Acoustical Insulation Density and its role in Acoustical Performance

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Sound control has become a significant issue in our society. Noise impacts how efficient we are in everyday activities at work and home. Article after article mentions the effects of noise pollution and privacy. Efficiency, health, safety and comfort all are impacted by the level of noise we are exposed to every day. Noise in our businesses (conversations, telephones, business machines etc.) distracts from our work and makes us less productive. Hearing losses from noise exposure is a very serious health hazard that is preventable. Just the basic headache from noise exposure has a major impact on health and productivity. Far more serious are accidents due to hearing loss.

Keeping people comfortable in the workplace, public places or home is critically important. Just like heating and air conditioning, comfort from noise is essential to a good environment. Noisy areas can cause occupants to feel irritable, distracted, anxious, hostile and annoyed without realizing that the noise is the contributing factor.

Thermafiber and USG have been involved in controlling undesirable noise for years and began publishing papers on sound control as early as 1985 when noise pollution was not a commonly recognized household issue. Gypsum board partition systems are partially important to controlling the acoustical performance in a project. However many other factors influence the gypsum board partitions acoustical performance: air cavities, resilient members, sealant details and various types of acoustical insulation are some of the variables that have significant effect.

It is well documented that acoustical insulation can dramatically improve the Sound Transmission Class (STC) rating of partitions. STC ratings also increase with thicker acoustical insulation. The following basic rules of thumb apply when acoustical insulation is used in a partition cavity: A) Insulating in wood framed walls, will increase STC ratings by 2 to 7 points. B) Insulating in metal framed (25 gauge) walls or resiliently isolated partitions will increase STC ratings by 4 to 8 points. [1]

However: To achieve the most sound control from a wall assembly, it is important to consider the best acoustical insulation for the application.

In 1985, Thermafiber/USG conducted extensive research into acoustical insulation and one of the important factors – ACOUSTICAL INSULATION DENSITY - to determine the optimum density for Thermafiber Sound Attenuation Fire Blankets (SAFB). [2] Over the years, there has been a lot of discussion over acoustical density and the role it plays in Transmission Loss (TL). Looking at the facts, there is no reason to question that heaver density mineral wool insulation provides the optium sound performance in drywall partitions. Even when the STC value is identical for both mineral wool and glass fiber insulation, consider the actual octave band frequencies of the sound that is to be controlled.

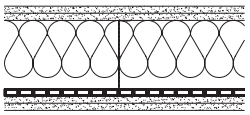
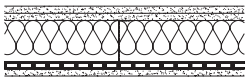
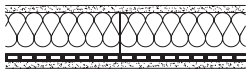
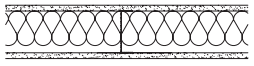
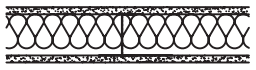
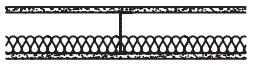
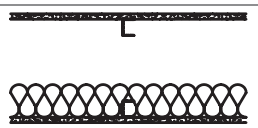
Thermafiber/USG research tests included evaluations of Thermafiber Mineral Wool Insulation from 2 lbs/cu.ft. to 12 lbs/cu.ft. and thickness from 1" to 12". Since Thermafiber Insulation is not manufactured in densities less than 2.0 lbs/cu.ft., glass fiber insulation was used in the evaluation for lower densities at 0.7 and 0.8 lbs/cu/ft. USG Research conducted the tests with a variety of partition designs. The results: Thermafiber mineral wool insulation in the 2.5 to 3.0 lbs/cu.ft. density range proved the best overall acoustical performance. Densities above the 3 lbs/cu.ft. provided improved sound attenuation at high frequencies, but the low-frequency performance starts to suffer at higher densities. Acoustical performance at mid and high frequency goes down significantly as insulation density falls below 2.5 lbs/cu.ft. Table 1 demonstrates the advantages of using Thermafiber SAFB's vs. glass fiber over a cross section of partitions.

Drywall partitions with Thermafiber SAFB's in the partition cavity consistently outperformed those that include glass fiber insulation with densities less than 2.5 lbs./cu.ft. In fact, tests conducted at Riverbank Acoustical Laboratories showed that partitions with Thermafiber SAFB's can provide STC ratings up to 4 points higher than those in which low density glass fiber ½" to 1" thicker is used. The acoustical benefits of cavity insulation as well as the effects of insulation density vary with frequency, the basic partition design and the insulation thickness. The effect of insulation density on acoustical performance must be determined for each partition.

The importance of noise comfort is essential to a good environment in places such as schools, hospitals, and offices.

Graph 1

Sound isolation advantage in decibels (dB) of 2.5 to 3.0 lb./cu.ft. Thermafiber Sound Attenuation Fire Blankets (SAFB) over 0.7 to 0.8 lb./cu.ft. glass fiber insulation (GF) in gypsum board (GB) partitions

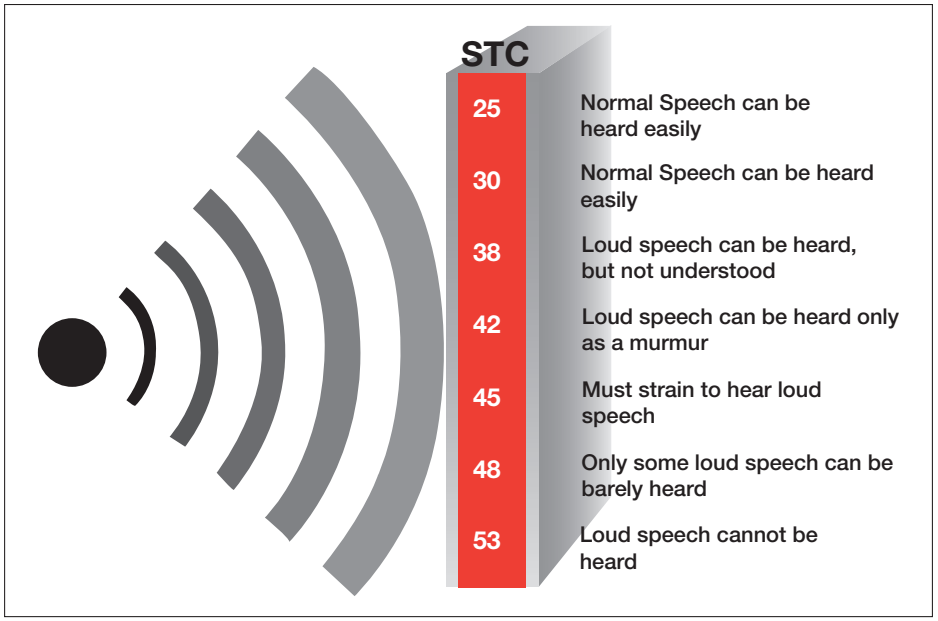
Partition Design (Insulation density only variable in each test)	Octave band center frequencies in Hz*						STC Improvement
	125	250	500	1000	2000	4000	
1. SAFB - 5-in. GF - 6-in. GB - 5/8 in. 	**dB** 1.0	**dB** 1.8	**dB** 2.9	**dB** 1.0	**dB** 6.2	**dB** 4.6	4
2. SAFB - 3-in. GF - 3-1/2-in. GB - 5/8-in. 	-0.6	1.3	1.3	0.4	3.8	2.3	2
3. SAFB - 3-in. GF - 3-1/2-in. GB - 5/8-in. 	-0.6	0.4	1.8	0.6	3.3	2.9	2
4. SAFB - 3-in. GF - 3-in. GB - 1/2-in. 	0.5	2.6	1.0	1.3	3.1	2.6	2
5. SAFB - 3-in. GF - 3-1/2-in. GB - 5/8-in. 	0.1	0.2	1.2	0	1.6	2.6	2
6. SAFB - 1-1/2 in. GF - 1-1/2-in. GB - 1/2-in. 	-0.5	2.0	1.8	2.4	3.0	2.0	0
7. SAFB - 3-in. GF - 3-1/2-in. GB - 5/8-in. 	2.5	2.7	2.4	4.4	5.2	3.0	3

*Octave band data is derived from 1/3-octave band data reported to nearest decibel. Conversion from 1/3-octaves to octaves is rounded to nearest 0.1 decibel. Test Reference Numbers:
1. RAL-TL84-139/TL83-230 2. RAL-TL84-147/TL84-144 3. RAL-TL84-148/TL84-145 4. USG 71508/71405 5. USG 830507/830509 6. USG 71413/71404 7. USG 830436/830501

Graph 1 shows the improvement in performance attributed to the density of the cavity insulation. Thermafiber SAFB's consistently provide higher sound isolation than low density glass fiber insulation over the entire 250 – 4000 Hz octave being fairly typical.

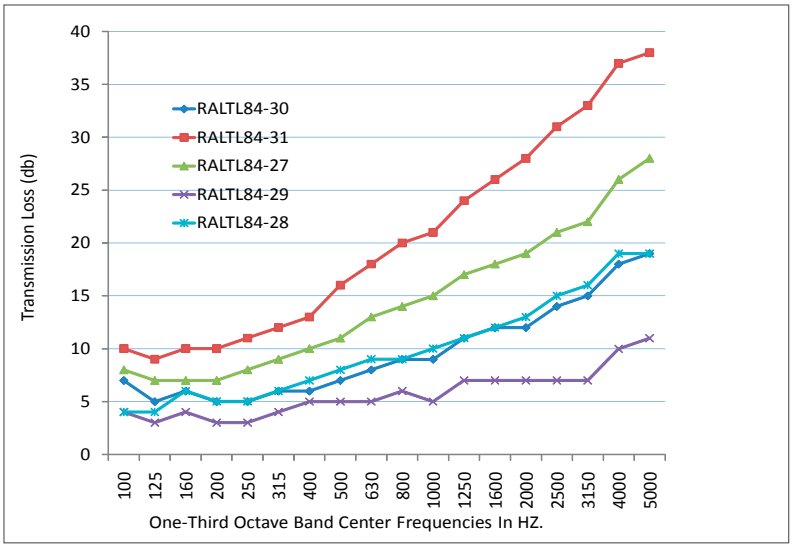
A significant advantage is made by adding higher density insulation in addition to the improvements that can be achieved with other sound improving methods such as resilient channels, air space depth, or additional layers of wall board.

This graphic displays the relationship between the STC Rating of a wall assembly and the resulting audible acoustic performance.



Graph 2 – shows that sound transmission loss through acoustical insulation increases significantly as density increases. Low density glass fiber must be nearly twice as thick as the standard Thermafiber SAFB's to provide the same attenuation (Ref. Curves 3 & 4). Using the higher density SAFB's helps minimizing the negative effects of sound leaks such as those found with electrical outlets.

Graph 2 – Effect of acoustical insulation thickness and density on sound transmission loss.



1) 4.3 pcf Thermafiber SAFB @ 5.5" Special Density – RAL-TL84-31
2) 2.8 pcf Thermafiber SAFB @ 6.0" Standard Density – RAL-TL84-27
3) 0.7 pcf Glass Fiber @ 6.0" – RAL-TL84-28
4) 2.8 pcf Thermafiber SAFB @ 3.0" Standard Density – RAL-TL84-30
5) 3.5 pcf Glass Fiber @ 3.5" – RAL-TL84-29

Summary:

Drywall partition systems with acoustical insulation in the 2.5 to 4 lbs./cu.ft. density range consistently out performs those with low density glass fiber.

If Thermafiber SAFB's are substituted in a partition tested with commonly used 0.7 to 0.8 lbs./cu.ft. glass fiber insulation, the sound transmission loss (STC) will always be superior or at least equal to the tested partition.

Consequently it cannot be assumed that a low density fiberglass can be substituted for Thermafiber SAFB's in a related partition without significantly reducing the acoustic or FIRE performance of the wall assembly.

Thermafiber SAFB's also have added advantages beyond sound:

1) Higher melt point than glass fiber
2) Superior Fire Resilience
3) Recycled Content up to 90%
4) Improved energy efficiency through high R value/inch.
5) Contributes to 33 LEED credits across 4 categories.

Thermafiber Inc. manufactures Sound Attenuation Fire Blankets (SAFB's) with a nominal density of 2.5lbs/cu.ft. based on the acoustic research, fire performance, handling characteristics, cost-to-performance ratio and percent recycled content.

References:

1) "STC Ratings for Various Wall Assemblies". STCratings.com <www.stcratings.com>
2) Warnock, A.C.C. & Quirt, J.D. "Control of Sound Transmission through Gypsum Board Walls". National Research Council Canada 1997:
3) "Sound Transmission Class". Wikipedia.com <www.wikipedia.com>
4) Shiner, Allen . "Sound Control Construction". USG Form & Function 1995:
5) Shiner, Allen . "How to Avoid Flanking Sound in your Acoustical Design". USG Form & Function 1993:
6) Roller , Stan. "Stereo TV a New Challenge in Hotel Sound Isolation". USG Form & Function 1988:
7) Roller , Stan & Waropay, Vincent. "Design Aid for Office Acoustics". USG Form & Function 1986:
8) Research Evaluates Role of Density in Acoustical Insulation Performance – H. Stanley Roller Architectural Construction Manager, Acoustics, United States Gypsum Co. 1985