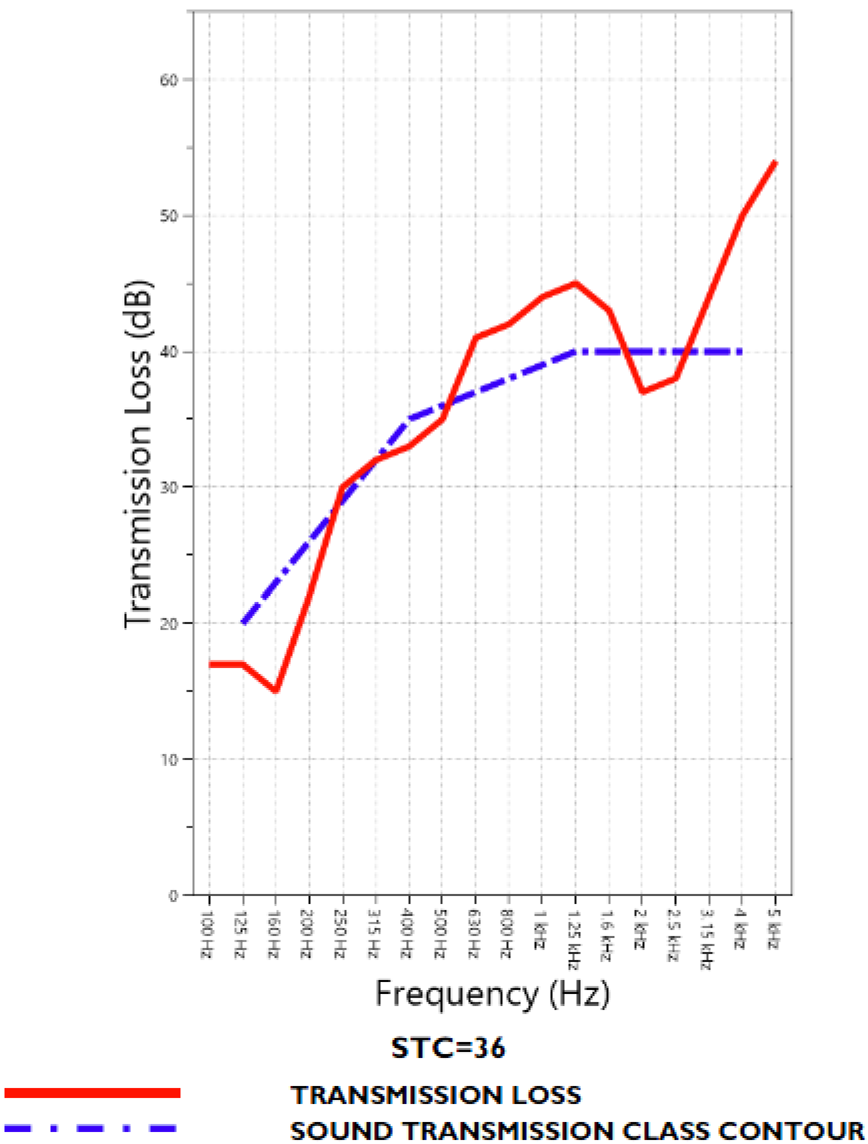


Figure 9: Transmission Loss versus Frequency for 35 STC Wall, Window Mate 30, and Glass

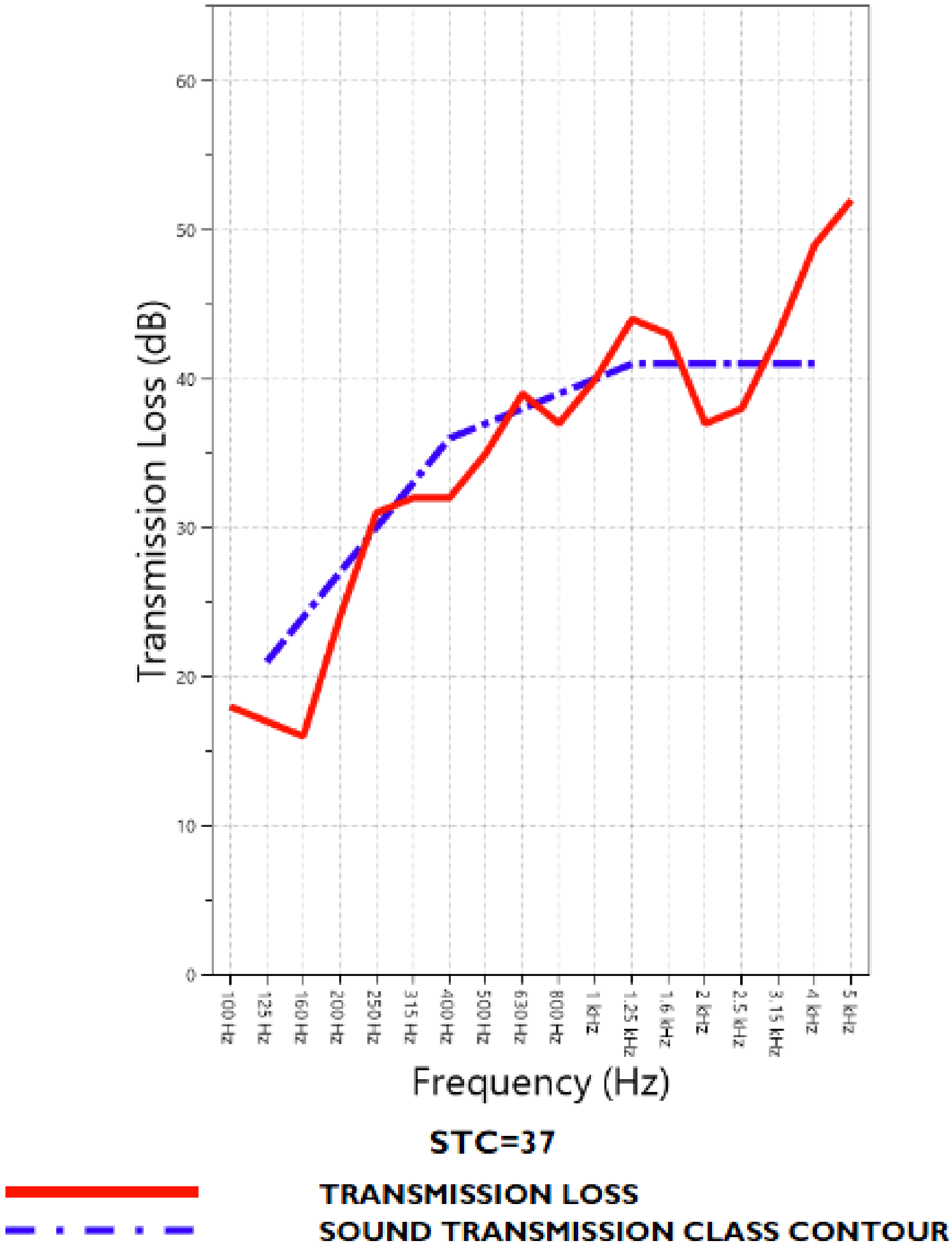
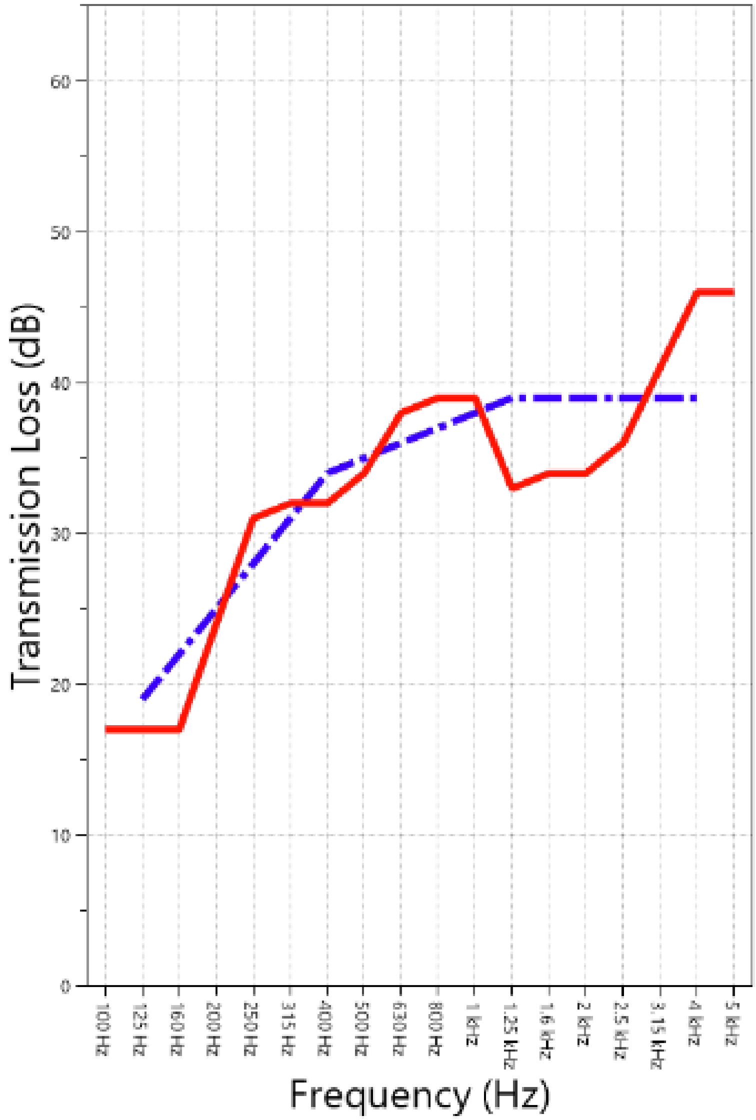


Figure 10: Transmission Loss versus Frequency for 35 STC Wall, Window Mullion (Tube), Mullion Mate 30, and Glass



STC=35

TRANSMISSION LOSS

SOUND TRANSMISSION CLASS CONTOUR

Figure 11 depicts the results of Sound Transmission Loss for the configurations shown in Figures 1, 2 and 3. When the window mullion (tube) is added to the configuration, there is a sharp decrease in Sound Transmission Loss at a frequency of 1250 Hz. This decrease impacts the composite STC negatively.

Figure 11: Performance Comparison of 35 STC Wall; Wall with Glass, and Window Mate 30; Wall with Glass, Window Mullion, and Mullion Mate 30

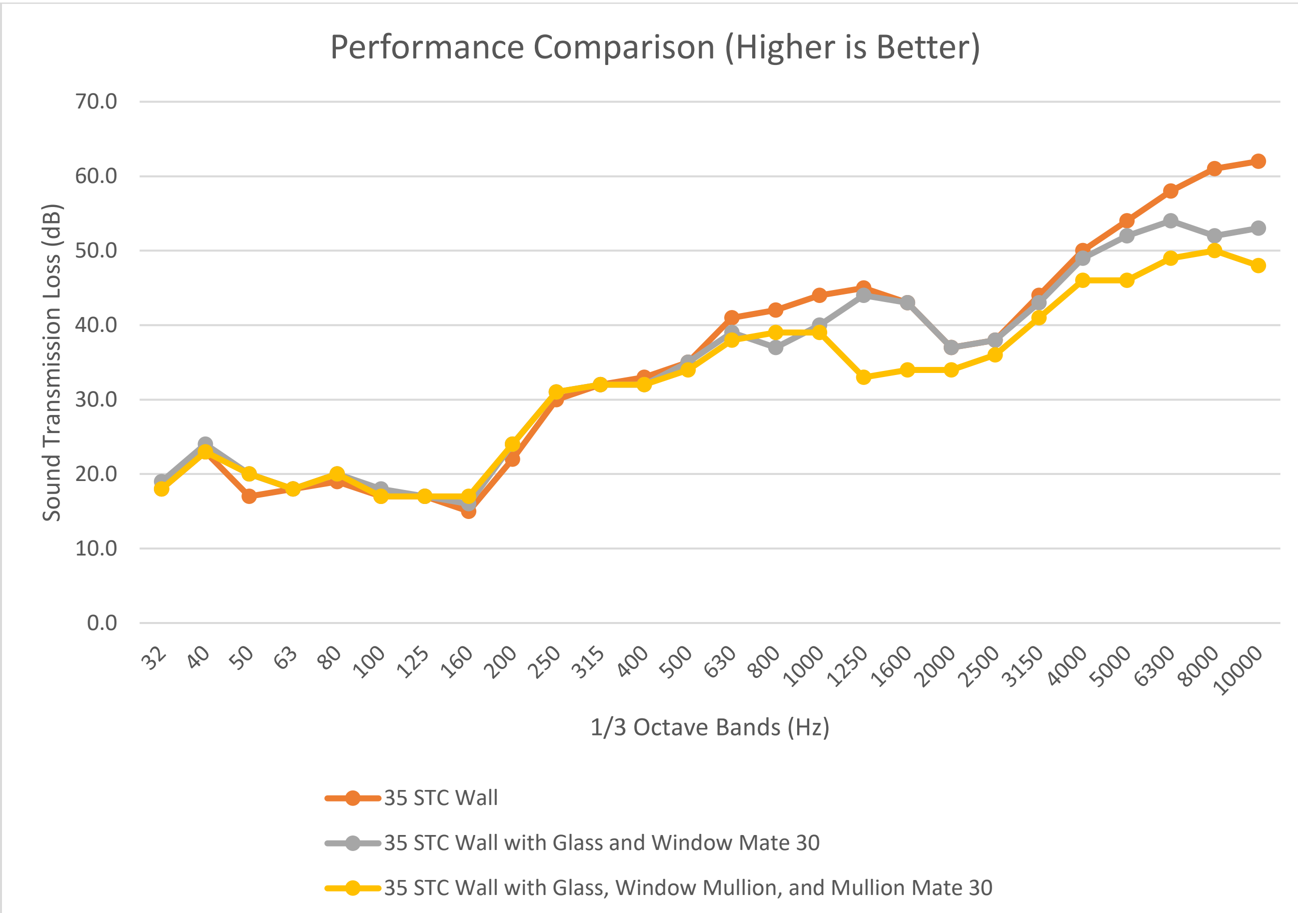


Table 2: Composite STC Results with 65 STC Wall

CONSTRUCTION	COMPOSITE STC
WALL (BASELINE)	66
WALL + Window Mate 40 PLUS + GLASS	56
WALL + Mullion Mate 40 PLUS + MULLION + GLASS	38

Figure 12: Transmission Loss versus Frequency for 65 STC Wall

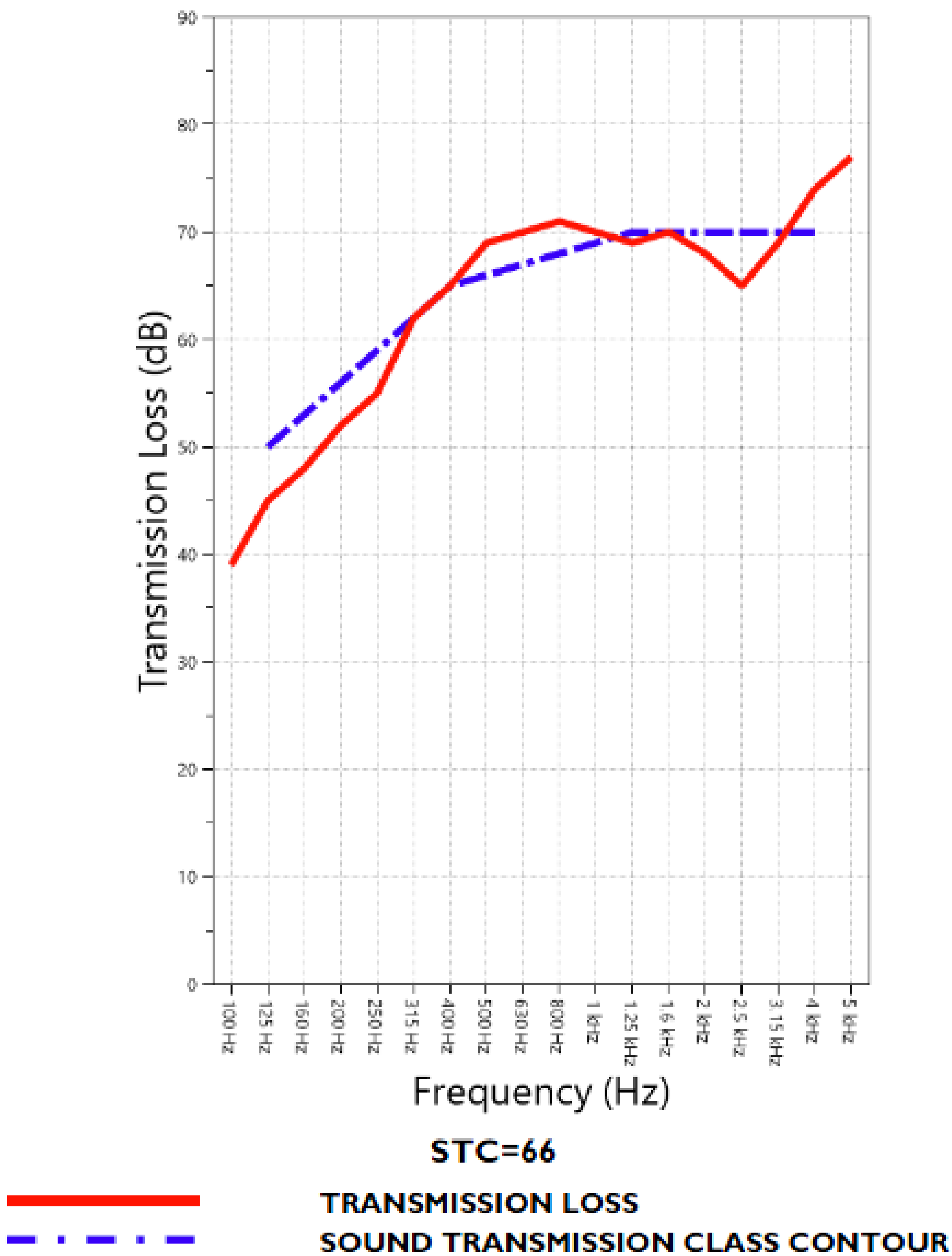


Figure 13: Transmission Loss versus Frequency for 65 STC Wall, Window Mate 40 PLUS, and Glass

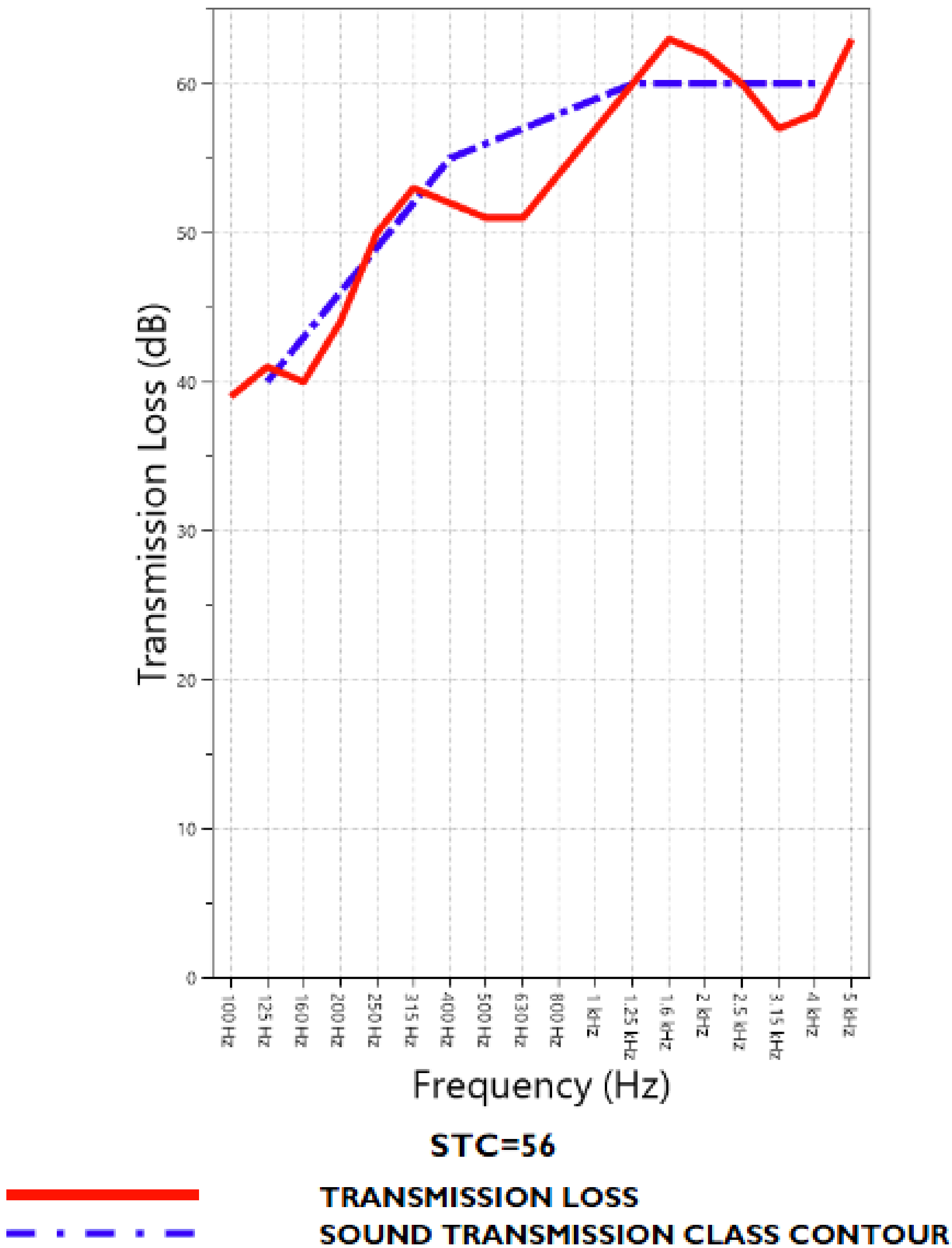


Figure 14: Transmission Loss versus Frequency for 65 STC Wall, Window Mullion (Tube), Mullion Mate 40 PLUS and Glass

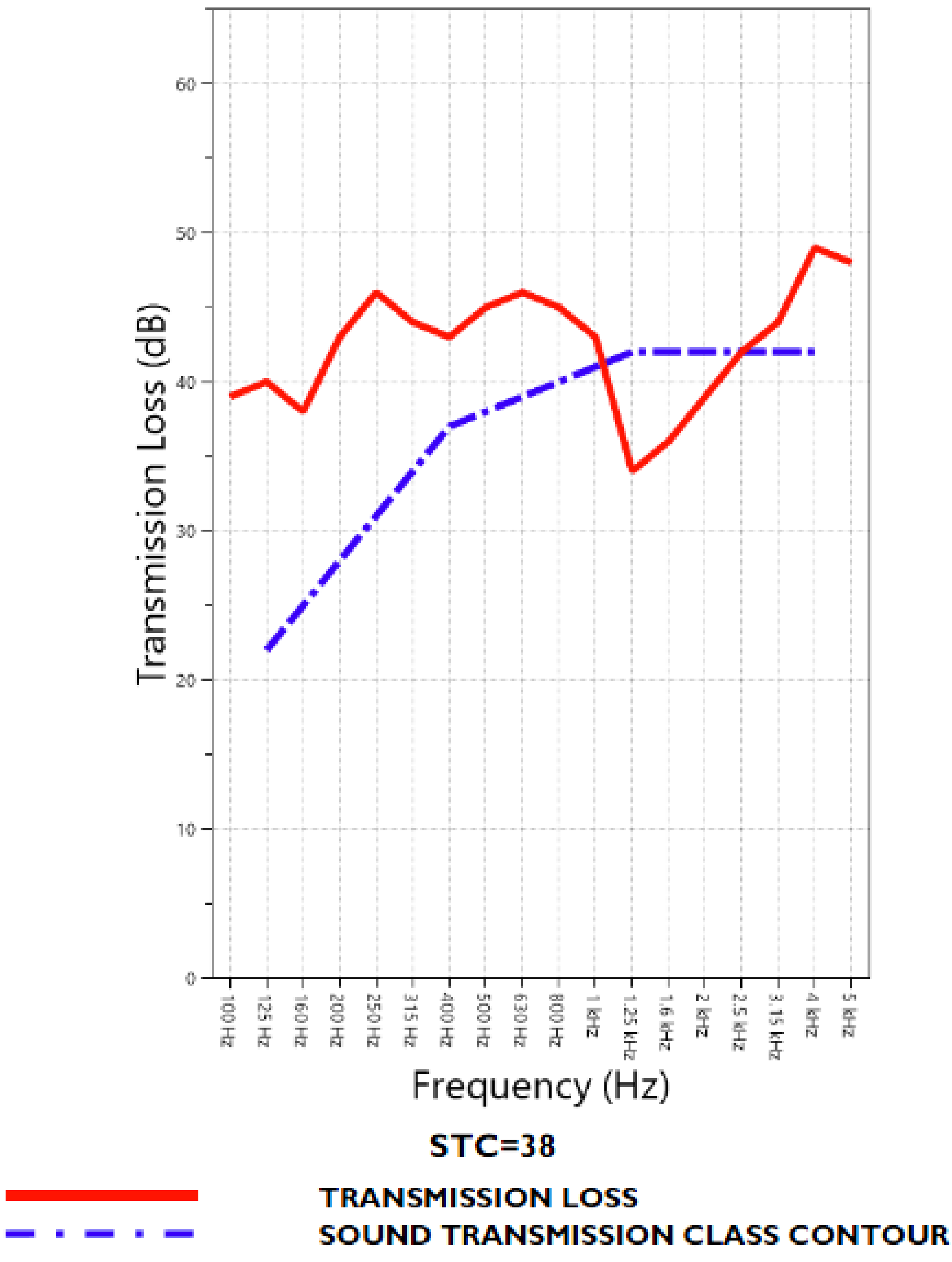
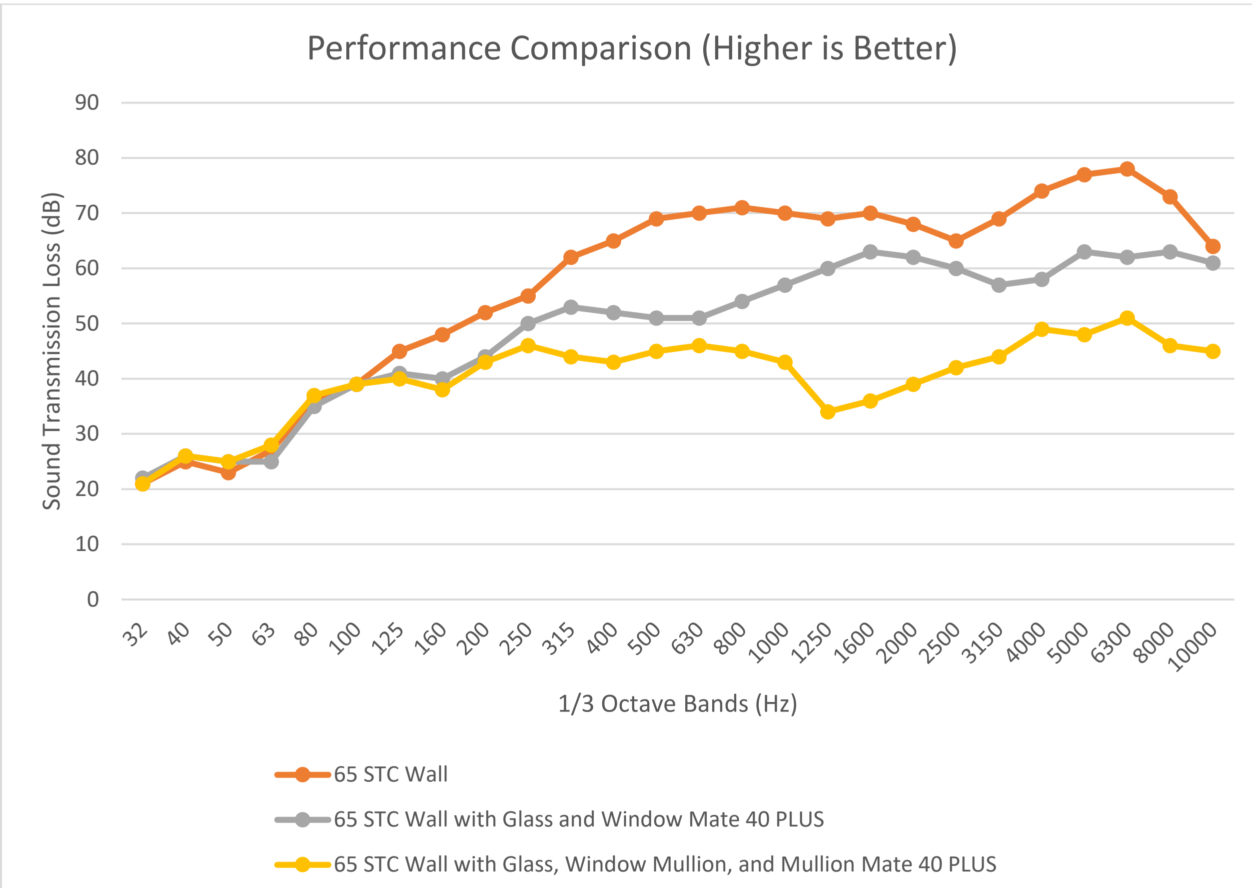


Figure 15 depicts the results of Sound Transmission Loss for the configurations shown in Figures 4, 5 and 6. When the window mullion (tube) is added to the configuration, there is a sharp decrease in Sound Transmission Loss at a frequency of 1250 Hz similar to Figure 11. This decrease impacts the composite STC negatively.

Figure 15: Performance Comparison of 65 STC Wall; Wall with Glass, and Window Mate 40 PLUS; Wall with Glass, Window Mullion, and Mullion Mate 40 PLUS



Conclusions

General:

1. The STC value is a result of a complex set of tests and calculations that take into account the sound transfer dampening of the specimen (test sample) and filler (wall) over a range of frequencies (see Appendix A).

2. Regardless of the wall construction and gap closure, the resulting composite STC is dictated by the weakest barrier of sound attenuation, which in this case, is the window mullion (tube), when present.

3. For the wall and gap closures tested, the STC of the wall dictates the high limit of the composite STC.

Wall-to-Mullion gap closure intersection:

4. Standard STC walls (STC of less than 40) depicted in Figures 1 and 3 (test construction) and Table 1, Figures 8 and 10 (results) will maintain standard STC when matched with standard "Mullion Mate 30" gap closures.

5. High STC walls (STC of 40 and greater) depicted in Figures 4 and 6 (test construction) and Table 2, Figures 12 and 14 (results) must be matched with the high STC "Mullion Mate 40 PLUS" gap closures. A high STC Mullion Mate only benefits where walls are STC 40 and greater.

Wall-to-Glass gap closure intersection:

6. Standard STC walls (STC of less than 40) depicted in Figures 1 and 2 (test construction) and Table 1, Figures 8 and 9 (results) will maintain standard STC when matched with standard "Window Mate 30" gap closures.

7. High STC walls (STC of 40 and greater) depicted in Figures 4 and 5 (test constructions) and Table 2, Figures 12 and 13 (results) must be matched with the high STC "Window Mate 40 PLUS" gap closures. A high STC Window Mate only benefits where walls are STC 40 and greater.

Appendix A: Calculating Composite Transmission Coefficient (TC)

Using Transmission Loss (TL) values at each frequency, the Transmission Coefficient (TC) is calculated with the formula below:

$$TC = 10^{-TL/10}$$

The composite Transmission Coefficient (TC) is calculated using the following formula:

$$Composite\ TC = \frac{(Wall_A)(Wall_{TC}) + (Specimen_A)(Specimen_{TC})}{Wall_A + Specimen_A}$$

Where:

$Wall_A = Area\ of\ the\ Wall\ [sq.ft.]$

$Specimen_A = Area\ of\ Specimen[sq.ft.]$

$Wall_{TC} = Transmission\ Coefficient\ of\ the\ Wall\ (unitless)$

$Specimen_{TC} = Transmission\ Coefficient\ of\ Specimen\ (unitless)$

With a configuration where the boundaries of the gap closure are the ends of the partition wall contacting glass, the specimen in the formula above is the combination of the gap closure and glass.

With a configuration where the boundaries are the end of the partition wall contacting glass and a window mullion, the specimen in the formula above is the combination of the window mullion, gap closure, and glass.

Using these values, the composite STC, as well as the STC for each specimen can be calculated using the techniques described in ASTM E90-09 (2016) and ASTM E413-16.

Bibliography

(1) ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements, ASTM International, West Conshohocken, PA, 2016, www.astm.org

(2) ASTM E413-16, Classification for Rating Sound Insulation, ASTM International, West Conshohocken, PA,