INNOVATIONS FOR LIVING®

EnergyComplete™ Interior Wall Sound Study

Technical Bulletin

Introduction

EnergyComplete's™ combined attribute as an air sealant and compressible foam gasket make it an excellent noise control solution for both interior and exterior wall partitions.* It is the foam's flexible compressibility that give it the important characteristic to not only conform and respond to surface irregularities, but to also seal and isolate the transmission of noise vibrations.

Sound travels a path of least resistance. As a result, there are two fundamental paths for sound or noise to travel:

1. Airborne Sound Noise Path (Sound vibrations that travel via the air)
2. Structure-borne Vibration Noise Path (Sound vibrations that travel via solid materials)

Just as springs help to isolate vibrations, the compressive characteristics of EnergyComplete™ foam reduce the transfer of structural vibrations through wall partitions.

Figure 1 below illustrates how these two fundamental sound paths influence the propagation of noise through an untreated interior wall or partition.

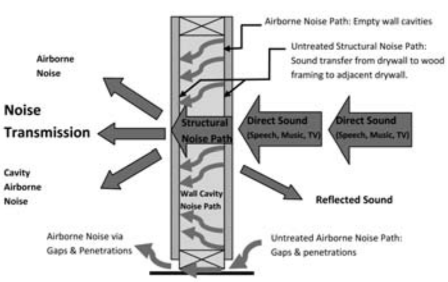

Figure 1. Noise paths through an Untreated wall assembly.

Direct airborne sound, such as speech, music, or television, will strike the surface of a wall (drywall) causing it to vibrate much like the head of a drum. The vibrating drywall in-turn causes airborne sound to fill the wall cavity as well as structure-borne vibrations from the drywall to transfer into the framing members to the adjacent drywall. As a result, both airborne and structure-borne vibrations contribute to setting a wall into motion. In effect, the wall becomes a large oscillating speaker transmitting noise vibration from one side of the wall to the other.

Unsealed air gaps and/or wall penetrations are paths of least resistance for noise to travel and should always be sealed first as part of any noise control strategy. Unsealed air gaps and penetrations can limit or even nullify the costly benefits of other sound control treatments.

Figure 2 below illustrates the effect of treating both airborne and structure-borne sound paths on an interior wall. Sealing air gaps, adding cavity insulation, and isolating structural vibration (between the drywall and framing) exemplify where critical sound path treatments can help control the transmission of noise through walls.

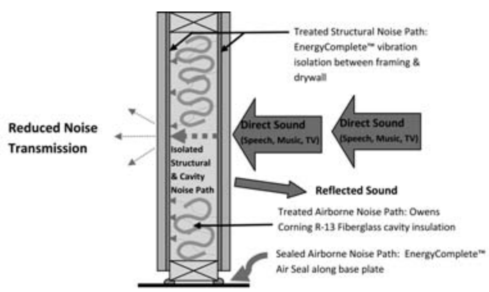

Figure 2. Reduced noise paths through a Treated wall assembly.

Interior Wall Sound Control Study

To understand the influences of noise transfer through interior walls a series of laboratory tests were conducted on identical interior walls treated with & without EnergyComplete™ and fiberglass cavity insulation. Tests were conducted at Owens Corning's NAVLAP certified acoustic laboratory where the sound control study compared 5 interior wall assemblies based on specific noise control treatments.

The base wall assembly was constructed of the following materials and is shown in Figure 3. All test specimen wall assemblies measured 12' long x 8' high.

i. One layer 5/8" thick, Type X, Drywall
ii. 2x4 wood studs, 16" on center, with double top plates and single bottom plate
iii. One layer 5/8" thick, Type X, Drywall
iv. Note: To exemplify the effect of small gaps or penetration openings commonly found in interior walls, a 1/8" open gap along length of wall at the base plate was introduced.

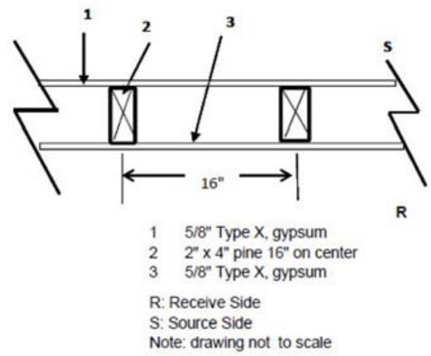

Figure 3: Base Untreated Interior Wall Assembly

The five (5) wall conditions tested were as follows:

1. **WALL #1:** Base Wall: Conventional 2x4 interior wall, unsealed 1/8" gap at base plate, no cavity insulation.
2. **WALL #2:** Conventional 2x4 interior wall, unsealed 1/8" gap at base plate, R-13 cavity insulation.
3. **WALL #3:** Conventional 2x4 interior wall, sealed 1/8" gap at base plate using EnergyComplete™, no cavity insulation.
4. **WALL #4:** Conventional 2x4 interior wall, sealed 1/8" gap at base plate using EnergyComplete™, R-13 fiberglass cavity insulation.
5. **WALL #5:** Conventional 2x4 interior wall, sealed 1/8" gap at base plate using EnergyComplete™, R-13 fiberglass cavity insulation, and EnergyComplete™ applied along the face of all vertical and horizontal framing studs, both sides of wall.

STC vs. Average Sound Transmission Loss (Ave TL) Results

All single number condensed sound rating systems have their benefits and weaknesses. It is for this reason that (2) types of sound control ratings, Sound Transmission Class (STC) and Average Transmission Loss (Ave TL) are presented to give the viewer a broad and balanced perspective of how wall assemblies compare and perform.

The Sound Transmission Class or STC of a partition is a single number rating based on laboratory sound transmission loss (TL) measurements per ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements. The single number STC rating is calculated from the transmission loss (TL) data (measured in decibels over 1/3 centered frequency bands from 125 thru 4000 hertz) per ASTM E413, "Classification for Rating Sound Insulation".

The Average Transmission Loss Rating (Ave TL) is based on the arithmetic average of the transmission loss data taken from ASTM E-90 test results and is focused on those "speech" frequencies most sensitive to the human ear between 160 and 4000 Hertz. Loudness studies indicate that for every 10 dB change in sound level the human ear perceives a 50% change in sound intensity.[1] A three (3) dB change in sound level is considered the threshold at which the human ear perceives a change in sound level and is equivalent to an approximate 15% change in the perceived sound intensity. For this reason that Ave TL is used to compare average decibel (dB) results for each wall with their perceived noise level.

Figure 4 illustrates the STC and Average TL performance ratings for each of the five (5) interior 2x4 wall conditions tested.

Importance of Air Sealing Gaps & Penetrations

As noted earlier, one of the most important first steps in controlling the intrusion of airborne noise through walls is making sure air gaps and penetrations are air sealed. In Figure 4, WALL #1, the untreated 2x4 wall with a 1/8" air gap at its base achieved a STC and Average TL rating of 28. Like most interior walls with unsealed electrical boxes and/or unsealed bottom plates this rating falls well within the typical performance range (high 20's) for this type of unsealed, untreated interior wall construction. At this performance level normal speech is easily heard through walls.

We can also see from Figure 4, WALL #3, that sealing the 1/8" air gap at its base with EnergyComplete™ significantly improved the overall noise control performance of the wall from STC/Ave TL-28 (WALL #1) to STC-35 and Ave TL-36, a substantial 8 dB (Ave TL) reduction in noise level by sealing the air gap at the base plate alone. An 8 dB decrease in noise level is considered clearly noticeable to the human ear and is equivalent to a 40% reduction in the perceived noise level.

Importance of Cavity Insulation with Air Sealing

Effective noise control requires a "Systems Approach" to significantly reduce the transfer of noise through walls. Adding cavity insulation is one of the most efficient and cost effective means to achieve this. However, installing cavity insulation in walls or ceilings without sealing open air gaps or penetrations can limit the beneficial attributes of the insulation. As seen in Figure 4, WALL #2, installing cavity insulation without first sealing air gaps and penetrations can compromise both the STC and the Ave TL performance ratings. An improvement of only 2 STC points and an Ave TL improvement of only 3 dB was achieved as compared to the untreated Wall #1 assembly. Remember, a 3 dB change is considered barely perceptible.

However, after the 1/8" air gap was sealed using EnergyComplete™ and R-13 cavity insulation installed, as shown in Figure 4, WALL #4, a significant improvement of 11 STC points and 13 Ave TL dB was achieved as compared to that of the untreated WALL #1. A 13 dB noise level reduction is equivalent to an impressive 58% reduction in the perceived noise level, 7 dB from properly sealing the wall for air leakage and an additional 5 dB from adding cavity insulation.

Importance of Vibration Isolation, Cavity Insulation, and Air Sealing

The noise control test results (Figure 4, WALL #1-#4) discussed thus far has focused on the treatment of airborne sound paths through walls via air gaps and/or the wall cavity. To

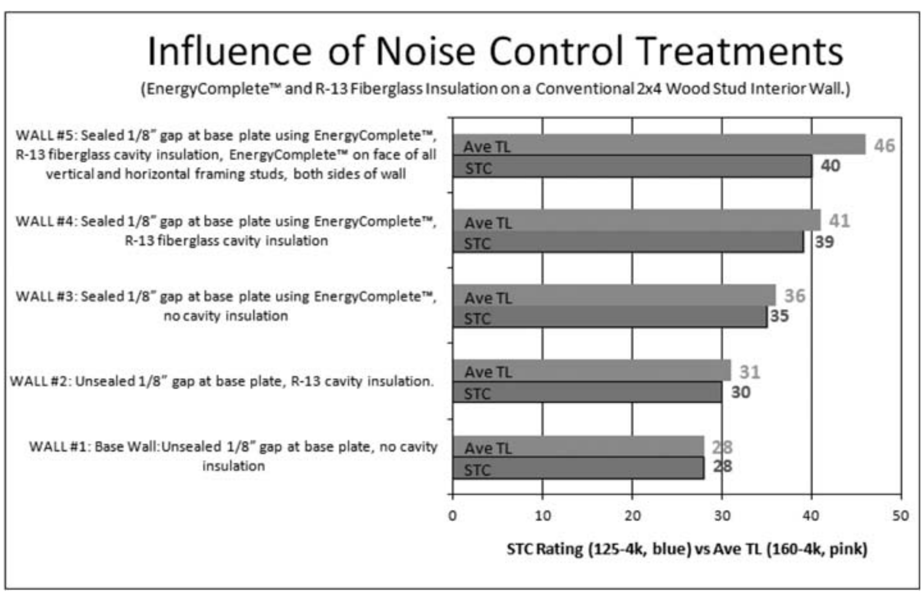

Figure 4: Influence of Noise Control Treatments

1 The percentage noise reduction is determined by correlating differences in sound levels to the ear's ability to perceive noise reduction across speech frequency bands as measured from acoustic industry standard human listening studies.

further improve the noise control characteristics of a partition, it is necessary to reduce the transfer of structure-borne vibrations primarily occurring between the drywall and partition framing.

Because EnergyComplete™ is a flexible and compressible seal gasket technology, it has the unique characteristic to act as a vibration isolator. Structure-borne vibrations can be reduced by the application of EnergyComplete™ along the face of the wood framing members. The flexible seal acts like a spring to reduce or "damp" the transfer of vibrations between the drywall and structural framing.

WALL #5 of Figure 4 illustrates the additional noise control improvements achieved from applying a 3/8" bead of EnergyComplete™ along both faces of the 2x4 wood framing members. Note that the STC performance only changes by 1 STC point, as compared to WALL #4, while the Ave TL rating gains a full 5 dB. The variation between these two rating systems is primarily due to how each rating system is calculated. STC ratings can prematurely be held down based on how the TL measured results are distributed relative to the "STC Contour". Once the movement of the STC rating becomes limited (often due to what is called "the 8 dB rule") the STC rating takes little consideration of other TL contributions of potentially beneficial frequency bands. As a result the STC rating can at times become difficult to estimate relative perceived noise level changes based on its single number rating. In contrast, the Ave TL rating takes into account the dB contribution across the human ear's most sensitive hearing range (speech frequencies from 160 thru 4000 hertz). As a result, the difference in Ave TL (dB) ratings between walls is equally reflected by the average TL across the noted frequency range.

In WALL #5, a change of 5 dB in the Ave TL rating as compared to WALL #4 is considered "clearly noticeable" to the human ear. A total Ave TL reduction of 18 dB is shown between the untreated WALL #1 and fully treated EnergyComplete™ and insulated noise control WALL #5. An 18 dB noise reduction is equivalent to a significant 70% reduction in the perceived noise level between walls. Looking closer we notice that when applying EnergyComplete™ (over framing members) with cavity insulation to a pre-sealed wall (WALL #3, Base Ref), that a full 10 dB reduction in noise level is available, equivalent to a 50% reduction in the perceived noise level. (See Table 1)

When compared to other noise control treatments, EnergyComplete™, as applied as a compressible bead over the face of framing members, is a low cost solution that minimizes impact to changes in wall thickness. As a result, door jambs typically do not require depth revisions.

Conclusion

A series of five (5) identical 2x4 interior wall assemblies were constructed and laboratory tested in accordance with ASTM E-90 guidelines to determine the noise control contribution of EnergyComplete™ and Owens Corning R-13 fiberglass cavity insulation. Both airborne and structure-borne sound paths were investigated with an emphasis on the noise control contribution from various product applications via the two fundamental sound paths.

Sound Transmission Class (STC) and Ave Transmission Loss (Ave TL) ratings were presented to give the viewer a broad and balanced perspective of how single number noise control ratings can influence the review of transmission loss (TL) data between partitions. Ave TL ratings evaluate the average transmission loss (TL) data across those (speech) frequencies (160 – 4000 Hz) most sensitive to the human ear. As a result, the Ave TL provided a closer

Table 1 below compares STC and Ave TL results for the five (5) interior 2x4 wall conditions tested.

Interior Wall Assembly Description	STC (125-4000 Hz)	Ave TL (160-4000 Hz)	Ave TL Improvement As compared to Base Wall #1 (dB)	% Perceived Noise Reduction As Compared to Base Wall #1 (Based on Ave TL)	Ave TL Improvement from EnergyComplete™ applied over framing members & R-13 cavity insulation (dB)	% Perceived Noise Reduction from EnergyComplete™ applied over framing members & R-13 cavity insulation (Based on Ave TL)
WALL #5: Sealed 1/8" gap w/ EnergyComplete™, R-13 cavity insulation, EnergyComplete™ on face of studs (both sides)	40	46	18	70%	10	50%
WALL #4: Sealed 1/8" gap w/ EnergyComplete™, R-13 cavity insulation	39	41	13	58%		
WALL #3: Sealed 1/8" gap w/ EnergyComplete™ only, no cavity insulation	35	36	8	40%	Base Ref	Base Ref
WALL #2: Sealed 1/8" gap at base plate, R-13 cavity insulation only	30	31	3	15%	—	—
WALL #1: UNTREATED BASE 2 x 4 WALL: 1/8" gap at base plate, no cavity fill	28	28	Base Ref	Base Ref	—	—

Table 1: STC and Ave TL results for the five (5) interior 2x4 wall conditions

approximation to how the human ear perceives broad band decibel changes/ reductions between wall constructions.

The importance of sealing interior wall gaps and penetrations using EnergyComplete™ cannot be over stated. Sealing a 1/8" base plate gap along the length of the test wall (WALL #3, Table 1) resulted in an Ave TL increase of 8 dB as compared to unsealed WALL #1; a 40% reduction in the perceived noise level.

Adding R-13 fiberglass cavity insulation to a sealed interior wall using EnergyComplete™ continued to improve the noise control characteristics of the wall by an additional 5 dB (considered clearly noticeable to the human ear) for a total Ave TL increase of 13 dB as compared to the untreated WALL #1. A 13 dB reduction is equivalent to a 58% reduction in the perceived noise level between walls.

Note. Installing cavity insulation without sealing air gaps or penetrations can detrimentally limit the beneficial attributes of cavity insulation. As indicated in Table 1, WALL #2, adding cavity insulation <u>without</u> sealing gaps limited the walls noise control improvement to only 3 dB (barely perceptible). Adding other noise control treatments to partition walls without first sealing all air gaps and penetrations can be costly and nullify the benefits of noise control treatments. Always make sure walls are air sealed.

EnergyComplete™ has the unique feature of being an excellent air seal and vibration isolator. Its flexible and compressible gasket allows it to act much like a spring to reduce the transfer of structure-borne vibrations through walls.

Table 1, WALL #5 shows the noise isolation benefit of adding EnergyComplete™ to the face of the framing members. An Ave TL increase of 5 dB resulted and is considered clearly noticeable as compared to the untreated framing WALL #4. A total Ave TL improvement of 18 dB was achieved as compared to untreated WALL #1 and equates to a 70% reduction in the perceived noise level.

WALL #5 also shows that when EnergyComplete™ and cavity insulation are applied to a "sealed" interior wall assembly (WALL #4) a 10 dB or 50% perceived noise reduction resulted.

Figure 5 below shows the sequential transmission loss (TL) curves as they relate to adding EnergyComplete™ and Owens Corning cavity insulation to interior WALLS #1, #3, #4, and #5. As is evident, the light gray section notes the significant (8 dB) benefits of sealing air gaps, the medium gray area reveals the benefits (5 dB) of adding fiberglass cavity insulation to wall cavities, and the dark gray section illustrates the benefits (5 dB) of adding EnergyComplete™ as a vibration isolator between the drywall and framing members. Together the Ave TL across speech frequencies (160-4000 hertz) achieved a dB reduction as much as 18 decibels. If the wall were pre-sealed for air/noise leakage the benefits of adding cavity insulation and EnergyComplete™ as a vibration isolator alone reduces noise levels by an impressive 10 dB. (Half the perceived noise level).

In conclusion, certified acoustic laboratory test results show that EnergyComplete™ and Owens Corning fiberglass cavity insulation can be an effective noise control solution to reduce the transmission of both airborne and structure-borne noise through wall partitions. Test results indicate that when used as both a sealant for air gaps and penetrations, and as a vibration isolator EnergyComplete™ combined with R-13 fiberglass cavity insulation can reduce sound transmission through interior walls by as much as 18 dB, equivalent to a 70% reduction in the perceived noise level.

* See Owens Corning EnergyComplete™ Technical Bulletin, Sound Control, "A Comparative Exterior Wall Sound Control Laboratory Study", Pub # 10011540

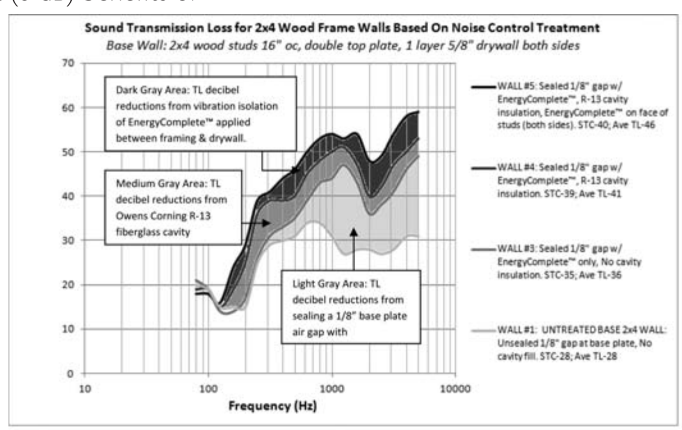

Figure 5: Sound Transmission Loss Curves for WALLS #1, #3, #4, and #5

OWENS CORNING
INNOVATIONS FOR LIVING®

OWENS CORNING INSULATING SYSTEMS, LLC
ONE OWENS CORNING PARKWAY
TOLEDO, OHIO 43659
1-800-GET-PINK®
www.owenscorning.com

Pub. No. 10017981. Printed in U.S.A. September 2012.