Bulletin No. B-234

AEROACOUSTIC®

Silentbarrier™

SOUND BARRIER TECHNOLOGY

The Art & Science of

casting acoustical shadows

New Lorraine Series

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INTRODUCTION

In modern production facilities, noise control is more of a concern now than ever before. As OSHA, state, and local regulations become stricter, manufacturers must modify their facilities to meet these requirements. The three most fundamental approaches to noise control is to reduce the noise at the source, along the path of propagation, or at the receiver. In most cases of industrial noise control, modifying the path of propagation is the only viable solution. This can be achieved by the scientific placement of an acoustic barrier directly between the noise source and the receiver which modifies the path of the noise. Much the same as nature provides protection from the wind and heat of the sun with trees and mountains, barriers properly placed cast "acoustical shadows". Those objects within the "acoustical shadows" are shielded and protected from the noisy environment.

The AEROACOUSTIC Corp. offers a line of acoustic panels for construction of barriers to solve your noise problems. The standard Model 3P and 4P "Silentbarrier" acoustic panels or normal temperature applications are of tongue and groove construction for each assembly and disassembly. Barriers come in a wide selection of shapes: single shielding walls, multiple walls, wall-ceiling combinations. Depending upon the size of the barrier and the required loading, the barrier can either be self-supporting or be attached to a steel structure. The most common application is a free-standing straight wall or 'L' shaped. There is no limitation to the size or configuration of the barrier. Each barrier is custom designed to the specific requirements of the application. Barriers can easily be blended into the surrounding decor and be made esthetically pleasing.

OTHER BULLETINS AVAILABLE FROM THE AEROACOUSTIC CORP.

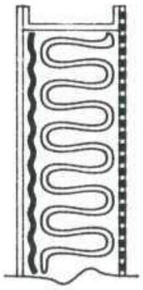
B-341	How to Select Industrial Silencers
B-729A	How to Silence Your Fan
B-433	Silentflow® Splitter Silencers
B-46	Silentflow® Louvers
B-136	Silentflow® Tubular Silencers
B-137	Silentflow® Vaneaxial Silencers
B-332A	Blowoff Silencers
B-238	Silentstack™ Stack Stuffer Silencers
B-235	Silentroom® Acoustic Enclosures and Portable Personnel Rooms
B-49	Silentflow® Electric Motor Silencers
B-148	Silentroom™ Enclosurers for Diesel Powered Equipment
B-67	How to Silence Your Small Gar Turbine
B-131	Silentflow® Gas Turbine Exhaust Silencing System
B-151	Silentjet™ Acoustical Sound Treatment for Jet Engine Test Cells
AC-101	Silentflow® Rectangular Duct Silencer

Silentbarrier™ ACOUSTIC PANEL CONSTRUCTION

MODEL 3P

THIS SERIES REPLACES THE PREVIOUS MODEL 2P AND ADDRESSES THE ASIAN AND EUROPEAN MARKET WHICH REQUIRES A 75mm PANEL. THE APPLICATION OF THIS PANEL SYSTEM INCLUDES OPEN-TOP ENCLOSURES, ENCLOSURES, SOUND BARRIERS AND PARTITIONS WHERE THE REQUIRED NOISE REDUCTION IS NOMINAL. THE MATERIALS OF CONSTRUCTION INCLUDE A 16 GAGE SOLID BACK COATED WITH A VISCOELASTIC FILM, THREE INCHES OF ACOUSTICAL FILL AND A 22 GAGE PERFORATED INTERIOR SURFACE.

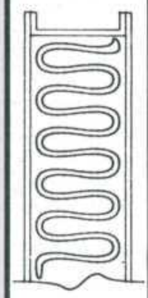
AVERAGE WEIGHT PER SQUARE FOOT IS 6.5 LBS.



MODEL 4P

THIS SERIES IS THE INDUSTRY STANDARD PANEL WHICH SATISFIES THE NOISE REDUCTION AND SOUND ABSORPTION FOR ALMOST ALL INDUSTRIAL APPLICATIONS; ENCLOSURES, ROOMS, PLENUMS, PARTITIONS AND SOUND BARRIERS. THE MATERIALS OF CONSTRUCTION INCLUDE A 16 GAGE SOLID BACK COATED WITH A VISCOELASTIC FILM, FOUR INCHES OF ACOUSTICAL FILL AND A 22 GAGE PERFORATED INTERIOR.

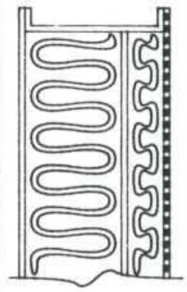
AVERAGE WEIGHT PER SQUARE FOOT IS 7.0 LBS.



MODEL 4PHS

THIS SERIES IS USED WHERE MAXIMUM EXTERIOR NOISE REDUCTION AND NO INTERIOR SOUND ABSORPTION IS REQUIRED. THE USE OF THIS PANEL INCLUDES ENCLOSURES, PARTITIONS, SOUND BARRIERS AND THERMAL PLENUMS. THE MATERIALS OF CONSTRUCTION INCLUDE A 16 GAGE SOLID EXTERIOR SURFACE, FOUR INCHES OF ACOUSTICAL FILL AND A 18 GAGE INTERIOR SURFACE.

AVERAGE WEIGHT PER SQUARE FOOT IS 7.5 LBS.



MODEL 6P

THIS SERIES IS DESIGNED FOR USE IN THE MOST SEVERE ACOUTIC ENVIRONMENTS PROVIDING A HIGH NOISE REDUCTION WITH THE ADDITION OF SOUND ABSORPTION. THE PANELS ARE USED FOR ENCLOSURES, PLENUMS AND SOUND BARRIERS FOR EXCEPTIONALLY NOISY EQUIPMENT. THE MATERIALS OF CONSTRUCTION INCLUDE A 16 GAGE SOLID EXTERIOR SURFACE, SIX INCHES OF ACOUSTICAL FILL, A SOLID SEPTUM SHEET AND A 22 GAGE PERFORATED INTERIOR SURFACE.

AVERAGE WEIGHT PER SQUARE FOOT IS 8.5 LBS.

STANDARD CONSTRUCTION

The exterior surface, internal channels and interior surface of the panels are of galvanized construction with a 3# Owens-Corning 703 resin-bonded fiberglass acoustic fill. The fill is inert, vermin and moisture proof and has a flame spread classification of 15 and a smoke development rating of zero. The panels are available in any width and height equal to or less than 60" wide by 144" long.

ALTERNATE CONSTRUCTION

When a painted surface is required, the panels are constructed of galvanneal. Galvannealed sheets are coated by a special process and then heat treated after coating to produce a zinc-iron alloy and eliminate the spangle. The panel can be painted without surface preparation other than normal cleaning. For applications in the chemical, pharmaceutical or food industry, the panels can be constructed of T-304 or T-316 stainless steel. Also, the acoustic fill in the panel can be wrapped with a protective layer of mylar to prevent contamination of the fill.

HI-TEMP CONSTRUCTION

When the temperature of the application is above 400°, the standard construction is not applicable. The panels can be constructed of either hot-rolled steel or T-409 stainless steel with a 6# US Gypsum mineral wood blanket acoustic fill and layer of glass cloth. If the panels are constructed of hot-rolled steel, they will be coated inside and out with a heat resistant flat black air dry coating. Either construction can withstand temperatures up to 1000°.

TABLE 1

TRANSMISSION LOSS OF *Silentbarrier*™ ACOUSTIC PANELS

Performance Certified by two (2) Independent Nationally Recognized Testing Laboratories in accordance with ASTM-E90-90 and E413-87 Test Standards.

1/1 OCTAVE BAND FREQUENCY Hz			63†			125			250			500			1000			2000			4000			8000†	
1/3 OCTAVE BAND FREQUENCY Hz		50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
MODEL	STC	SOUND TRANSMISSION LOSS IN DECIBELS																							
3P, 3PHT PANEL	40		21			23			27			38			46			55			61			61	
		—	—	—	26	21	24	24	28	31	36	39	41	44	47	51	53	55	58	60	62	62	—	—	—
4P, 4PHT PANEL	44		22			24			31			42			52			61			66			66	
		—	—	—	24	23	24	28	31	36	40	43	47	50	53	57	60	61	63	66	66	65	—	—	—
4P WINDOW PANEL	43		22			25			30			42			51			59			65			65	
		—	—	—	25	24	27	27	31	35	39	41	46	49	52	54	57	59	61	64	65	65	—	—	—
4PHS † PANEL	53		22			29			40			53			60			61			66			66	
		—	—	—	29	29	30	36	45	47	50	53	58	59	60	59	60	61	62	65	66	68	—	—	—
4PHS WINDOW PANEL	48		23			27			40			53			60			61			66			66	
		—	—	—	29	24	30	36	45	47	50	53	58	59	60	59	60	61	62	65	66	68	—	—	—
4PHS DOOR PANEL	48		23			28			38			44			53			56			64			64	
		—	—	—	26	28	33	38	38	37	41	45	48	52	53	53	54	56	60	63	64	64	—	—	—
6P, 6PHT PANEL	55		22			31			44			57			62			66			71			71	
		—	—	—	28	31	41	41	46	50	55	57	60	61	62	63	65	65	67	70	71	71	—	—	—

† - ESTIMATED VALUES PROVIDED FOR ACOUSTIC CALCULATIONS
STC - SOUND TRANSMISSION CLASS

TABLE 2

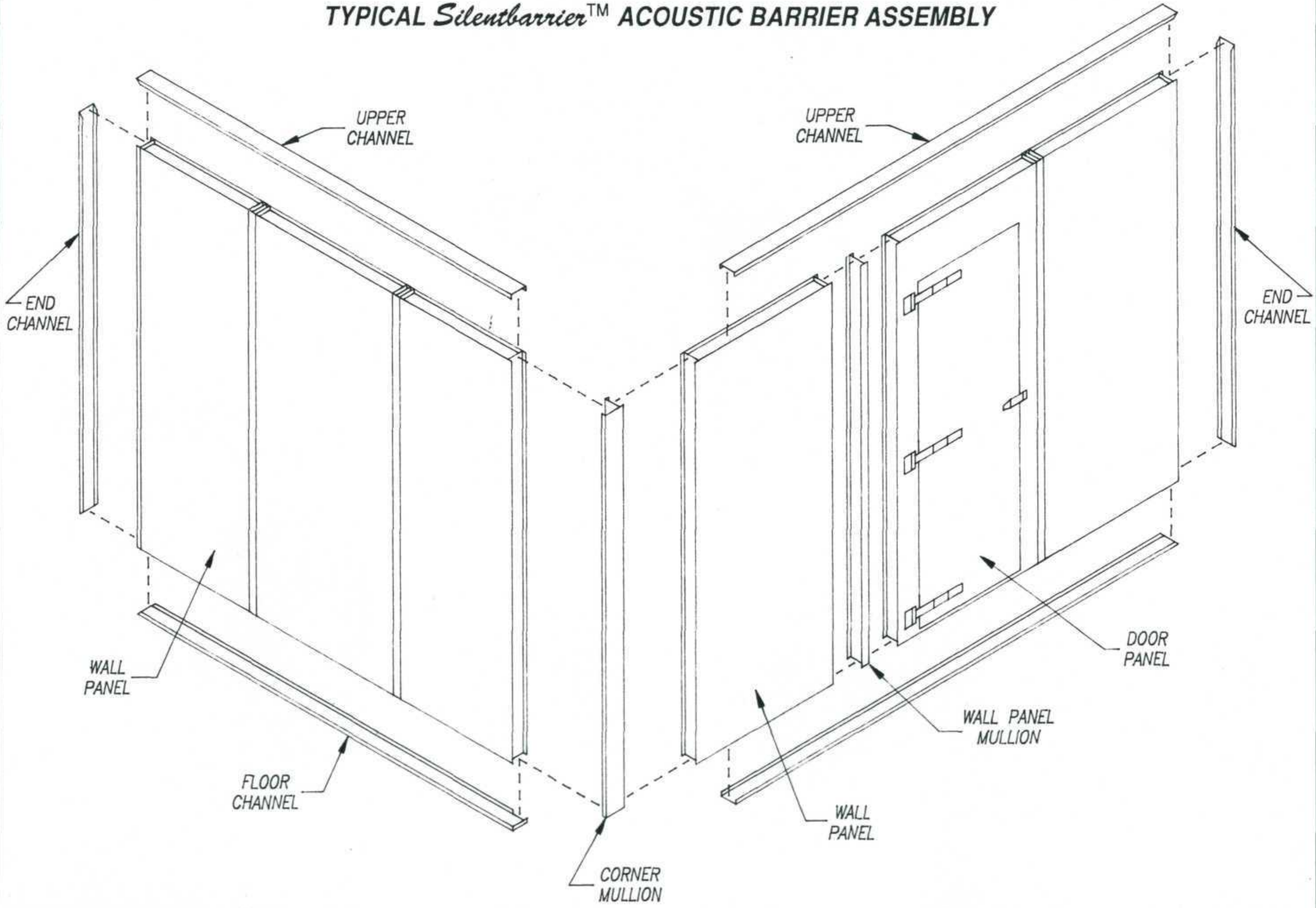
SOUND ABSORPTION COEFFICIENT OF *Silentbarrier*™ ACOUSTIC PANELS

Performance Certified by two (2) Independent Nationally Recognized Testing Laboratories in accordance with ASTM C423-90a and E95-91 Test Standards.

1/1 OCTAVE BAND FREQUENCY Hz			63†			125			250			500			1000			2000			4000			8000†	
1/3 OCTAVE BAND FREQUENCY Hz		50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
MODEL	NRC	SOUND ABSORPTION COEFFICIENT IN SABIN/SQ FT																							
3P PANEL	1.10		0.32			0.46			0.96			1.25			1.06			1.07			1.03			0.82	
		—	—	—	0.27	0.46	0.52	0.69	0.96	1.12	1.28	1.25	1.14	1.11	1.06	1.08	1.06	1.07	1.06	1.08	1.03	1.05	—	—	—
3PHT PANEL	1.10		0.25			0.35			1.11			1.17			1.06			1.00			1.02			0.82	
		—	—	—	0.43	0.35	0.66	1.03	1.11	1.20	1.20	1.17	1.11	1.09	1.06	1.05	1.03	1.00	1.02	1.00	1.02	1.04	—	—	—
4P PANEL	1.15		0.47			0.67			1.27			1.20			1.08			1.04			1.04			0.83	
		—	—	—	0.42	0.67	0.90	1.24	1.27	1.27	1.24	1.20	1.13	1.10	1.08	1.06	1.03	1.04	1.05	1.02	1.04	1.06	—	—	—
4PHT PANEL	1.05		0.55			0.78			1.10			1.08			1.05			1.03			0.99			0.79	
		—	—	—	0.64	0.78	0.99	1.19	1.10	1.12	1.16	1.08	1.08	1.07	1.05	1.04	1.04	1.03	1.02	1.01	0.99	0.99	—	—	—
4PHS PANEL	•		•			•			•			•			•			•			•			•	
		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
6P PANEL	0.95		0.26			0.37			0.80			1.06			1.00			0.99			0.97			0.78	
		—	—	—	0.58	0.37	0.37	0.52	0.80	1.08	1.10	1.06	1.06	1.03	1.00	1.05	1.02	0.99	1.05	0.99	0.97	1.00	—	—	—
6PHT † PANEL	0.90		0.17			0.24			0.68			0.97			1.00			0.99			0.92			0.74	
		—	—	—	0.44	0.68	0.92	0.44	0.68	0.92	1.01	0.97	0.98	1.02	1.00	1.04	1.00	0.99	1.04	0.93	0.92	0.94	—	—	—

• - ABSORPTION COEFFICIENTS ARE NOT AVAILABLE FOR A PANEL WITH SOLID SHEETS ON BOTH SIDES
† - ESTIMATED VALUES PROVIDED FOR ACOUSTIC CALCULATIONS
NRC - NOISE REDUCTION COEFFICIENT

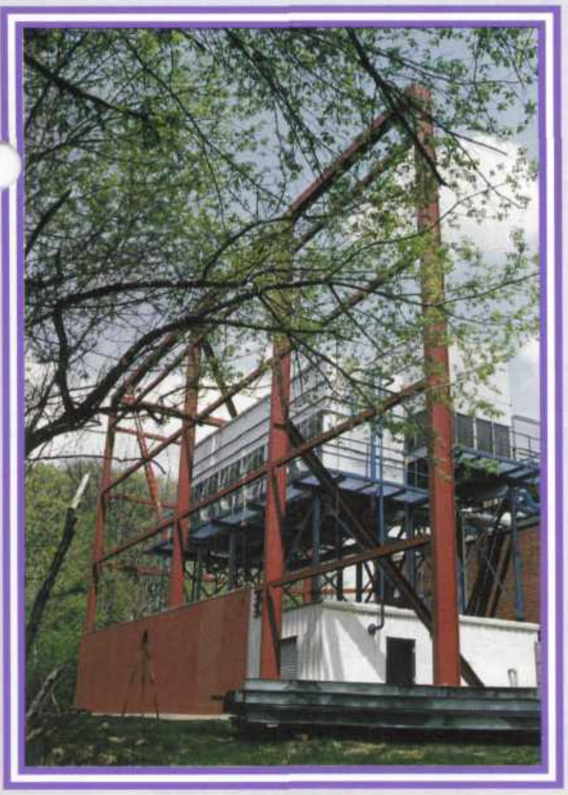
TYPICAL *Silentbarrier*™ ACOUSTIC BARRIER ASSEMBLY

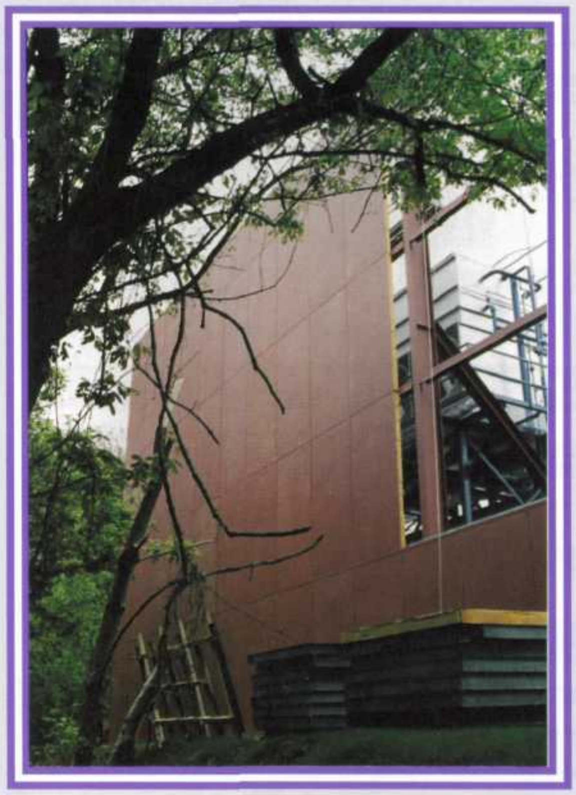


The barrier is designed to reduce the noise which is emanating from a fuel line heater and the discharge stack. The barrier measures 16' long x 10' wide x 10' high and is constructed of Model 4P acoustic panels mounted to a steel structure.

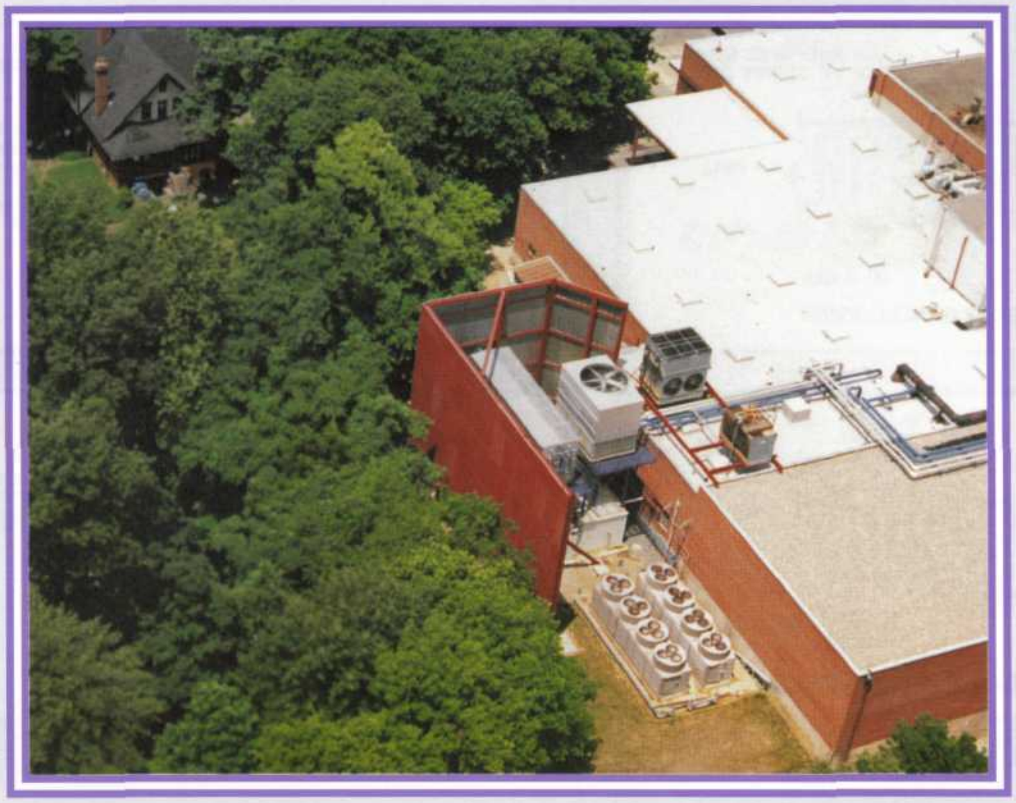
The barrier measures 13' long x 10' wide x 12' high and is constructed of Model 4P acoustic panels mounted to a steel structure and is guy-wired for wind loading. The barrier is designed to isolate the fan discharge and casing radiated noise from the nearby residential property.

The barrier is mounted on the roof of an office building and is designed to isolate the noise emanating from the air-handling unit from the nearby residential property. The barrier measures 25' long x 12' wide x 13' high and is constructed of Model 4P acoustic panels mounted to a steel structure.

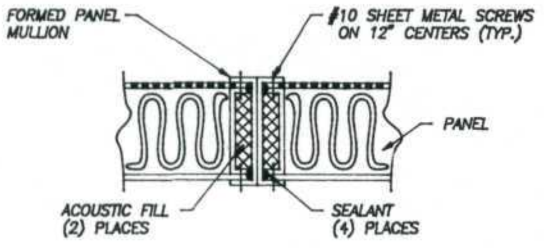




The barrier depicted above is shown during panel erection and below is an aerial view of the completed installation. The barrier measures 73' long x 35' wide x 45' high and is constructed of Model 4P panels mounted to a steel structure. The purpose of the barrier is to reduce the noise level from the elevated cooling towers by 25 dB in the 250 Hz band at the neighbors house which is shown below.

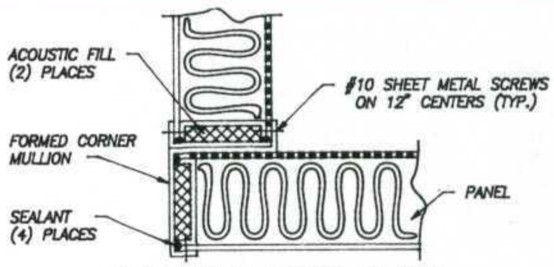


STANDARD PANEL CONNECTIONS *



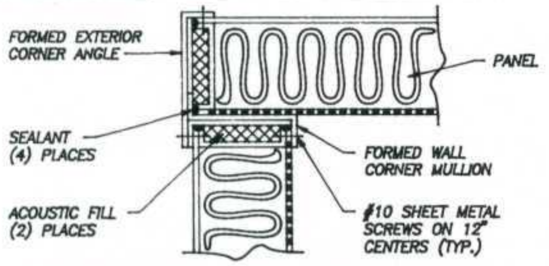
WALL PANEL JOINT

DETAIL 1



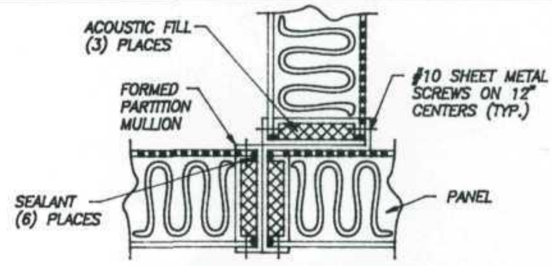
WALL PANEL CORNER DETAIL

DETAIL 2



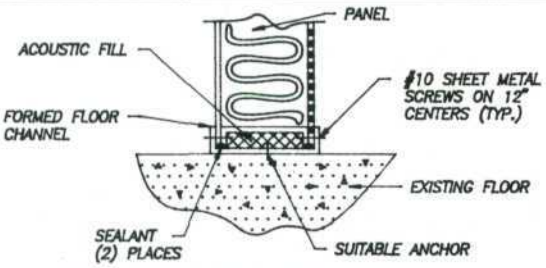
REMOVABLE WALL PANEL CORNER DETAIL

DETAIL 3



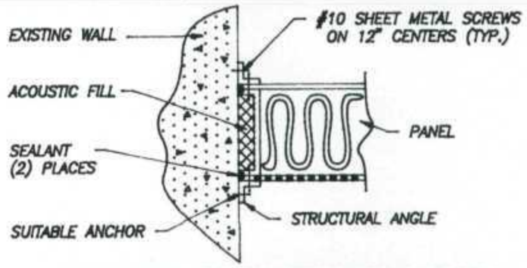
PARTITION WALL JOINT

DETAIL 4



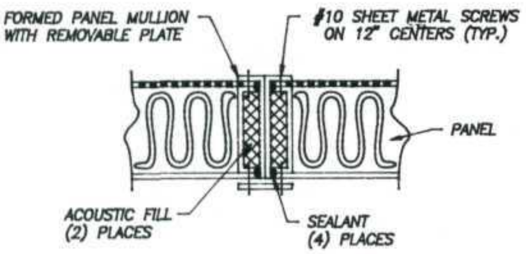
WALL PANEL TO FLOOR OR WALL JOINT

DETAIL 5



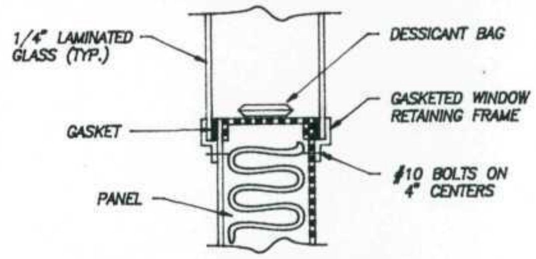
WALL PANEL TO EXISTING WALL JOINT

DETAIL 6



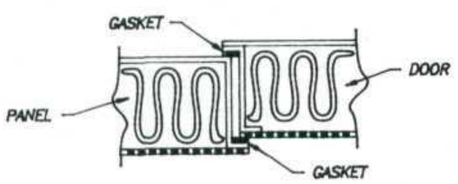
REMOVABLE WALL JOINT

DETAIL 7



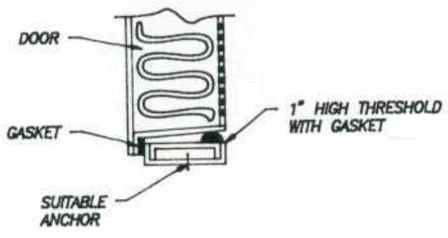
WINDOW SEAL

DETAIL 8



DOOR HEAD AND JAMB SEAL

DETAIL 9

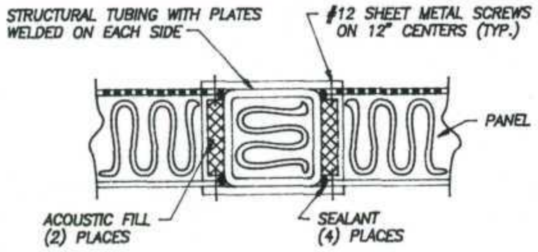


SINGLE/DOUBLE DOOR SILL SEAL

DETAIL 10

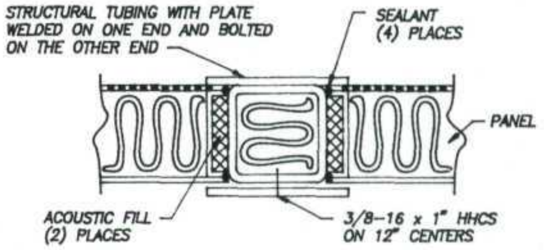
*** BARRIER HEIGHT AND/OR WIDTH NOT TO EXCEED 12 FEET**

STRUCTURAL PANEL CONNECTIONS *



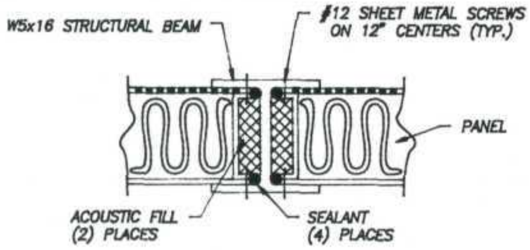
WALL PANEL JOINT

DETAIL 1



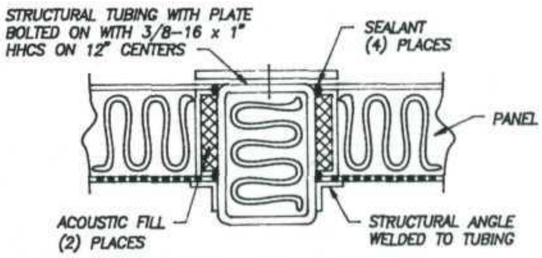
REMOVABLE WALL PANEL JOINT

DETAIL 2



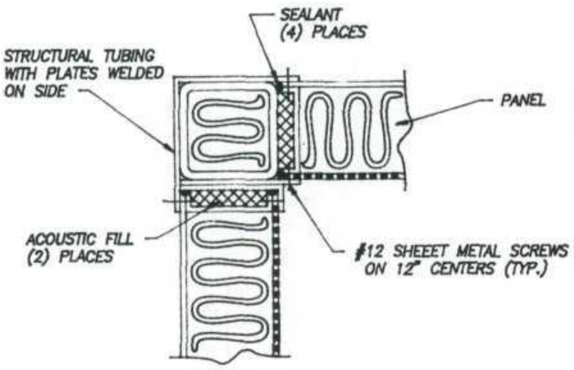
WALL PANEL JOINT

DETAIL 3



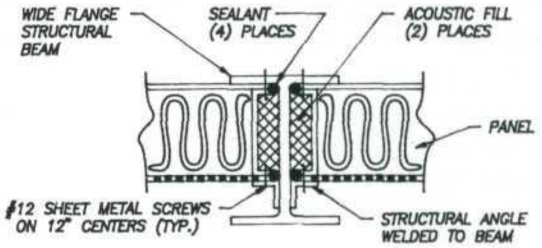
REMOVABLE WALL PANEL JOINT

DETAIL 4



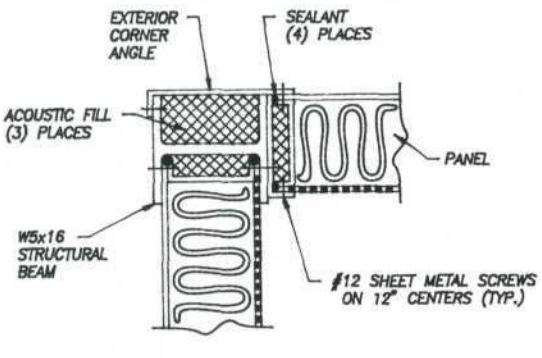
WALL PANEL CORNER JOINT

DETAIL 5



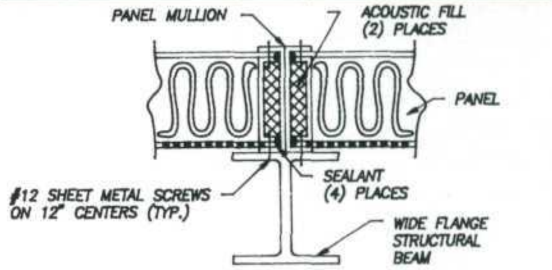
WALL PANEL JOINT

DETAIL 6



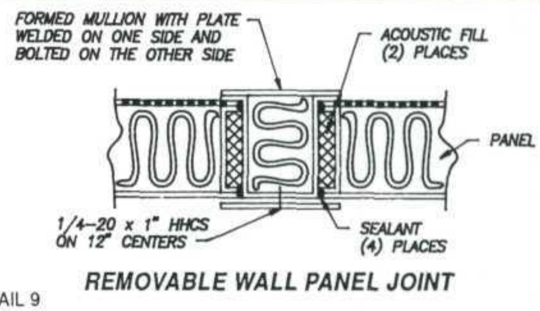
WALL PANEL CORNER JOINT

DETAIL 7



WALL PANEL JOINT

DETAIL 8



REMOVABLE WALL PANEL JOINT

DETAIL 9

*** BARRIER HEIGHT AND/OR WIDTH EXCEEDS 12 FEET**

Silentbarrier™ DESIGN AND PERFORMANCE

The use of an acoustic barrier between a noise source and the receiver is an effective solution to reduce the noise level at the receiver without interfering with the operation or maintenance of the equipment. The physical dimensions and location of the barrier are critical so as to envelop the noise sensitive area in the "acoustical shadow" cast by the barrier. The calculations below and the charts on the following pages are based upon an infinite outdoor barrier in a free field. An infinite barrier is defined as a barrier whose length greatly exceeds its height so that the only noise to reach the receiver is from over the top of the barrier. A free field means an area where there are no reflective surfaces such as other walls, roofs, or equipment which can increase the noise level at the receiver.

The placement and height of a barrier with respect to the noise source will greatly affect the barriers' performance. The insertion loss of a barrier can be increased by raising the height of the barrier or moving the noise source or receiver closer to the barrier. The insertion loss of an infinite outdoor barrier in a free field can be estimated based upon the following equations:

$$IL = 10 \log(N + 0.2) + 12.0$$
$$N = 2\Delta / \lambda$$
$$\lambda = c / f$$
$$\Delta = A + B - D$$

where:
- IL: insertion loss (per octave band in dB)
- N: Fresnel number for diffraction around the barrier edge
- Δ: difference between the shortest diffracted path and the direct path without a barrier
- λ: wavelength (ft)
- c: speed of sound; 1,125 ft/sec
- f: frequency (Hz)

Using the above equations and the example shown below, the estimated insertion loss of the barrier is as follows:

Octave Bank Center Frequency	62.5	125	250	500	1000	2000	4000	8000
Barrier Insertion Loss	9.0	11.0	13.5	16.1	19.0	21.9	24.9	27.9

The above calculated insertion loss values are accurate, however, there is a physical upper limit due to atmospheric irregularities and turbulence. Experimental data has shown that the upper limit is approximately 24 dB, therefore, in the above example, the 4000 and 8000 Hz band is limited to 24 dB. When designing a barrier, several factors should be taken into consideration:

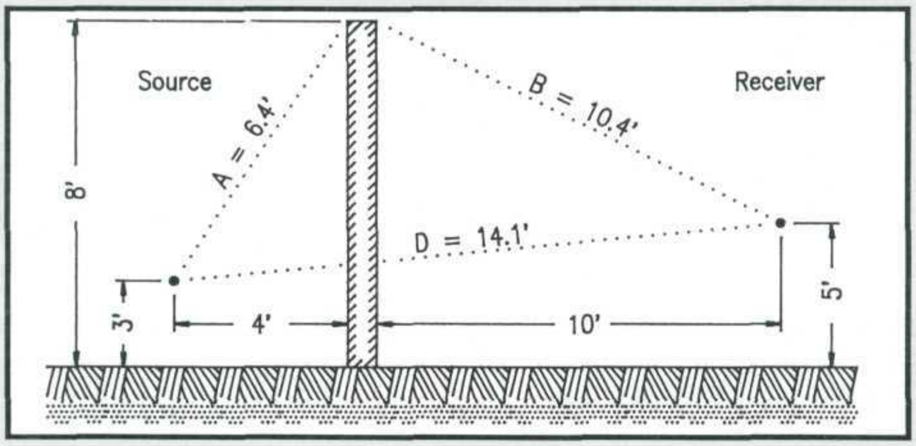
— the transmission loss of the barrier must be 10 dB greater in each of the eight octave bands than the insertion loss to eliminate any noise contribution which could reach the receiver thru the barrier.

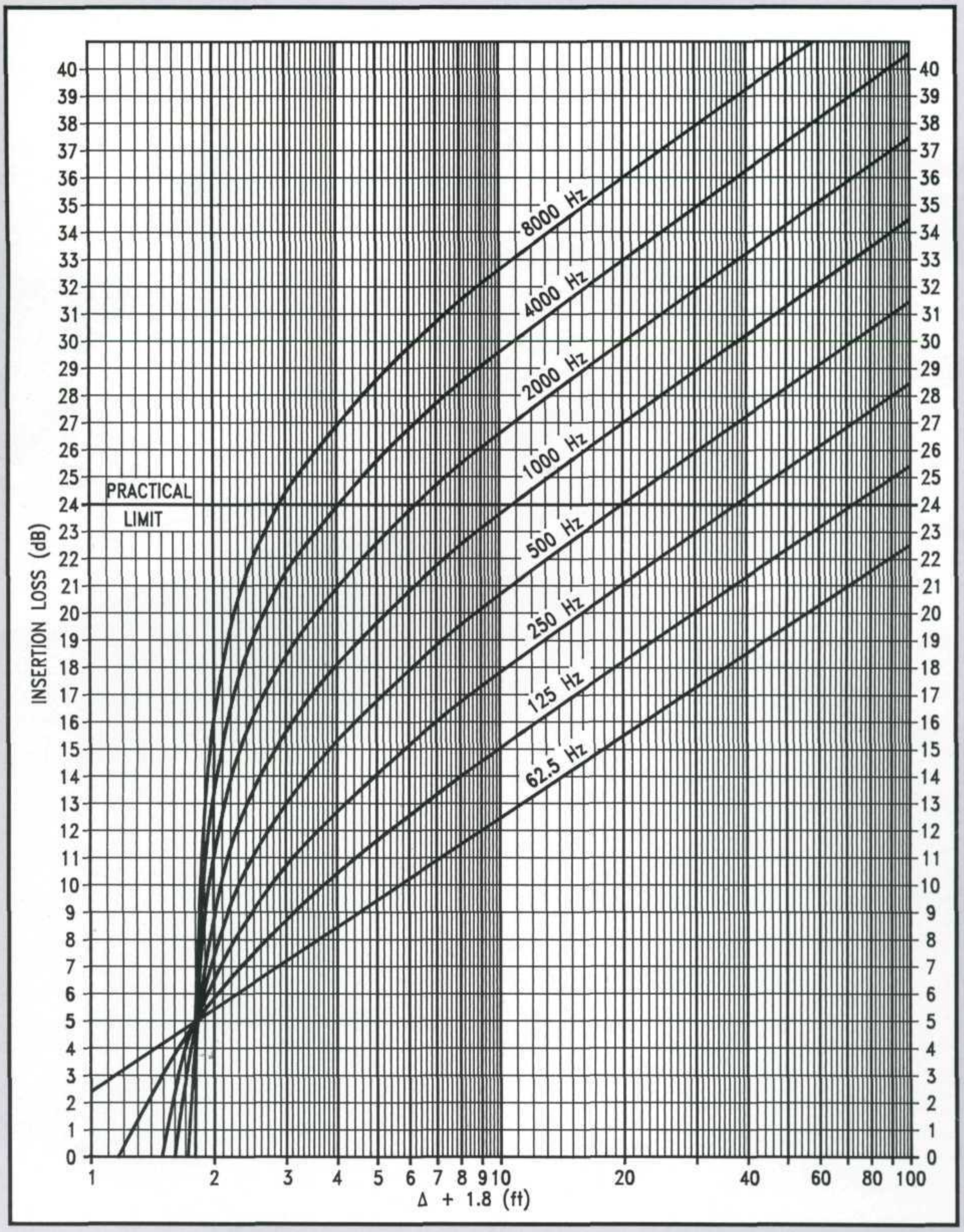
— the barrier should break the line of sight between the noise source and the receiver. If the barrier, noise source and the receiver are at the same elevation, the insertion loss of the barrier will be 5 dB.

— the sound absorbent side of the barrier should face towards the noise source to reduce the build-up of sound between the source and the barrier and also reduce the noise which is reflected in the opposing direction. This will increase the insertion loss of barrier by 1 or 2 dB.

One drawback with these calculations is that it is based upon an infinite barrier which is almost never the case in a practical application. However, the following correction factors can be used to estimate the insertion loss of a semi-infinite barrier. After calculating the finite barrier insertion loss values, subtract the following corrections based upon a ratio of the barrier length versus height.

Ratio of length/height	1.0	2.0	3.0	4.0
Correction Factor	5.0	3.0	2.0	1.0





In lieu of plodding thru the calculations on the previous page, above is an easy to use insertion loss chart. Using this chart, the only item which has to be calculated is Δ (delta). Once this is calculated, add 1.8 to Δ , draw a vertical line at this value on the chart and read the intersection points with the frequency curves to obtain the insertion loss values remembering to take into consideration the 24 dB upper limit.

The previous calculations are based upon an infinite barrier in a free field. When the barrier is placed outdoors, nearby reflective surfaces should be evaluated and taken in to consideration when calculating the sound pressure levels. Also, if the barrier is placed indoors, the insertion loss and acoustic analysis becomes very complicated. In either case, please contact The AEROACOUSTIC Corp's Engineering Department for assistance.