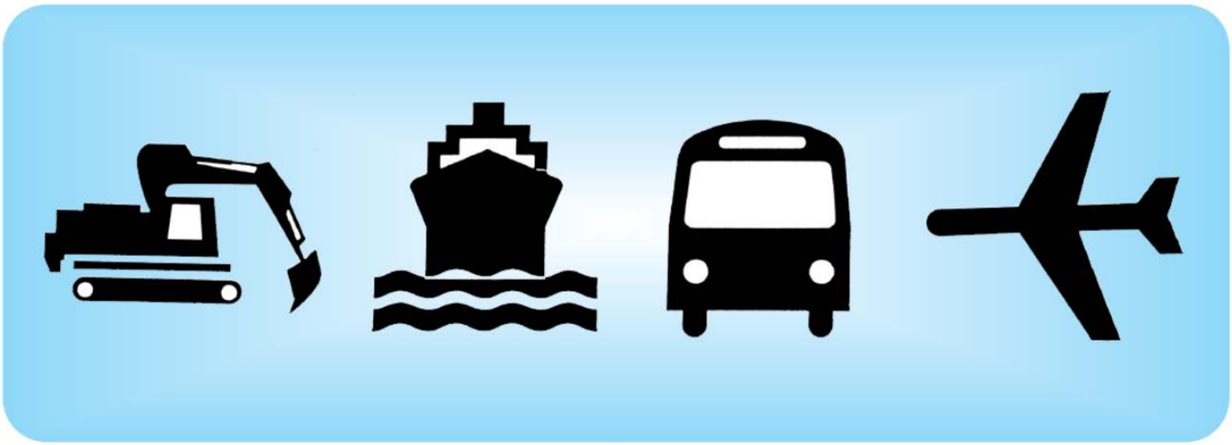
Technical Discussion

Introduction

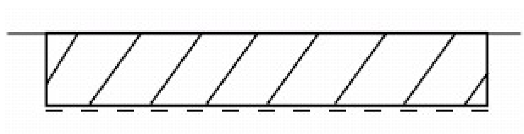
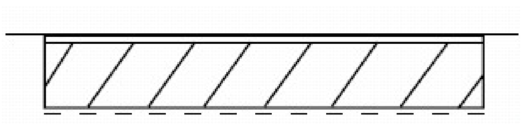
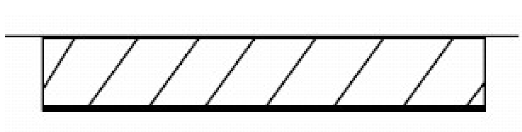
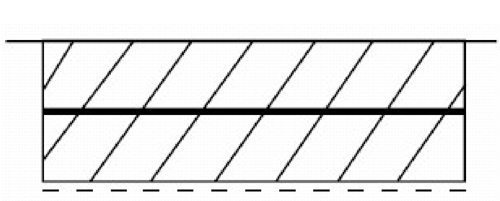
Before exploring various aspects of designing original equipment for quiet operation, the OEM Design/Product development engineering should review the technical discussion sections covering product types and treatment strategies.



Before Selecting Acoustical Materials:

- Identify noise source components and where possible determine the relative overall dB levels and frequency distribution.
- Relocate or remove noisy components away from operator areas.
- In air flow systems utilize proper aerodynamic principles to minimize noise generated by turbulence.
- Reduce operating speeds of rotating components.
- Alter operating speeds to avoid coincidence with equipment resonant frequencies.
- Isolate and decouple rotating components from the supporting structure.
- Utilize flexible connections on all equipment intakes, exhaust lines, electrical conduit and other service or utility lines.
- Where practical, manufacture OEM component parts where impingement or impact takes place out of plastics of other non-metallic materials with better inherent damping qualities. Examples include gears, rollers, stops and guides.
- Minimize the use of thin gauge sheet metal for large surface area equipment panels and as necessary use stiffeners and bracing to limit structural resonance that generates airborne noise.
- Minimize the percentage of open area in panels designed to contain noise.
- Utilize closed cell gasketing and seals around doors and removable panel sections.
- Reduce drop heights on parts or material impacting hoppers, chutes and parts bins.
- Where practical, utilize expanded metal instead of sheet metal for belt guards.

Source Control Treatment Using HUSHCORE™ Absorbers, Composites and Damping

Product Cross Sectional View	Component Layers	Recommended Uses
	Adhesive Absorber Facing	Used to line the inside of cabinets, compartments and panels where the existing skin provides the necessary transmission loss. Increasing the thickness and/or density increases low frequency acoustical absorption.
	Adhesive Damping Absorber Facing	Used to line the inside of cabinets, compartments and panels where it is necessary to add mass to the existing skin, reduce structural resonance and absorb airborne sound. The absorber layer faces the noise source.
	Adhesive Absorber Barrier	Used to line the outside surfaces of equipment housings, connected ducts, pipes and other guards and panels where inside surfaces are not practical to treat. The absorber layer acts as a decoupler/spacer to enhance the transmission loss of the barrier.
	Adhesive Absorber Barrier Absorber Facing	Used to line the inside of cabinets, compartments and panels where the existing skin is light gauge and not capable of providing enough transmission loss. To get the full benefit from these decoupled absorber/barrier composites, the percentage of open area in the cabinet or panel should be 10% or less of the total surface area.
	Adhesive Damping	Used to line inside or outside surfaces of thin metal or other rigid surfaces to reduce noise generated by structural resonance. This product group can be applied in sheets or using a liquid damping compound.
		Typical source treatment at left. HUSHCORE acoustical materials are used to line OEM portable air compressor housings.

Technical Discussion

Fire Safety

The most commonly utilized acoustical foams for OEM applications are polyester and polyether polyurethane materials rated at UL94-HF1. These materials will burn in the presence of a flame and give off toxic combustion products. Although the UL94 rating carries a "self-extinguishing" designation, this terminology is not intended to reflect properties of the material under actual fire conditions. Many of the fiberglass based products and quilted blankets carry Class A ratings as per the stringent ASTM E-84 tunnel test. The E-84 Class A rating conforms to most fire hazard building code regulations. Some specialty foams have been developed to meet this Class A rating.

Density

Performance of absorber products is directly related to the density. In many cases increased density for a given thickness results in increased absorption ratings most dramatically in the low frequency range and reduce performance in the high frequencies. This begins when the absorber product becomes so dense that it begins to take on characteristics of a barrier thus reflecting some of the short wavelength high frequency noise. Density of damping treatments does not usually have a well defined effect on performance although adding more mass to the surface will ultimately change its natural frequency. In barrier materials, doubling the density of the barrier increases the transmission loss by 6 dB.

Thickness

Material thickness of absorber products has much the same effect as increasing product density with increased performance in the lower frequencies. Degradation of higher frequency absorption with increased thickness is not typical. Increasing absorber thickness yields a small incremental increase in absorption in high frequencies compared to the increase in low frequencies. In damping materials, thickness of the coverage as it relates to the treated surface thickness will affect performance. As a general rule the damping material should be at least equal to the thickness of the surface it is applied to and two or three times if high loss factors need to be attain. In barrier materials, increasing the thickness changes performance as defined by the mass law which states that transmission loss will increase by 6 dB for each doubling of the mass or frequency.

Coverage

Performance of absorber products is not coverage dependent. The function of the absorber materials is to dissipate acoustic energy and limit reverberant build-up. As a general rule 75% of the noise build-up can be eliminated inside an enclosure or compartment with as little as 50% coverage of inside reflective surfaces. Likewise, damping treatments and coatings are not coverage dependent. Attacking surface areas where vibrational motion is most prevalent is more important than 100% coverage. A 40% to 60% coverage is usually sufficient. To the contrary barrier materials rely on complete coverage as close to 100% as possible to realize their full acoustic performance. Potential practical limitations for various coverages are as follows: maximum 10 dB reduction for 90% coverage, 15 dB reduction for 98% coverage and 20 dB reduction for 99% coverage.

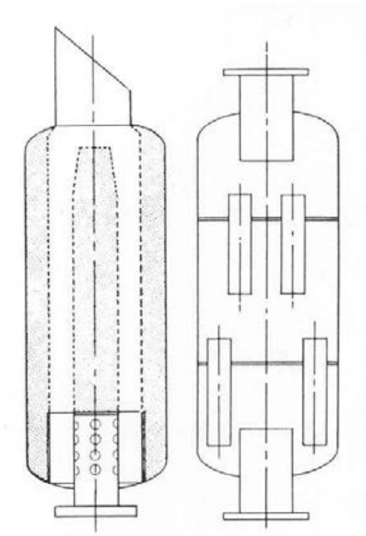
Facings

Usually it is necessary to incorporate some type of thin membrane facing to cover the absorber layer exposed to the noise source inside a cabinet or enclosure. This protects the product from contamination and provides a surface that can be wiped down. As long as the film facing is in the 1 to 4 mil thickness range there will be a minimal effect on acoustic performance. Many times there is only a frequency shift with slightly lower absorption in the higher frequencies. Damping and barrier materials are many times part of composite products not exposed to the environment and are not covered with facings. Some typical facings are tedlar, mylar and urethane.

Installation

Most products are available in standard rolls, sheets or die cut to meet OEM specifications. The products can usually be hand cut using a utility knife, scissors, band saw or other common cutting tools. Attachment is recommended with solvent based contact adhesives for the urethane foam absorbers and composites. Adhesive recommendations should be reviewed in detail at the time of application as special considerations must be made depending on the surface shape and preparation, whether the surface is oriented horizontal or vertical and what working time is required. Pressure sensitive adhesive systems (PSA) are available for most products and are highly recommended. High tack acrylic based PSA backings are preferred to assure the best bond. Stick clips, insulation pins and other mechanical fasteners may be necessary in addition to the adhesives.

Technical Discussion

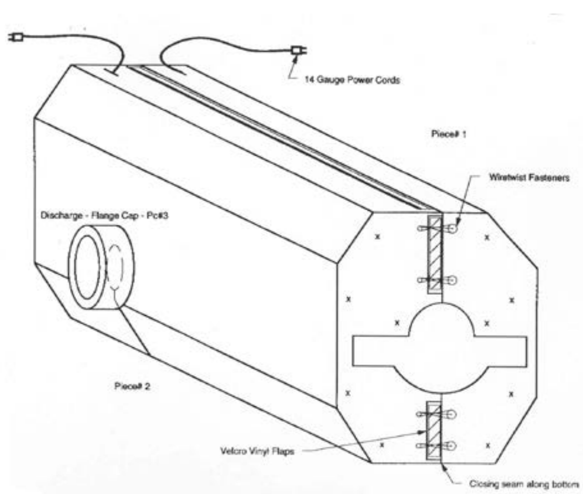


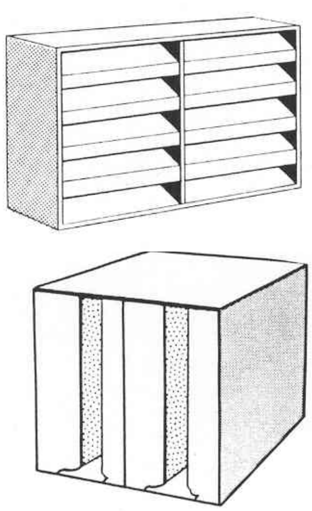
Sizing Machinery Mufflers

Many OEM process systems utilize rotary-positive blowers that will require mufflers or silencers on both the intake and discharge. Without such treatment noise levels could easily be in the 110 to 115 dBA range. Blower sizes are described in inches (for example 12x25) where the first number represents the timing gear diameter and the second number represents the length of the rotor. The product of the gear circumference in feet and the blower RPM is the peripheral velocity of the timing gear. Noise and pulsation produced by rotary-positive blowers inherently reaches a critical level at gear pitch-line velocities of about 3300 feet per minute (FPM) for intakes and 2700 FPM for discharges. These critical gear pitch-line velocities are commonly referred to as the blower transition speeds. Muffler selections shown in the HUSH FLOW™ muffler product section make reference to the blower transition speed. Consult BRD Sales Engineers on muffler applications for process systems and for other equipment such as compressors, engines, generators, turbines, etc. . . .

Designing Sound Blankets

Custom fit removable thermal/acoustic blankets such as the one shown at right are designed based on the equipment or component field measurements and/or housing/casing drawings. For proper construction and fit it is necessary to determine the equipment casing surface temperature. The inner and outer jacketing should be completely water resistant and suitable for both caustic and acidic environments. For durability, all blanket construction should be double sewn lock stitch with a minimum of 7 stitches per inch. All mating match seam blankets should have an overlapping flap cover which is also an extension of the loaded vinyl flexible barrier layer (internal to the blanket). This is essential for minimizing noise leaks. Stainless steel quilting pins should be utilized no greater than 18” apart to prevent shifting of the insulation. Hog ring construction should be avoided wherever possible in order to assure the highest blanket design quality possible.





Selecting Ventilation Silencers

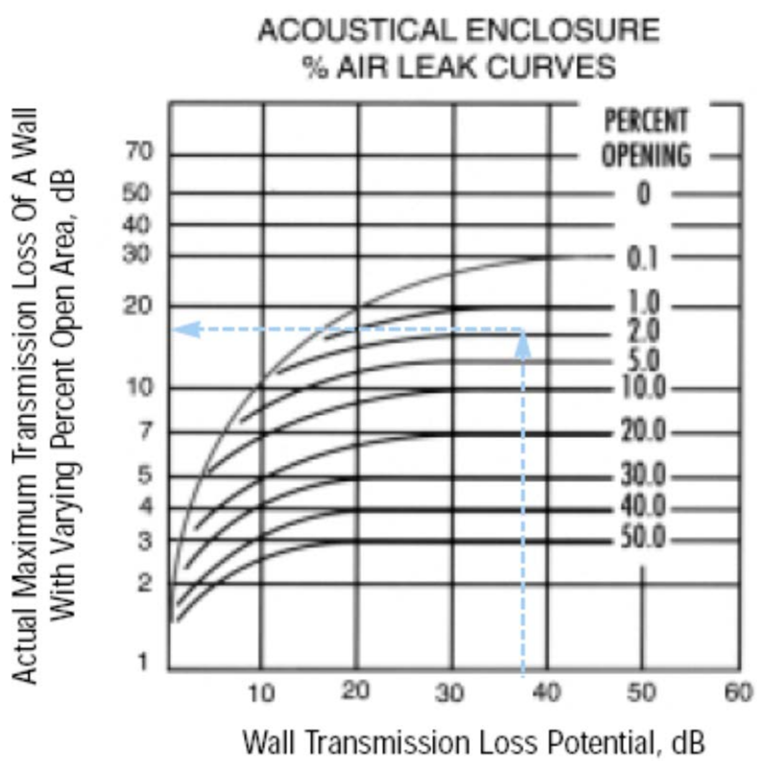
Fan and HVAC silencers on commonly used on low pressure air handling systems and equipment. Acoustic louvers are utilized in conjunction with enclosure or mechanical room ventilation where noise isolation is important. The fundamental tone of frequency that a fan produces is a function of each blade on the fan wheel passing the cut-off sheet on the fan housing. This is commonly referred to as the blade passage frequency (BPF). The first and second multiples of the BPF (harmonics) are prominent but less critical. Calculating the BPF is done by multiplying the fan RPM times the number of blades on the fan wheel, divided by 60 (converts to cycles per second or Hertz). Silencer performance can be approximated by finding the rated insertion loss of the silencer in the octave band where the BPF falls.

Designing Acoustical Enclosures

Noisy equipment and systems may require path control modular acoustical enclosures where source treatments are not practical or effective. Sound enclosures can be freestanding structures, partially integrated or fully integrated with the equipment. Key design considerations for OEM acoustical enclosures include durability, aesthetic appeal, accessibility and visibility, acoustic performance, cost of installation and material manufacturing costs. Depending on the type of equipment, system or process; lighting and ventilation are also important considerations. The goal of the product engineer is to meet the acoustic requirements with a design that incorporates all the necessary features.

Enclosure Design Rule #1: Air Leaks

The chart at right shows how actual sound transmission loss relates to the enclosure wall transmission loss potential (from lab test data) and the percent open area. As shown in the example, as little as 2% open area over the entire surface area of an enclosure reduces the 38dB potential transmission loss to only 18dB actual transmission loss. Air leaks occur around windows and doors, at panel joints, around cutouts to accommodate pipes, ducts, utility lines and other obstructions and where the enclosure does not seal against the floor. Where enclosure ventilation is required, openings that are not acoustically baffled will further reduce the actual dB transmission loss.



Effective Enclosure Design Will Assure The Lowest $ Per dB Cost

Enclosure Design Rule #2: Ventilation

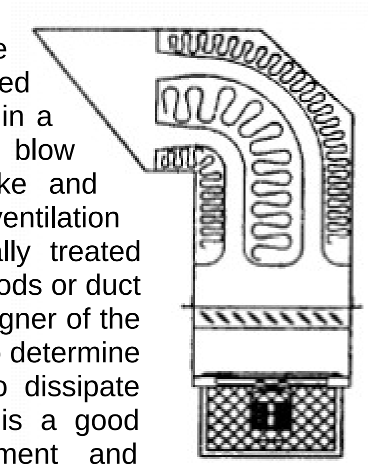
VENTILATION AIR CALCULATION

$$ACFM = \frac{BTU/HR}{1.1 \times \Delta °F}$$

Δ °F= Allowable temperature rise inside the enclosure

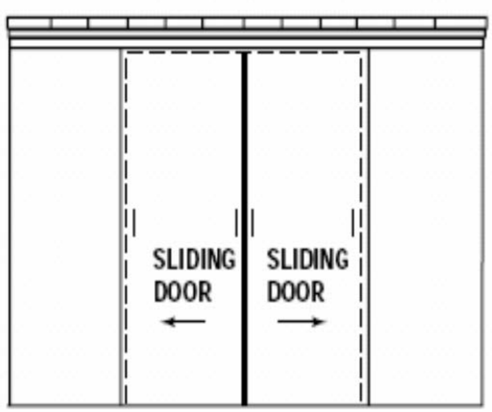
BTU/HR = Heat rejection to the inside of the enclosure from all equipment/systems

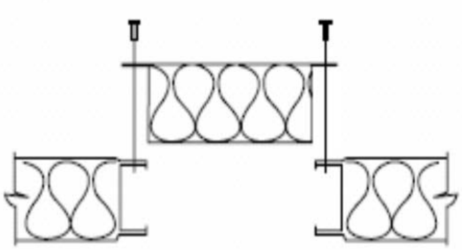
ACFM = Estimated ventilation air flow required.

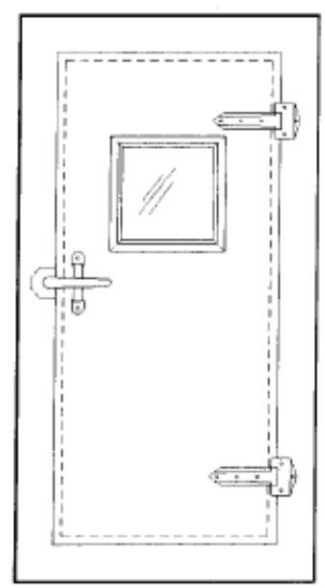


Heat build-up inside acoustical enclosures can be dissipated using forced ventilation fans and blowers in a draw through (see right) or blow through design. The intake and discharge of forced ventilation systems must be acoustically treated with louvers, lined baffles, hoods or duct silencers. The owner or designer of the enclosed equipment needs to determine what is sufficient air flow to dissipate heat. The formula at left is a good guideline. Proper placement and location of intake and discharge openings should ideally bring in air low on one side or end of the enclosure and draw air over the equipment before exiting on the opposite end or side.

Enclosure Design Rule #3: Access







Removable panel sections (bottom left) can allow for infrequent maintenance access in a limited area. Hinged doors (at right) provide for more frequent access but require clearance for the door swing outside the enclosure. Sliding doors (see left) also provide easy access without protruding into work area space outside the enclosure. Acoustical performance of sliding doors is less than that of hinged doors. Double doors provide access to a larger area. Sliding or removable roof panels and sections are best for major repairs requiring a crane. Small enclosure designs can be a knock down design where all panels are latched together for quick and easy disassembly.