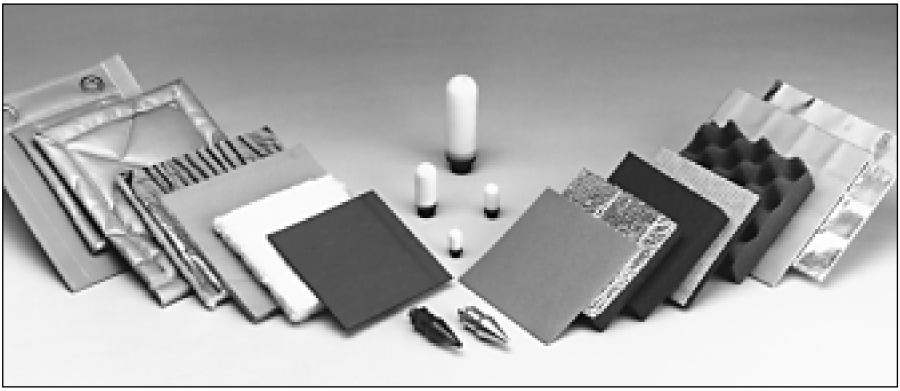
Technical Section: Noise Control Products



A noise control solution can be accomplished by blocking the noise, absorbing it, damping the noise or isolating the noise source. Most often the solution will involve several of these choices.

Barriers

Barriers are just what the name implies, something that blocks, in this case, sound. Barriers can be common building materials such as concrete blocks, bricks, drywall or glass. Most often in the industrial noise control solution the barriers are sheet metal, plywood or loaded vinyl curtains.

The ability of a material to block sound is based on its transmission loss (TL). In Figure 1 you can see not only the transmission loss of various acoustical materials, but also notice that as the frequency and density increase the TL increases. In short, the density of the material being used determines transmission loss. That's why steel is better than plywood.

In addition to transmission loss, the noise reduction coefficient (NRC) and standard transmission classification (STC) adds to the acoustical material's ability to absorb and block sound respectively.

The NRC is a rating given to an acoustical material directly relating to its ability to absorb noise. It is the average sound absorption rating for frequencies between 250 and 2,000 Hz.

The STC is a number used to determine how much noise will get through a material. In a real world situation, the noise reduction of a system will be about one-half to three-fourths of the barrier material's rated STC.

Material	Frequency (Hz) 125	250	500	1000	2000	4000	8000	STC
Lead	**Transmission Loss**							
1⁄32" 2.0 lb./sq. ft.	22	24	29	33	40	43	49	31
1⁄64" 1.0 lb./sq. ft.	19	20	24	27	33	39	43	26
Plywood								
¾" 2.0 lb./sq. ft.	24	22	27	28	25	27	35	25
¼" 0.7 lb./sq. ft.	17	15	20	24	28	27	25	22
Loaded Vinyl Sheet								
0.5 lb./sq. ft.	11	12	15	20	26	32	37	18
1.0 lb./sq. ft.	15	17	21	28	33	37	43	25
18 ga. Steel 2.0 lb./sq. ft.	15	19	31	32	35	48	53	29
16 ga. Steel 2.5 lb./sq. ft.	21	30	34	37	40	47	52	35

Figure 1: Transmission loss (typical) of common acoustical materials in dB

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If air can get into an enclosure, then noise can get out. If you have access into the enclosure, such as a conveyor or parts chute, noise will escape. All of these contribute to the reduced effectiveness of enclosures.

Absorption

Let's assume the size of the enclosure has been determined and all the holes, penetrations and leaks have been identified. How can the noise loss be minimized? By lining the inside of the enclosure with an acoustical absorption material.

Every time two sound waves of equal intensity merge, the result is a 3dB additive effect. See Figure 6. Thus, the noise inside the enclosure is actually higher than it was without anything around it. By placing the absorption material in the enclosure, the bounce around, or reverberant noise, along with direct noise, is absorbed.

Due to the varying lengths of sound waves, absorption coefficients are dependent on the thickness and density of the absorber. The thicker the absorber, the higher the Noise Reduction Coefficients (NRC) and absorption coefficients will be. Figure 2 shows the absorption coefficients of some of the more typically used materials.

The absorption process takes place when soundwave energy is transformed into heat energy. This takes place when the wave has to work its way through all of the pores in foam, or around and through the fibers in fiberglass. For this reason, foams must be open cell, and the cell size must be controlled. This is what makes an acoustical quality foam. Foams with a wide range of pore sizes do not make good absorbers.

In fiberglass, the density, binder and fibers must be controlled to produce a quality absorber. If the material is too dense, it will act as a barrier and reflect the sound waves. If it is too loose, there is no resistance and the soundwave energy is not dissipated.

Facings on absorbers are used only to protect the absorber from dust, grit, grime, oil, water, abuse, or to add aesthetic value. Facings, as shown in Figure 3, affect the absorption coefficients. The most common facings are mylar, tedlar, urethane and perforated vinyl for extremely harsh environments such as truck and tractor cabs. Thickness of the facing should never exceed 2 mils. The drawbacks to using facings are, in some cases, reduced performance and added cost.

Some flame and smoke contribution levels cannot be met with foams, even though they do meet UL94 specifications. In these instances, fiberglass or other absorbers must be used. Fiberglass and mineral wool are not only used for high temperature applications but are also cost efficient.

Fiberglass, in 4 lb./cu. ft. density, found mostly in engine compartments and HVAC applications, is an excellent absorber. It can also be die cut and pinned in place for some industrial applications. In molded form, it is used for pipe and duct wrap. When a barrier is placed over the absorber, it makes an excellent barrier/absorber system, ideal for

Material	Frequency (Hz) 125	250	500	1000	2000	4000	NRC
Fibrous Glass 4 lb./cu. ft.	**Sound Absorption Coefficients**						
(Typical) Hard Backing							
1" Thick	.07	.23	.48	.83	.88	.80	.60
2" Thick	.20	.55	.89	.97	.83	.79	.81
4" Thick	.30	.91	.99	.97	.94	.89	.95
Polyurethane Foam							
(Open Cell)							
¼" Thick	.05	.07	.10	.20	.45	.81	.20
½" Thick	.05	.12	.25	.57	.89	.98	.46
1" Thick	.14	.30	.63	.91	.98	.91	.70
2" Thick	.35	.51	.82	.98	.97	.95	.82

Figure 2: Sound absorption coefficients of common acoustical materials

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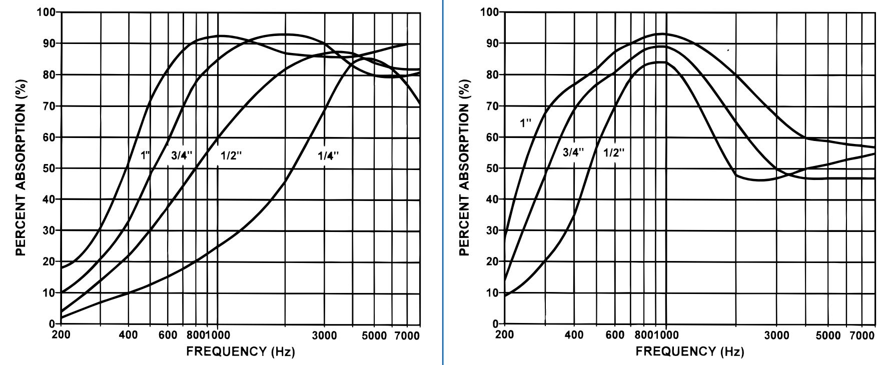

Foam (no facing) | Foam (aluminized film facing)

Figure 3

steam, water and hydraulic pipes, as well as aluminum pipes conveying plastic pellets.

If you have a noise problem, a good chance is that it can be solved using readily available, reasonably priced materials. Keep in mind that other materials are also available for cleanroom environments and pharmaceutical, drug processing, and high humidity process areas, which promote growth of fungi and must be steam cleaned.

NOTE: Transmission loss barriers such as sheet metal, loaded vinyl and acoustical sound absorbers such as foams and fiberglass are not interchangeable. Transmission loss barriers have very little sound absorption qualities and acoustical absorbers have practically no transmission loss qualities. In order to realize effective noise control results, both materials must be used in combination. The weight of the transmission loss barrier and thickness of the sound absorption material are both sound intensity and frequency related.

Damping Sheets and Tiles

Damping is used to reduce resonant vibration, and it serves two types of conditions in noise control—structural and impact. Damping reduces inaudible noise carried by structural members or surfaces, called structureborne noise, which may generate a considerable amount of audible airborne noise at resonance. Structural resonance is the adding and/or prolonging of sound energy by the reflection or vibration of other objects.

Damping is used to reduce structural resonance, which becomes airborne noise, in shipboard, computer, electronics, aircraft and business machine applications.

Damping serves to reduce the time factor and magnitude of impact noise when a structural surface such as sheet metal or reinforced fiberglass is struck. It does not absorb the initial impact noise, but it reduces the "ringing" or "thunder" of the metal in time and magnitude.

For reducing impact noise in hoppers, chutes, bins and conveyors, there are three things to remember:

1. A rule of thumb—the damping material thickness should be a minimum of one-half the thickness of the material to which it is being applied.

2. Damping reduces only the noise generated by parts striking the structural material that is being dampened. It will do nothing for the noise generated when parts impact on other parts. For this type of noise also consider the use of an absorber.

3. Damping materials do not wear very well. It is recommended that the damping material

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not be placed in high wear areas. The reduction will be just as effective if the material is placed on the outside of the hopper or bin or on the underside of the chute or conveyor.

What we have discussed thus far is called extensional damping. (See Figure 4.) The performance of an extensionally damped system can be improved upon by adding a constraining layer. This could become cost prohibitive but for critical applications may be necessary.

Damping Adhesives

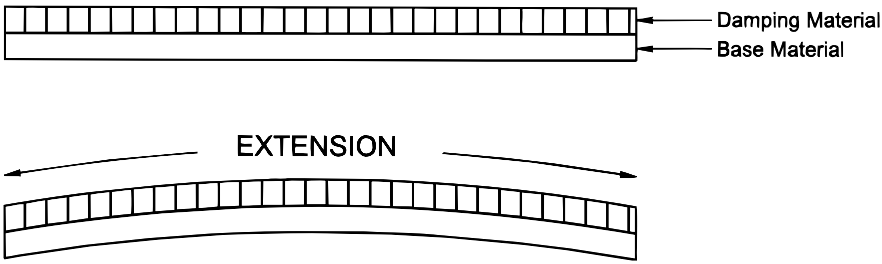
The weak link in a damped system is the adhesive. If the adhesive allows the damping sheet to slip and slide, its effectiveness will be greatly reduced. Therefore, damping sheets have an acrylic pressure sensitive adhesive (PSA), and an epoxy adhesive is used for the damping tiles.

Spray Damp

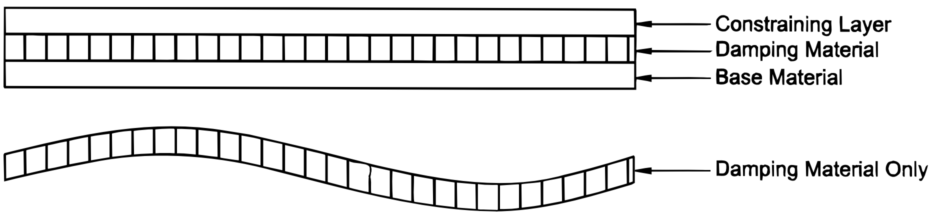
The best and easiest form of damping is with sheets and tiles applied to flat or near flat surfaces, but irregular shaped structural members —such as gear housings, oil pans or structural steel—make using sheet or tile material impractical or impossible. These applications require the use of sprayable damping material. Using the proper application equipment and procedures, this material can be applied to produce results very close to the sheet materials. For smaller, non-production line jobs, the material can be troweled or brushed onto the structural surfaces.

For more detailed information on damping and damping materials, contact your sales engineer or Tech Products.

Structural Damping Systems



Extensional Damping
Damping Achieved By Extensional Strain In Damping Material



Constrained Layer Damping
Damping Achieved By Shear Strain In Damping Material

Figure 4

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EXAMPLE

The first step in working on a noise problem is to identify the noise source and to measure the sound in both sound pressure and frequency. The Sound Pressure Level (SPL) is measured in decibels (dB), while the frequency (Hz) will be measured in octave or 1/3-octave bands. OSHA law states an allowable exposure to noise but says nothing about the frequency of the noise. To solve a noise problem, the frequency must be known. That is why absorption and transmission loss values are given in frequencies.

Frequency Weighting Scale

To find out if a suggested barrier will produce the desired results, some calculations must be made. These calculations will take the octave band readings and, by using a weighting factor, produce an equivalent "A"-scale result.

To illustrate this, assume the following: Sound pressure levels (dB) were measured in octave bands as shown.

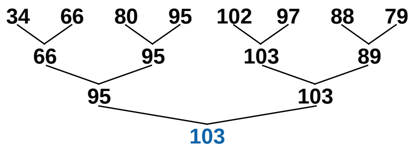
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000
Frequency (dB)	73	92	96	104	105	97	87	78

To determine the A-scale reading, we must reduce the dB readings to a single dB(A) level utilizing the chart in Figure 5. The correction factors are added or subtracted as the signs indicate. Remember the A-scale is corrected to closely produce the response characteristic of the human ear; that is why factors are subtracted at the very low frequency, below 250 Hz.

(Hz)	31.5	63	125	250	500	1000	2000	4000
dB	73	92	96	104	105	97	87	78
A-Scale Correction Factor	–39	–26	–16	–9	–3	0	+1	+1
A-Weighted Equivalent	34	66	80	95	102	97	88	79

Remember these are logarithmic numbers, so the A-weighted equivalent numbers can't be averaged. To determine the A-scale equivalent, use the chart shown in Figure 6 for the addition of unequal decibel levels.

The A-weighted equivalent becomes:



From this example it is clear that this piece of equipment exceeds allowable noise exposure limits.

To correct the problem, assume the equipment can be enclosed. Use a curtain material that has a 1lb./sq. ft. mass and a 1" absorber for the enclosure. From the TL chart in Figure 1, we have the following:

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Hz	31.5	63	125	250	500	1000	2000	4000
Original Readings dB	73	92	96	104	105	97	87	78
TL of 1lb./sq. ft. Curtain	0	–3	–15	–16	–21	–26	–33	–38
=	73	89	81	88	84	71	54	40
A-Scale Correction Factor	–34	–26	–16	–9	–3	0	+1	+1
A-Weighted Equivalent	39	63	65	79	81	71	55	41

63 79 81 55

79 81

83

With the A-scale projected to be 83, we can say that with a properly designed enclosure using a 1lb./sq. ft. curtain material this equipment would be in compliance, since present OSHA law is 85 dB(A).

A-Weighting Scale			
Frequency (Hz)	A-Scale	Frequency (Hz)	A-Scale
20	–50.5	630	–1.9
25	–44.7	800	–0.8
31.5	–39.4	1000	0
40	–34.6	1250	0.6
50	–30.2	1600	1.0
63	–26.2	2000	1.2
80	–22.5	2500	1.3
100	–19.1	3150	1.2
125	–16.1	4000	1.0
160	–13.4	5000	0.5
200	–10.9	6300	–0.1
250	–8.6	8000	–1.1
315	–6.6	10000	–2.5
400	–4.8	12500	–4.3
500	–3.2		

Figure 5: Weighting Factors for the A-Scale

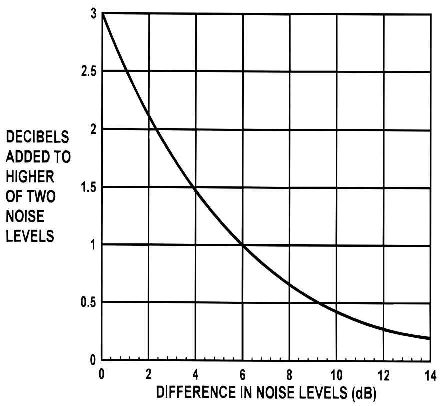

Figure 6: Addition of unequal decibel levels