Noise Control for Power Generation Equipment

Project #504

The key sources of noise in a commercial or home generator are engine vibration, engine exhaust and the cooling fan. Vibration from the cyclically driven engine travels through the rigid framework to sheet-metal enclosure panels, causing both structures to broadcast the energy as airborne noise. Tip noise from the fan blades, as well as turbulence from intake and exhaust air, add to the airborne noise. Controlling the overall noise levels requires addressing both airborne and structureborne noise.

Airborne Noise Management
Two efficient methods for controlling airborne noise are blocking it with a weighted barrier and absorbing it with acoustical foam.

Barriers—Equipment manufacturers can achieve significant noise control by lining the generator's sheet metal enclosure with E-A-R's flexible (limp), non-lead weighted acoustical barrier or a decoupled barrier (barrier over foam). Ideally, at least 90 percent of the enclosure should be lined, and openings should be limited.

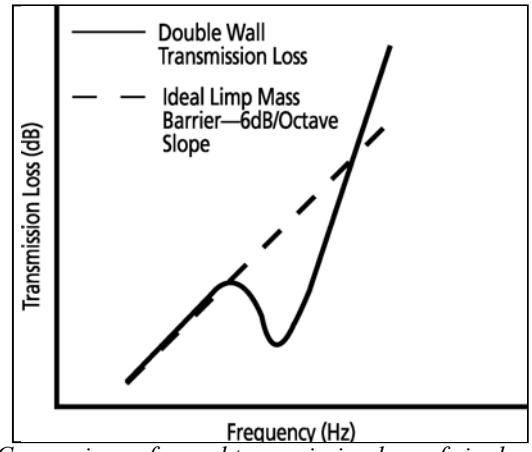
The performance of a barrier is quantified by transmission loss or the level of sound blocked by the mass. It is governed by mass law, represented by the equation

$$TL = 20\ Log_{10}\ (SM \times F) - 33.5\ dB$$

where TL is transmission loss, SM is total surface mass in pound per square foot and F is frequency.

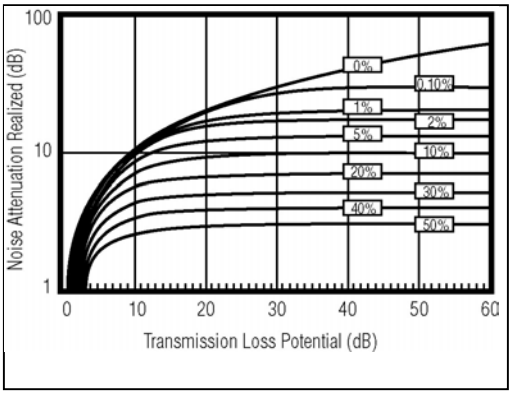
Doubling either the mass of the barrier or the frequency of the sound nets a theoretical 6 dB improvement in transmission loss, essentially doubling the noise-blocking performance of the barrier.

Product designers can further improve transmission loss by adding a decoupler that separates the barrier from the enclosure wall. E-A-R's decoupled barriers comprise an acoustical foam, which is adhered to the inside of the enclosure, and a weighted barrier, which faces the noise source. The foam-and-barrier (double-wall) construction acts like a spring-mass system, in which the composite dissipates or resonates, depending on frequency. The thickness of the foam needed depends on the frequency of the problem noise. Essentially, the thicker the decoupler and the lower its stiffness, the lower the frequency that sets the system into resonance (the point at which it stops impeding sound waves).



Comparison of sound transmission loss of single- and double-wall barriers

Absorbers—The uniform cell structure of E-A-R's TUFCOTE® acoustical foams efficiently dissipates airborne noise. Most power generation equipment requires several openings in the metal enclosure—for air intake, exhaust and heat release. These openings can be detrimental to the performance of barriers and decoupled barriers as they allow noise to escape unhindered. By incorporating acoustical absorbers such as TUFCOTE foams as a lining for louvers or by creating a *torturous path* for airflow, noise will be absorbed before it escapes the enclosure.



Performance of an equipment enclosure, based on percentage of open surface area.

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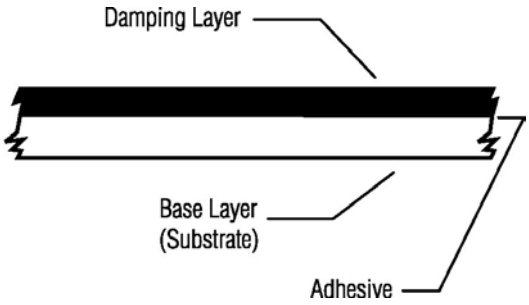
Structureborne Noise Management
Often, a generator's enclosure is hard-mounted to the same frame or foundation as the internal equipment creating the problem vibration energy. That vibration travels through the connections into the light-gauge metal panels, which efficiently radiate the energy as sound.

Structural damping provides a means for eliminating the energy by converting it to low-grade heat. The damping materials can be applied directly to the exterior surface of the enclosure—called extensional damping—which often results in dramatic noise and vibration reduction.



Cross section of damping material

Multi-Function Composites
TUFCOTE multi-layer composites can provide cost-effective noise and vibration control for power generation equipment. Barrier-foam or foam-barrier-foam constructions can both block and absorb the airborne sound. TUFCOTE composites are available with a variety of protective facings, which protect the foams from grease and fluids, and enhance the noise control performance as well. E-A-R's SM aluminized polyester facing also reflects light back into the enclosure, for easier maintenance, and deflects radiant heat. (See Engineer's Notebook EN-501)

Enclosures with structureborne noise problems can be efficiently treated with E-A-R composites of damping sheet and acoustical foam, such as ISOLOSS® NV-7520-100SM composite. Applied to enclosure interiors, the damping material reduces structural vibration by adding stiffness and mass, while the one-inch acoustical foam absorbs noise from the mechanical equipment.

Materials Selection
E-A-R applications engineers can help specify materials that provide the optimum solution, based on these criteria:

- Customer design objectives
- Frequency of the noise of concern
- Operating temperature range
- Operating environment—exposure to fluids, oil, grease, chemicals; likelihood of punctures, rips, tears
- Need for reflected light

Broad Range of Materials
Here are descriptions of E-A-R materials commonly employed in power generation noise and vibration control applications.

- TUFCOTE acoustical foams—thicknesses from .25-inch to 2-inches; numerous facings available, including reflective and fiber-reinforced
- TUFCOTE barriers—non-lead loaded vinyl or polyurethane; weights ranging from 1/2 lb/ft^2 to 2 lb/ft^2.
- TUFCOTE decoupled barrier composites and barrier/absorber composites—available in a range of barrier weights, decoupler thicknesses and absorption layer thicknesses; can be faced with numerous films
- ISOLOSS NV damping materials and composites—employ NV urethane damping material alone or in composite with TUFCOTE acoustical foam, faced with aluminized polyester or other facings, as required

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