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HOME

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FROM AN INDUSTRY-
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QUIET!

Reduce a Home Theater to Silence **BY** Bob Ankosko

It's 11:00 on a Sunday night. Your honey just went up to bed and you can't wait to crank up your latest Blu-ray acquisition: *Jimi Plays Berkeley*, a long-forgotten 1970 documentary that has been restored and remixed in 5.1 surround. Seconds after Hendrix rips into the first number, the dreaded foot stomping from above begins. The party's over before it even starts. Last time it was a cataclysmic crescendo from *Inception* that did you in. Frustrated, you vow to remedy the situation and, once and for all, soundproof the family room that doubles as your home theater.

Sound familiar? Ever wonder what it would take to soundproof a home theater/media room/man cave? Or maybe you're building a new home or planning an addition to accommodate the theater of your dreams and want to include proper sound isolation as part of the plan.

We called on home theater guru Anthony Grimani and asked him to walk us through the basics of soundproofing. Grimani is president and founder of Performance Media Industries (pmilt.com), a Novato,

California-based firm that designs and engineers world-class home theaters and professional studios. PMI's specialty is architectural acoustics, which involves everything from selecting bass-friendly room dimensions to adding acoustical wall treatments to managing construction projects and building soundproof rooms. Grimani is also co-founder of MSR Acoustics (msr-inc.com), which supplies acoustical tuning systems and specialty construction materials based on PMI's designs. As a veteran of Dolby Labs and Lucasfilm THX, he was

instrumental in developing standards for home theater and is credited with developing the Surround EX format for introduction with *Star Wars: Episode I—The Phantom Menace* in 1999. Grimani is also a long-time instructor for the Custom Electronic Design & Installation Association (CEDIA), which runs an educational program for professional electronics installers and technicians.

Not-So-Good Vibrations

When you think about it, there's not much to the walls in a typical American home: sheets of

half-inch-thick drywall screwed or nailed to 2-by-4 studs. Rap your knuckle on the wall, and it sounds hollow, which explains in part why standard walls don't do a very good job of containing sound. If the kids are clowning around in the room next to your home office, you hear the ruckus. If they're playing *Call of Duty* or watching *The Avengers*—subwoofer cranked up to 11—you hear *and feel* the sonic mayhem.

Standard drywall construction has what acousticians call a sound transmission class (STC) rating of 40 decibels; the higher the number, the better the material is



• Left: Phase one of a "lounge-cinema" designed by PMI, Ltd., showing the framing with isolated double-wall construction and spring-suspended ceiling structure. The internal walls do not connect with the ceiling but are instead tied back to the external load-bearing wall with rubber isolators. Right: Phase two shows the room after the drywall has gone up. The finished room is pictured at the top of the page.

Photo by Studio 1 Inc., Courtesy of AVAL

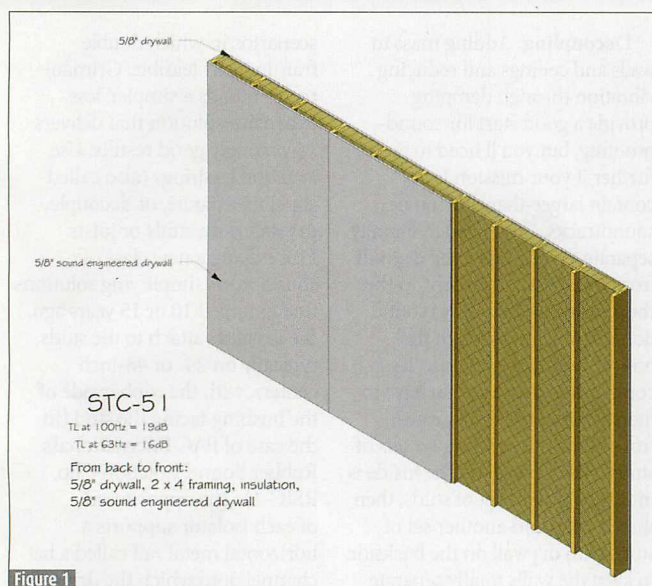


Figure 1

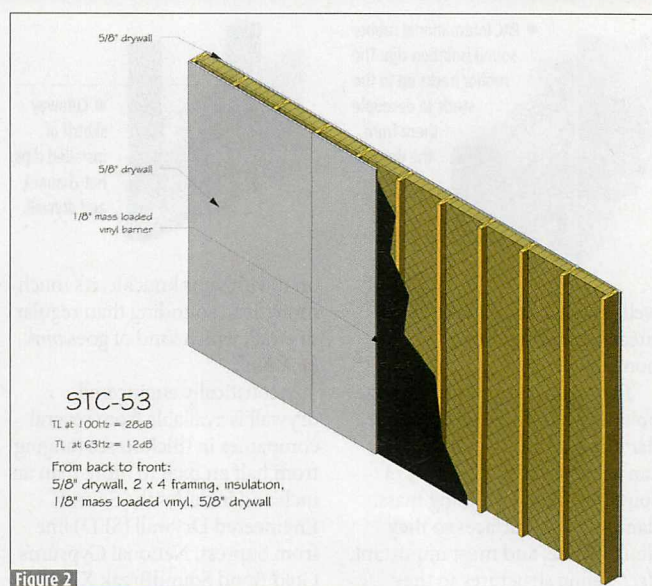


Figure 2

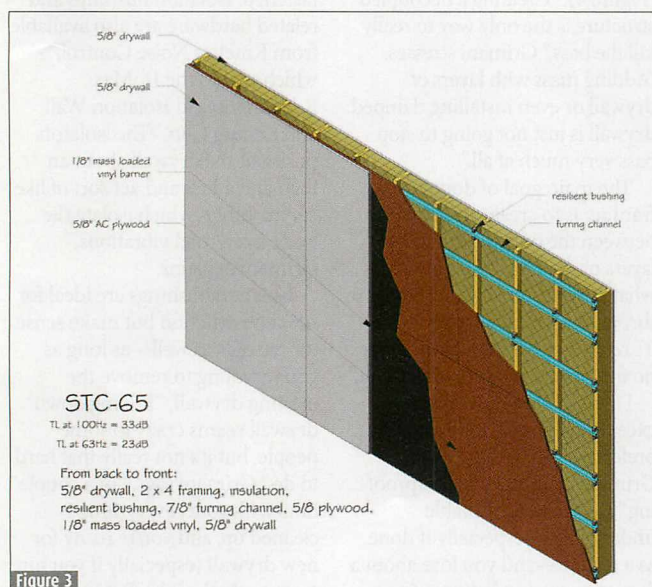


Figure 3

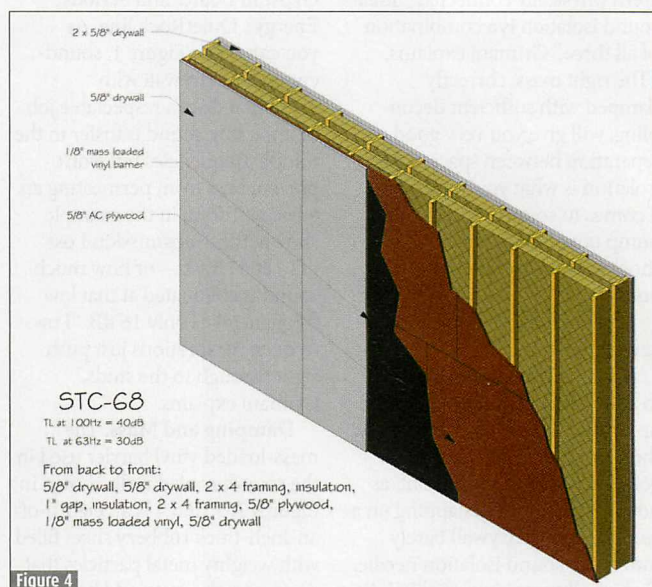


Figure 4

Diagrams courtesy of PMI, Ltd. pmiltd.com

at blocking sound. When you crank up your system to experience Jimi playing "Voodoo Child" at concert volumes, it's easy to hit a very loud peak sound-pressure level of 110 dB. An STC of 40 means a person on the other side of the wall will definitely hear Jimi jamming, and if you were to measure the volume with a sound meter, it would register about 70 dB, which is loud enough to be bothersome. You begin to have an appreciation for how the phrase *paper-thin walls* came into being.

Grimani likes to compare the walls and ceiling of a home theater to a giant sail. "Think of the drywall as a big tarp that collects the air displaced by your speakers," he says. On a boat, the

sail transmits energy from the wind through a mast to the hull and propels it forward. In a home theater with standard construction, the drywall collects the air and vibrates; that vibration is transmitted through the studs to the wall on the other side or the floor above. (Good luck if either of those spaces is a bedroom.) So most of the sound you hear in the room above, below, or adjacent to a home theater actually travels through the studs that connect the two walls or the joists that connect the ceiling to the floor above. Sound also leaks through electrical outlets, lighting fixtures, and other openings that aren't properly sealed. And then there's just shoddy construction with materials that don't line up,

leaving gaps, seams that aren't caulked, etc.

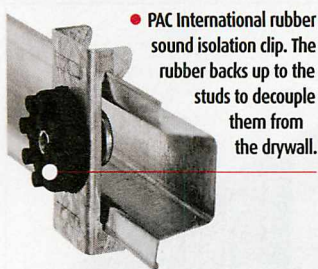
"Sometimes people think, *Well, I'll just add a second layer of drywall, and that will get rid of the problem*," Grimani observes. "It helps a little but not much. It's like the difference between using a light sail and a heavy sail—it still pushes the boat forward." People also believe that putting fiberglass or other forms of insulation in the wall will improve the sound isolation, but it barely does because sound transmits through the studs, not the air. "Air is not a very good transmitter, so shoving a bunch of fiberglass in there won't make much of a difference," Grimani says. He notes that you'll get about the same minimal improvement you get by doubling

up on the drywall (more on that in a moment).

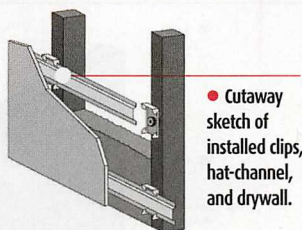
Another common misconception is that putting foam or acoustic panels on the walls and ceiling will somehow stop sound from going into the room next door. "That would be the equivalent of putting wood blocks in front of your sail to stop the boat from moving," Grimani says. "Insane! The wind is going to get around those blocks, hit the sail, and move the boat forward." Sound absorber panels are intended to control echoes inside a room, not block sound.

Soundproofing 101

It seems there are plenty of approaches to soundproofing that either don't work or don't work



● PAC International rubber sound isolation clip. The rubber backs up to the studs to decouple them from the drywall.



● Cutaway sketch of installed clips, hat-channel, and drywall.

well, so what does it take to successfully soundproof a home theater?

The science of soundproofing boils down to three things: mass, damping, and decoupling. You can achieve varying degrees of soundproofing by adding mass, damping wall surfaces so they don't vibrate, and most important, decoupling structures so they aren't physically connected. "Ideal sound isolation is a combination of all three," Grimani explains.

"The right mass, correctly damped with sufficient decoupling, will give you very good separation between spaces." And isolation is what you want when it comes to sound systems that pump out enough bass to send shockwaves throughout the house.

Let's take a closer look at those key ingredients.

Mass. The most common way to add mass to a wall is to double up on drywall, the idea being that the heavier the wall, the less it's going to transmit sound. But, as noted earlier, simply slapping on a second layer of drywall barely moves the sound isolation needle. Technically speaking, you'll get an additional 3 dB of sound isolation, which is like barely nudging down the volume on your A/V receiver. In other words, it's game over when Optimus Prime and Megatron start duking it out an hour after your kids go to sleep. "Mass on its own doesn't quite cut it," Grimani says. "Damping and decoupling go a lot further."

Damping. The idea behind damping is to reduce vibration in the ceiling and walls of a room, which in turn will mitigate the transmission of sound through studs and joists to an adjacent room. There are a couple of options, starting with specialty drywall that's made for soundproofing. "It's internally damped with a viscoelastic compound that absorbs sound and vibration," Grimani explains. "When you rap

on it with your knuckle, it's much more dead sounding than regular drywall, which kind of goes *bink bink bink*."

Acoustically engineered drywall is available from several companies in thicknesses ranging from half an inch to more than an inch and includes the Sound-Engineered Drywall (SED) line from Supress, National Gypsum's Gold Bond SoundBreak XP Gypsum Board, and Serious Energy's QuietRock line. As you can see in Figure 1, sound-engineered drywall with insulation does a respectable job of impeding sound transfer in the middle frequencies but won't prevent bass from permeating an adjacent room; in the example shown, the Transmission Loss (TL) at 63 hertz—or how much sound is attenuated at that low frequency—is only 16 dB. "Low-frequency vibrations just push right through to the studs," Grimani explains.

Damping and Mass. The mass-loaded vinyl barrier used in the soundproofed walls shown in Figures 2, 3, and 4 is an eighth-of-an-inch-thick rubbery sheet filled with weighty metal particles that professionals use to add both damping and mass to walls and ceilings. Whereas drywall is a rigid mass that vibrates and resonates, a mass-loaded barrier is what acousticians call a limp mass, which means it's floppy and doesn't vibrate; it's also surprisingly heavy, weighing about a pound per square foot, which makes it tricky to work with. Vinyl barrier is typically stapled to wood studs (or screwed to metal studs) prior to adding the drywall or sandwiched between plywood and drywall as in Figure 3. Just about every company that sells acoustical products offers a version of vinyl barrier; Acoustiblok, made by a NASA spinoff company of the same name, is one of the most common forms of vinyl barrier and comes in eighth- and quarter-inch thicknesses.

Decoupling. Adding mass to walls and ceilings and reducing vibration through damping provide a good start for soundproofing, but you'll need to go further if your mission is to contain larger-than-life movie soundtracks. "You need to literally separate, or decouple, the drywall from the studs, preferably on the theater side of the wall so sound doesn't transmit through the house," Grimani explains. "It's a complicated process. You have to literally build two walls, one in front of the other, with two sets of studs." The drywall on the inside is mounted on one set of studs, then there's a gap and another set of studs with drywall on the backside to keep the walls totally separate (Figure 4). "Creating a decoupled structure is the only way to really kill the bass," Grimani stresses. "Adding mass with layers of drywall or even installing damped drywall is just not going to stop bass very much at all."

The main goal of double framing is to create an air gap between the outside and inside layers of drywall. "That air gap is what prevents the bass from going through," Grimani explains, "so it's really important that there are no intermediate layers of drywall."

Double framing works exceptionally well and is still the preferred approach for what Grimani calls "great soundproofing." But it is a formidable undertaking—especially if done as a retrofit—and you lose about a foot of your room's dimensions. Still, it's a worthwhile investment that offers clear-cut benefits. In addition to excellent sound isolation, you'll enjoy the unintended consequence of a better-sounding home theater space. "The walls on the theater side are less rigid than standard single-frame walls, so they absorb bass instead of reflecting it, which substantially reduces standing waves," he explains. "So the problem of bass being really loud in one seat and really quiet in another is eliminated, or substantially reduced, and you end up with a room that has tight, punchy bass just because the walls are not acting as strong reflectors. That's a nice benefit."

Decoupling for Dummies

For retrofit and new-construction

scenarios in which double framing isn't feasible, Grimani recommends a simpler, less expensive solution that delivers surprisingly good results: Use isolation bushings (also called clips) to separate, or decouple, drywall from studs or joists. Embodying a new class of soundproof-simplifying solutions that emerged 10 or 15 years ago, the isolators attach to the studs, typically on 24- or 48-inch centers, with the rubber side of the bushing facing the stud (in the case of PAC International's Rubber Sound Isolation Clip, RSIC-1). The opposite side of each isolator supports a horizontal metal rail called a hat channel onto which the drywall is fastened. Isolation bushings and related hardware are also available from Kinetics Noise Control, which makes the IsoMax Resilient Sound Isolation Wall and Ceiling Clip. "The isolators push out the drywall about an inch and a half and act sort of like car bushings, which isolate the body from road vibrations," Grimani explains.

Isolation bushings are ideal for new construction but make sense for retrofits as well—as long as you're willing to remove the existing drywall. "Pulling down drywall seems crazy to some people, but it's not really that hard to do," Grimani says. "In a couple hours, it's gone, everything is cleaned up, and you're ready for new drywall (especially if you hire a pro to do the job). Put in those bushings with a layer or two of

● Top: Acoustiblok vinyl barrier adds damping and mass to the walls. Bottom: Drywall is installed over the Acoustiblok barrier.



drywall, a bit of insulation, and you can gain about 15 dB of additional soundproofing over a standard wall for an STC of 55 dB. That's a huge improvement between rooms. The main benefit is in the midrange, but with low frequencies it really seems like the bass transfer is largely gone." And, as we'll see in a moment, there are ways to make a good thing even better. (Here's a fun fact: To get to 55 dB of isolation between rooms using only half-inch drywall, you would have to use *seven layers* on each side of the wall!)

Soundproofing by the Numbers

Like they say in sports, "No pain, no gain." If you're willing to put in the time and effort and put up with the inconvenience of living in a construction zone for a few days—or longer if it's a DIY project—it is possible to add soundproofing to an existing home theater space. But it's not a walk in the park.

"There is no doubt in my mind that working from scratch in a new construction setting is a lot easier than a retrofit," Grimani says. "If you want to soundproof an existing home theater so you can enjoy the latest action movies with their steady stream of big bass wallpops without waking the kid sleeping next door, doing it as a retrofit is complicated. That's not to say you can't do it, but be prepared to do a fair amount of construction."

When it comes to new construction, the principles and techniques are the same. "It's just that you don't have to figure out how to retrofit stuff or worry about disrupting the family during construction," Grimani says. "You just want to build it right the first time."

Whether you're looking to soundproof an existing room or working with plans for a new home or addition, Grimani has come up with 10 basic steps to effective sound isolation. Of course, results will vary depending on the materials and specific techniques used, but if you follow the basics, you'll achieve worthwhile results. Says Grimani, "At minimum, if you want to get to the point where you have reasonable isolation across all frequencies—bass,

middle, and highs—here are the steps."

1 RIP DOWN THE DRYWALL ON THE THEATER SIDE.

2 CLEAN UP EVERYTHING AND PLUG ALL THE HOLES.

"Basically, put caulk anywhere it looks like there's a junction or a gap to get rid of the transfer points," Grimani says. Drape putty packs on the backside of all electrical outlets. IsoBackers from Kinetics Noise Control work well and are fireproof and electrically nonconductive.

3 ADD INSULATION.

Grimani recommends a special type of insulation known generically as rockwool and sold under the trade name Roxul. "Rockwool is a very high-order thermal insulation made of volcanic rock that's been spun into a fiber," he says, noting that it's not very common in the U.S., especially in more southern states. If you can't get it, just use regular fiberglass insulation.

4 SECURE ISOLATION BUSHINGS TO THE STUDS AND CEILING JOISTS,

following manufacturer recommendations. As noted earlier, examples include PAC International's Rubber Sound Isolation Clip (RSIC-1) and Kinetics Noise Control's IsoMax Resilient Sound Isolation Clip.

5 MOUNT A METAL HAT CHANNEL

(also called a hat track, furring channel, or resilient channel) onto the isolators; it's called a hat channel because it looks like a hat when you look at it in cross section. "The track squeezes into the metal part of the isolation blocks and provides support for your drywall," Grimani explains. "The tracks go horizontally, kind of like ribs every 24 inches or so. So now, instead of vertical studs, you have a bunch of horizontal metal tracks that you hang your drywall from." Hat channels are available from PAC International and Johnson Bros.

6 INSTALL ½-INCH PLYWOOD.

Position the 4-by-8 sheets horizontally and use screws to secure the wood panels to the



Photo by Studio J Inc., Courtesy of ANAI

- An installed Kinetics Noise Control KSCH spring-loaded ceiling suspension bracket. The bracket is hung from blocking placed between truss members to reinforce the ceiling. Metal C-channel is run between the brackets, and hat-channel will be run perpendicular to the C-channel, forming a grid to which the drywall attaches.



- Green Glue noiseproofing compound can be used in place of a vinyl barrier.

hat channel. Note: Adding a plywood layer is optional, and skipping it will only slightly reduce overall sound isolation. But keep in mind that it's an inexpensive way to create a backing layer that makes it easy to hang speakers, projectors—you name it—without having to hunt for studs.

7 USE A CAULK GUN TO APPLY GREEN GLUE

damping compound to the drywall before installing it over the plywood; follow the manufacturer's recommendations on how to apply the compound. Note: In cases in which you're more interested in adding mass without thickening the walls too much, the mass-loaded vinyl barrier depicted in Figures 2, 3, and 4 is a good option, but you wouldn't typically use both Green Glue and a vinyl barrier.

8 INSTALL ½-INCH DRYWALL OVER THE PLYWOOD

after you apply Green Glue. Position the drywall vertically to avoid overlapping seams; doing so helps reduce sound transfer.

9 SOUNDPROOF THE FLOOR.

It can be easy to overlook the floor, especially in a retrofit in which you have to deal with the hassle of mismatched floor heights, but the same principles that apply to walls and ceilings—mass, damping, and decoupling—are valid here, too. "Soundproofing the floor is a little more complicated," Grimani says, noting that the exact course of action is determined by what's beneath the floor—whether it's a concrete slab, crawl space, or a finished room. One approach is to install an isolation mat and subflooring, which will raise the height of the floor between a half-inch and almost 2 inches, depending on the materials used. To get around that, you have to create an elevated threshold. Not ideal, but doable.

Grimani cites two products worth considering: Dura Undercushion's Duracoustic ⅝-inch rubber mat, which is made out of recycled tires, and Kinetic Noise Control's Roll-out Isolation Material (RIM), which provides much better isolation. "RIM flooring is a fiberglass mat



● Kinetics IsoBacker acoustical outlet putty pads get rid of transfer points at junction gaps.

with these little blocks glued into it,” Grimani explains. “You roll it out and put a subfloor on top of it—usually two layers of three-quarter-inch plywood. The soundproofed floor is almost 2 inches taller than the original floor, but you now have what is essentially a trampoline that blocks the sound transfer between spaces.”

10 SPACKLE, SAND, AND PAINT THE NEW SURFACES.

When all is said and done, you’ll have three key soundproofing principles working for you: You get mass from the plywood and drywall, damping from the Green Glue, and decoupling from the isolators. The steps outlined here point the way toward a good retrofit, according to Grimani. But keep in mind that it’s a generic solution with plenty of wiggle room—which is why it makes a lot of sense to consult an acoustics/soundproofing professional as a first step. As is the case with any type of construction, “if you’re trying to build a house that’s supposed to be classical revival, talk to an architect and a builder who are familiar with that style of construction.”

The Price of Quiet

When PMI is hired for a project, Grimani and his team analyze the situation, discuss goals with the owner, and prepare a detailed plan that a building crew can follow. “In new construction, I look at the entertainment and privacy areas as an architect, define where sound isolation is needed, and specify how it should be implemented,” he says. “We provide a complete set of soundproofing instruc-

tions, right down to the length of every screw. Depending on the project, it can cost a few thousand dollars to get to that level of data, but it’s worth it because you now have an engineered and documented solution.”

And what about the actual construction—what does a retrofit job cost if it’s done by a professional? It all depends on where you live and the exact steps you follow. But “you have to imagine a contractor is going to be in there for at least three or four days,” Grimani says, adding that ideally you want a contractor who specializes in home theater soundproofing. With that in mind, he says you can expect to spend around \$30 per square foot of surface to go from regular drywall construction to a soundproofed structure with reasonable isolation.

One Final Tip

It’s no secret that the deep bass is extremely difficult to contain,

which is why Grimani recommends putting subwoofers and floorstanding speakers on rubber blocks instead of placing them directly on the floor. Doing so reduces the transfer of acoustic energy into the floor, which, by the way, is exacerbated by the spikes found on some speakers. “All spikes do is ensure that low-frequency vibration from the woofers is really pushed down into the floor—not a good idea if you’re trying to keep things quiet,” Grimani says. Mason Industries sells Super W Pads for placement under compressors, HVAC units, and other machinery in industrial spaces. Intended to reduce noise and vibration, the pads come in a sheet made up of 2-by-2-inch rubber waffle pads, which are perfect for decoupling subwoofers and speakers. All you have to do is break off a few squares and put them under the corners of your subwoofers and speakers. Every little bit helps. ¶

RESOURCES

PRODUCTS

A listing of products mentioned in the article.

Damping Compound

Green Glue Noiseproofing Compound (greengluecompany.com)

Insulation

Roxul, North American subsidiary of Rockwool International (roxul.com)

Isolation Bushings, Hat Channels, and Accessories

Kinetics Noise Control (kineticsnoise.com): IsoMax Resilient Sound Isolation Wall and Ceiling Clip, IsoBacker Acoustical Outlet Backer Putty Pad
Johnson Bros. Metal Forming Co. (johnsonrollforming.com): Hat Channels
PAC International (pac-intl.com): RSIC-1 Rubber Sound Isolation Clip

Mass-Loaded Vinyl Barrier

Mass-loaded vinyl barrier is sold under many different brand names
Acoustiblok (acoustiblok.com): Acoustiblok Soundproofing Material, available in 1/8- and 1/4-inch thicknesses

Sound-Engineered Drywall

Soundproof panels are available from several companies but will likely be a special order item at Home Depot or Lowe’s.
National Gypsum (nationalgypsum.com): Gold Bond SoundBreak XP 1/2- and 5/8-inch Gypsum Board
Serious Energy (quietrock.com): QuietRock line of sound-damped panels, available in 1/2-, 5/8-, and 1 1/8-inch thicknesses
Suppress (suppressproducts.com): Sound Engineered Drywall (SED) in 1/2-, 5/8-, 3/4-, and 1-inch thicknesses

Soundproof Flooring

Dura Undercushions Ltd. (duracushion.com): Duracoustic rubber matting

Sound Absorbing Supports

Mason Industries (mason-industries.com): Super W Pads, intended for industrial applications, but they make excellent speaker isolators

ADDITIONAL INFORMATION

Acoustical Consultants and Contractors: Check local listings
American Institute of Architects (AIA) (aia.org)
Acoustical Society of America (ASA) (acousticalsociety.org)
Acoustical Solutions, Inc. (acousticalsolutions.com)
Super Soundproofing Co. (soundproofing.org)