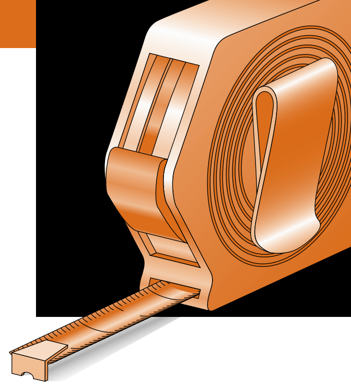


Industrial Noise Control

Introduction

The information in this publication is intended to provide:

1) A description and interpretation of OSHA's basic requirements with regard to industrial noise control.

2) A working knowledge of the fundamental terminology used in the field of industrial noise-control design.

3) Design guidelines for incorporating wood structural panels (plywood, OSB and COM-PLY®) in industrial noise-control projects, including methods for estimating the potential effectiveness of various noise-control measures commonly considered.

For complete details on any of the subjects outlined, study the references listed on the back cover. References are indicated by italicized numbers in parentheses ( ).

Sound may be transmitted into a building or between parts of a building in two basic ways: a) by sound waves transmitted through the air – airborne sound, or b) through vibrations transmitted into solids or building components from a source which is structurally connected. (Vibrating components then transmit the sound to the air.) For the purposes of this publication, airborne sound problems will be the primary consideration.

Airborne sounds may be transmitted either directly through the air, such as through floor, wall, or ceiling openings, or in the following manner: sound waves acting on one side of a floor, wall or ceiling surface cause the surface to vibrate like a diaphragm and transmit the sound waves into the air space on the opposite side.

In order to "isolate" unwanted airborne sound from a given source in buildings, the designer must recognize that the floor, wall and ceiling coverings of the existing structure, and the shape and size of the structure containing the source, will all affect the control measures. Airborne sound may be transmitted directly to a receiver, or it may be affected by reflection, resonance, reverberation, diffusion, diffraction and absorption. Each of these terms is defined in the following text, and/or in the glossary.

For industrial noise problems, designers thinking in terms of a source-path-receiver relationship will most often be interested in reducing the noise level from a given source by isolating it from the receiver through the use of barriers or enclosures. The materials used for these barriers or enclosures will be required to reflect and/or absorb airborne sound.

Reflective materials are typically hard and dense, while good absorptive materials are usually light and fibrous. Wood structural panels are generally most applicable as sound reflectors, although they may be required to provide structural support for absorptive materials. In any case, airtight surfaces will be the most effective sound barriers.

Absorptive materials can reduce the energy of the sound transmitted through a barrier in double-wall constructions, and the amount of sound reflected by a barrier. Attached to the face of reflective surfaces, absorptive materials can reduce the noise level on the source side of the barrier.

The effect of absorptive materials in double-wall construction is discussed on page 6, "Wood Structural Panels and Sound Absorption."

Before going into further explanation of terms and specifics on noise-control methods, a look at basic OSHA requirements is in order. The following section covers these requirements.

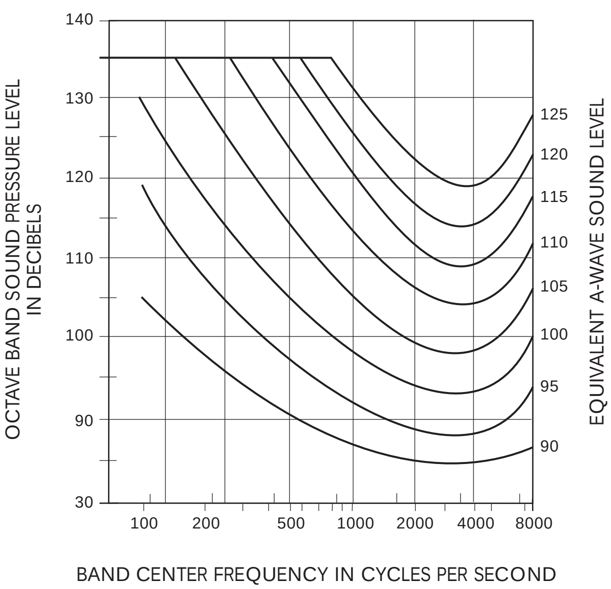
APA

The Engineered Wood Association

OSHA Section 1910.95 – Occupational Noise Exposure

The Occupational Safety and Health Act of 1970 states that "…a continuing, effective hearing conservation program shall be administered'' to protect employees from potentially damaging effects of exposure to occupational noise. Permissible exposure limits established by OSHA are defined by their Table G-16 – note the excerpt below:

"(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:'' *(see Band Center Frequency in Cycles per Second reprinted below).*



Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table G-16.

TABLE G-16 Permissible Noise Exposures[1]

Duration Per Day, Hours	Sound Level dBA Slow Response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

[1]"When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 \ldots C_n/T_n$, exceeds unity, then the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.''

Example: If an employee were exposed to a 90 dBA noise level for 5 hours and a 95 dBA noise level for 3 hours, the exposure would be evaluated as follows:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} = \frac{5}{8} + \frac{3}{4} = 1.37 > 1.0$$

Therefore this exposure exceeds the allowable limits, and corrective noise abatement measures would be required.

"(b) (1) When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous."

Determining Sound-Level and Permissible Limits

Loss of hearing occurs as a result of the cumulative effect of exposure to sound above a maximum intensity and over a maximum duration in a given period of time. The basic permissible intensity is 90 dBA for a duration of eight hours out of a day. The amount of sound energy absorbed during such an exposure is considered to be the upper limit of a daily dose, which will not produce disabling loss of hearing in more than 20 percent of the exposed population.

Table G-16 indicates the duration of exposure to higher sound intensities, which will result in no more damage to hearing than produced by eight hours at 90 dBA. Exposure to steady sound levels above 115 dBA, regardless of the duration, should be avoided.

The abbreviation dB in the right-hand column of Table G-16 stands for decibels, the unit of measurement of sound levels. The term dBA indicates decibels as indicated on the A scale of a sound level meter. The A scale is one of several on the sound level meter – a measuring instrument used to determine sound intensity. On this scale, the instrument reacts in much the same way as does the human ear in that it is much less responsive to low pitched tones than to those of higher pitch. The "slow'' response is another setting of the instrument that causes it to average out high level noises of brief duration (such as hammering), rather than responding to the individual impact noises.

It is important to note that decibels are measured on a logarithmic rather than a linear scale. Every increase of 10 dB represents a tripling of the sound pressure intensity. A 100 dB noise is, therefore, three times as intense as a 90 dB, rather than about 10 percent more intense, as might be expected. Illustrated another way, if one machine produces a sound level of 90 dB, a second machine of the same kind placed next to it will result in a combined noise level of 93 dB, rather than 180 dB, which might be expected.

The following two tables relate dBA units to common sounds. Note the change in apparent loudness produced by a 10-decibel change in sound level.

TABLE 1[2] Subjective Effect of Changes in Sound Characteristics

Change in Sound Level	Change in Apparent Loudness
3dBA	Just perceptible
5dBA	Clearly noticeable
10dBA	Twice as loud (or 1/2)
20dBA	Much louder (or quieter)

TABLE 2[2] Comparison of Sound Pressure Level, and Common Sounds in dBA

Decibels	Loudness
140	Jet aircraft and artillery fire
130	Threshold of pain
120	
110	Near elevated train
100	Inside propeller plane
90	Full symphony or band
80	Inside auto at high speed
70	
60	Conversation, face to face
50	Inside general office
40	Inside private office
30	Inside bedroom
20	Inside empty theatre
10	
0	Threshold of hearing

Noise Control Design Considerations Wood Structural Panels and Sound Isolation

Noise-control measures can be applied to the source, in the noise path between the source and the receiver, or at the receiver. It is best to consider this source-path-receiver relationship in discussion of noise-control measures.

Noise-control problems are usually approached with economic considerations weighed against desirable and/or required results.

Wood structural panels can generally be used effectively in wall-barrier and room-enclosure systems between the source and the receiver. In the simplest form, a single-wall wood structural panel barrier can be considered, but for best efficiency with a floor-to-ceiling barrier (or an enclosure), a double-wall construction should be used.

Mass Law

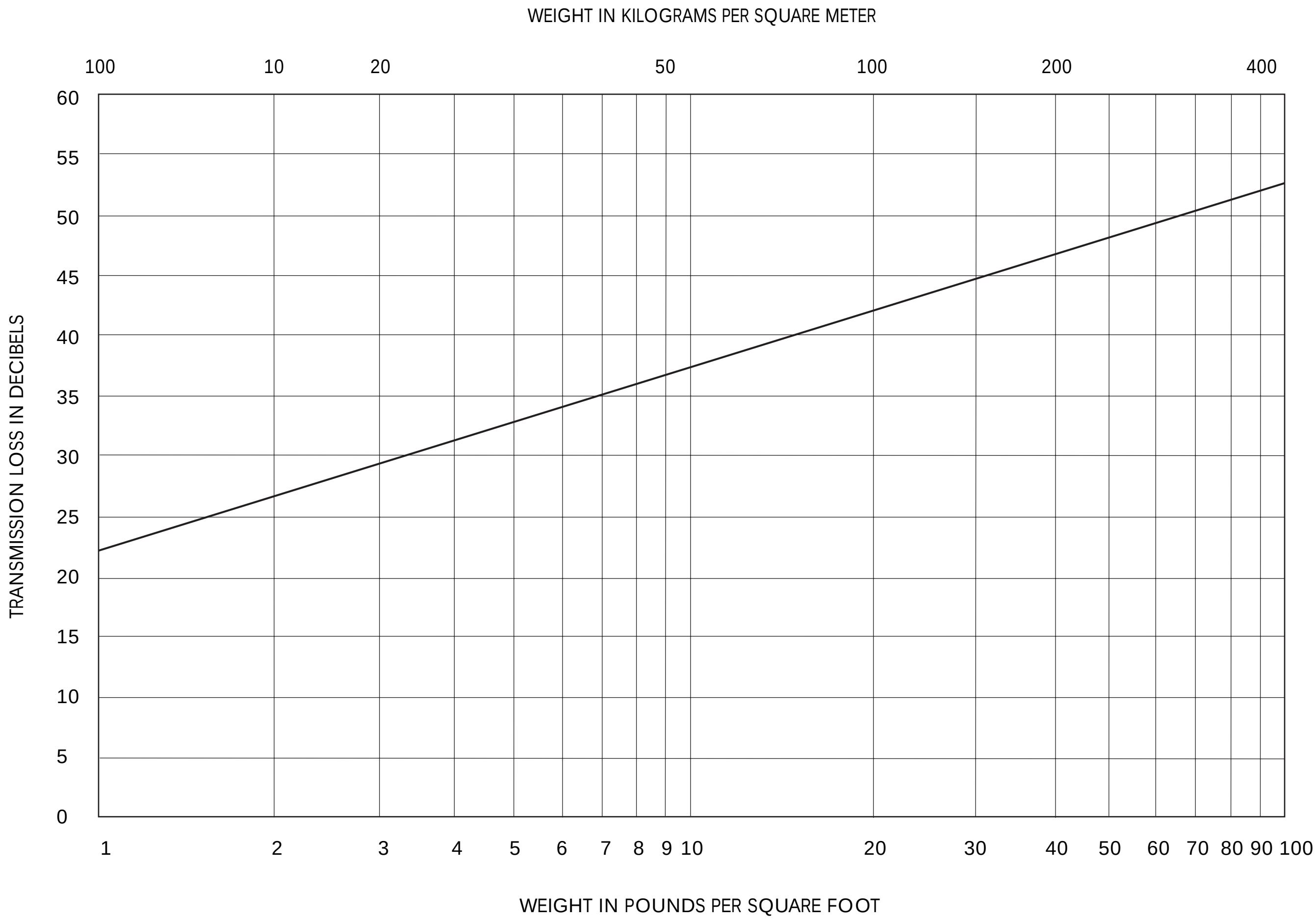
The noise-isolation potential of a given barrier or enclosure can be approximated initially if the weight per unit area is known. The following equation can be used for this estimate[1]:

$$TL = 23 + 14.5 \log_{10} m$$

Where:

– TL is the sound transmission loss through the barrier in dB.
– m is the "mass'' of the partition in psf.

FIGURE 1 The Mass Law Relation Between Average Sound Transmission Loss and Mass Per Unit Area of Partition



A plot of this empirical law known as the "mass law'' results in the straight-line relationship shown in Figure 1. (Other mass-law relationships can also be made such as TL vs. a product of the sound frequency and the material surface weight, and relationships that consider the incident angle of the noise source. [*See reference No. 6.]*)

The mass law relationship may be used to *approximate* the potential effectiveness of a given construction – single or double wall (without acoustical treatment of any kind).

Double-Wall Construction

For double-wall constructions (two separate layers not rigidly connected), Figure 2 may be used to estimate the double-wall "increase'' for an average frequency range. (Note that the wall surfaces must be constructed with no rigid connection between them to take full advantage of the air space.) This method should result in a reasonable estimate if good acoustical construction practices are followed. Test results fit well to this relationship for a variety of wall systems utilizing wood structural panels such as – Note panels 214, 215 and 218 in Table 3, page 5.

FIGURE 2(3) Transmission Loss (TL) Increase – Double Wall with Air Space vs. Solid Wall

(Weights equal, two separate layers not rigidly connected)

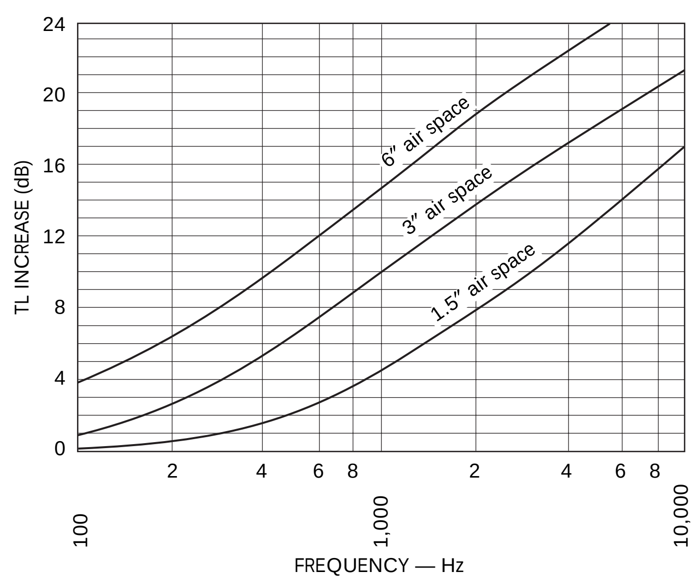


TABLE 3(1)

NBS Panel No.	Description of Partition	Thickness (in.)	Weight (psf)	Transmission Loss (dB) Avg. 125-4000 Hz	125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	750 Hz	1000 Hz	2000 Hz	4000 Hz
211	Plywood, 1/4-in., glued to both sides of 1 x 3 in. studs, 16 in. o.c.	3	2.5	24	16	16	18	20	26	27	28	37	33
212	Same as panel 211 except 1/2-in. gypsum wallboard nailed to each face	4	6.6	40	26	34	33	40	39	44	46	50	50
214	Plywood, 1/4-in., glued to opposite sides of 1 x 3 in. staggered wood studs, 16 in. o.c. in each leaf, 4 in. air space	4	2.9	26	14	17	20	23	28	30	33	40	30
215	Same as panel 214 except 1/2-in. gypsum wallboard glued to both plywood faces	5	7.0	46	40	37	39	45	48	50	51	54	55
216	Plywood, 1/4-in., glued to opposite sides of two sets of 2 x 2 in. wood studs, 16 in. o.c., inner sides of studs spaced 1 in., two sheets 1/2-in. gypsum wallboard inserted in 1 in. space	4-3/4	8.0	35	18	25	29	31	32	37	42	49	51
217	Plywood, 1/4-in., glued to opposite sides of 2 x 2 in. wood studs, 16 in. o.c., inner sides of studs spaced 1/4-in., one sheet 1/4-in. plywood inserted between studs, paper-backed mineral wool inserted in air spaces	4	5.2	37	20	31	31	35	37	41	41	49	50
218	Plywood, 1/4-in., glued to outer surface of 2 x 2 in. wood studs 16 in. o.c., 1/2-in. gypsum wallboard nailed to inner surfaces of studs, 1 in. air space between gypsum wallboards	5-3/4	7.4	39	27	24	29	33	37	42	46	55	55

See Table 3, with excerpts from Reference 1, citing tests conducted by the National Bureau of Standards. Panel construction 215 can be used to illustrate the combined use of Figures 1 and 2. From Table 3, the TL average for a frequency range from 125 to 4000 Hz is shown as 46 dB.

– Figure 1 shows a TL of approximately 36 dB for a 7 psf surface weight.

– Figure 2 indicates an average increase of approximately 9 dB could be expected over a frequency range of 100 to 4000 Hz, if the double walls are separated by a 4″ air space, and if the wall surfaces are not rigidly connected.

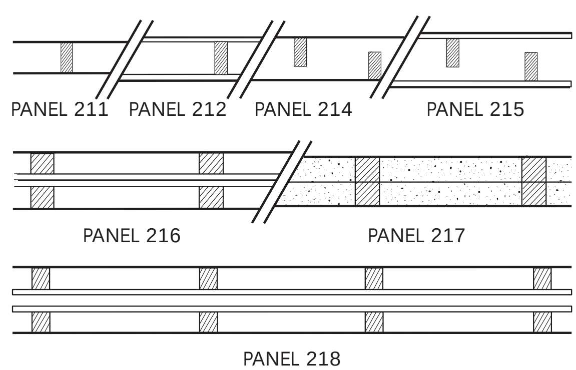
– As can be seen in this example, the calculated transmission loss of 45 dB is a good approximation of the test results.

Note: While the assemblies listed in Table 3 were tested using plywood, it is believed that other structural-use panels (oriented strand board [OSB] and COM-PLY®) may be substituted on a thickness for thickness basis. Because of their substantially similar strength and stiffness properties and slightly higher density, use of these structural wood panel products in lieu of plywood should have little or no adverse effect on the rating of tested systems.

Similarly, the TL value for panel 214 calculates to be about 38 dB (compared to a test average of 26 dB), and panel 218 calculates to be about 37 dB (compared to a test average of 39 dB). The apparent discrepancy in the calculated TL value for construction 214 may be attributed to special acoustical behavior of the thin plywood skins.

Average values from Table 3 for panels 211, 212, 216 and 217 may be compared directly with TL vs surface-weight values from the curve in Figure 1 (neglect the space contribution since the wall layers are rigidly connected).

FIGURE 3(1)



Relation Between TL and STC:

It should be noted that Transmission-Loss (TL) values and Sound-Transmission-Class (STC) values are derived by different methods, and they are not necessarily comparable.

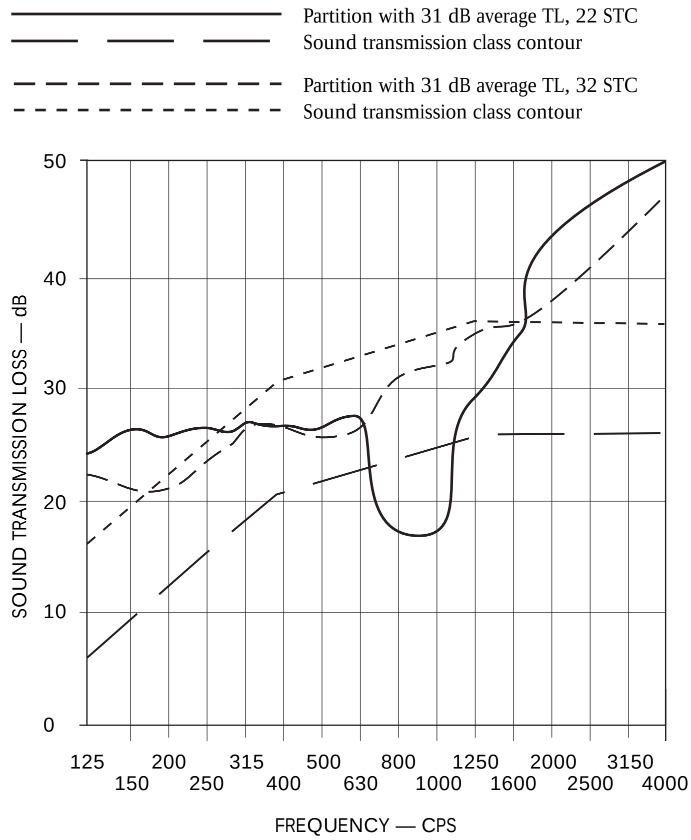
A TL value is a simple average of transmission-loss values measured in decibels over a certain frequency range (say from 125 to 4000 Hz).

STC values are taken from a "standard contour'' which is fitted to the transmission-loss curve, and adjusted to reflect the subjective (human) response at measured frequencies (described in ASTM E413). That is, the curve is weighted in a fashion similar to the A-weighted scale on the sound-level meter discussed previously. The STC value for a given construction (the dB unit is dropped) may be significantly lower or higher than the average TL value. STC values can be considered a "rating of effectiveness'' for a given construction with respect to isolation of airborne sound.

Note in Figure 4 how two partitions with identical "averages'' for their Transmission Loss can have STC ratings which differ by as much as 10 points. The deep "dip'' in the curve for the STC-22 partition is a serious deficiency in its isolation performance; yet the "average'' of values at the various frequencies disguises the deficiency. The STC-32 partition is much better as a sound barrier, as the rating indicates[(2)].

For further information about STC ratings of wood structural panel assemblies, see APA's *Design/Construction Guide: Noise-Rated Systems,* W460.

FIGURE 4[(2)] Determination of Sound Transmission Class



Wood Structural Panel and Sound Absorption

While sound-transmission *isolation* depends primarily on the mass and stiffness of a material, *absorption* of sound is best provided by porous materials. The basic physical characteristics of materials that are good sound absorbers automatically make them poor sound isolators.

A rigidly supported single layer of wood structural panels has relatively poor absorption properties, but it can help to isolate noise, and provide the needed structural support for the light, fibrous materials that typically have good sound-absorption properties. Wood structural panel-based barriers or enclosures are usually made more effective by adding such materials to enclosure surface areas, or to the "space'' in double-layer constructions. Sound energy is dissipated in these absorptive materials in the form of heat.

There are literally hundreds of absorbents available today; their performance differs widely and ratings change constantly. For current data, refer to Sweets catalog, or to the annual "Bulletin of the Acoustical Materials Association,'' 335 East 45th Street, New York, New York 10017.

Sound Absorption Coefficient

The ratio of the sound energy absorbed to the energy incident upon a surface is called the "absorption coefficient'' of the material. A perfectly acoustically absorbent surface would have an absorption coefficient of 1.00. Surfaces with absorption coefficients less than 0.05 are considered primarily reflective.

The two standardized methods used to determine absorption coefficients are:

1) The "Reverberation Room Method''
 – ASTM C423.

2) The "Impedance Tube Method''
 – ASTM C384.

Of the two, values developed from the reverberation-room method more realistically simulate actual use conditions. Absorption coefficients based on this method are most common. There is no well-defined relationship between coefficients developed from the two methods, but values from the reverberation-room method tend to be somewhat higher than tube values, especially where mounting methods permit diaphragm vibration of a material.

As an illustration of this difference, note that for the plywood construction indicated in the table below, the average absorption coefficient between 250 and 2000 Hz would be about 0.12. This range is the one commonly used for calculating noise reduction. (See following paragraphs.) These values were obtained by the reverberation room method, and are good only for this construction.

TABLE 4 Sound Absorption Coefficients at Given Frequency (Hz)

1/4″ plywood both sides of studs	128	256	512	1024	2048	Average
	.31	.11	.14	.12	.10	.16

The absorption coefficient for plywood from 1/4″ to 3/4″ is less than 0.04 by the impedance tube method, measured over this same frequency range.[5] Confusion in this regard can be avoided by associating a test method with absorption coefficient values, just as you would indicate the scale used in relating sound level measurements, or distinguish between "TL" and "STC" values.

Noise Reduction (NR)

The NR is a measure of noise reduction within a given space. The effect of introducing absorption into a space can be calculated with reasonable accuracy as follows:

$NR = 10 \log_{10} Ao + Aa$

where: NR = Noise Reduction, or Sound-Pressure-Level reduction in dB;

Ao = original absorption present in sabins;

Aa = added absorption in sabins.

Note: The surface area in square feet multiplied by the absorption coefficient = the sabins of absorption. When added absorption covers an existing surface, the coefficient of the added absorption must be reduced by the coefficient of the existing surface covered by the added absorption. In a highly absorptive space, the effect of added absorption is small, compared with its effect in a non-absorptive space. In practice less than 10 dB noise reduction can be obtained by the use of absorption alone.[2]

Absorbent materials placed between the studs in a partition construction with independently supported wall surfaces (acting as diaphragms) can retard the movement of the air and thereby increase the efficiency of the wall in reducing sound transmission. When the wall surfaces of a double-wall construction are directly connected to common rigid studs, however, the partition can act as a single vibrating unit, rendering the absorbent material ineffective with respect to reducing the sound transmitted through the wall. Resilient channels may often be used effectively to isolate wall surfaces for this purpose.

Notes on Good Noise-Control Practice

1) Study the source-path-receiver relationships until the source of unwanted noise and path(s) to the receiver are well understood.

2) If barriers or enclosures are to be used, specify tight controls during construction at all joints to avoid airborne "noise leaks." Sealants may often be used to good advantage here.

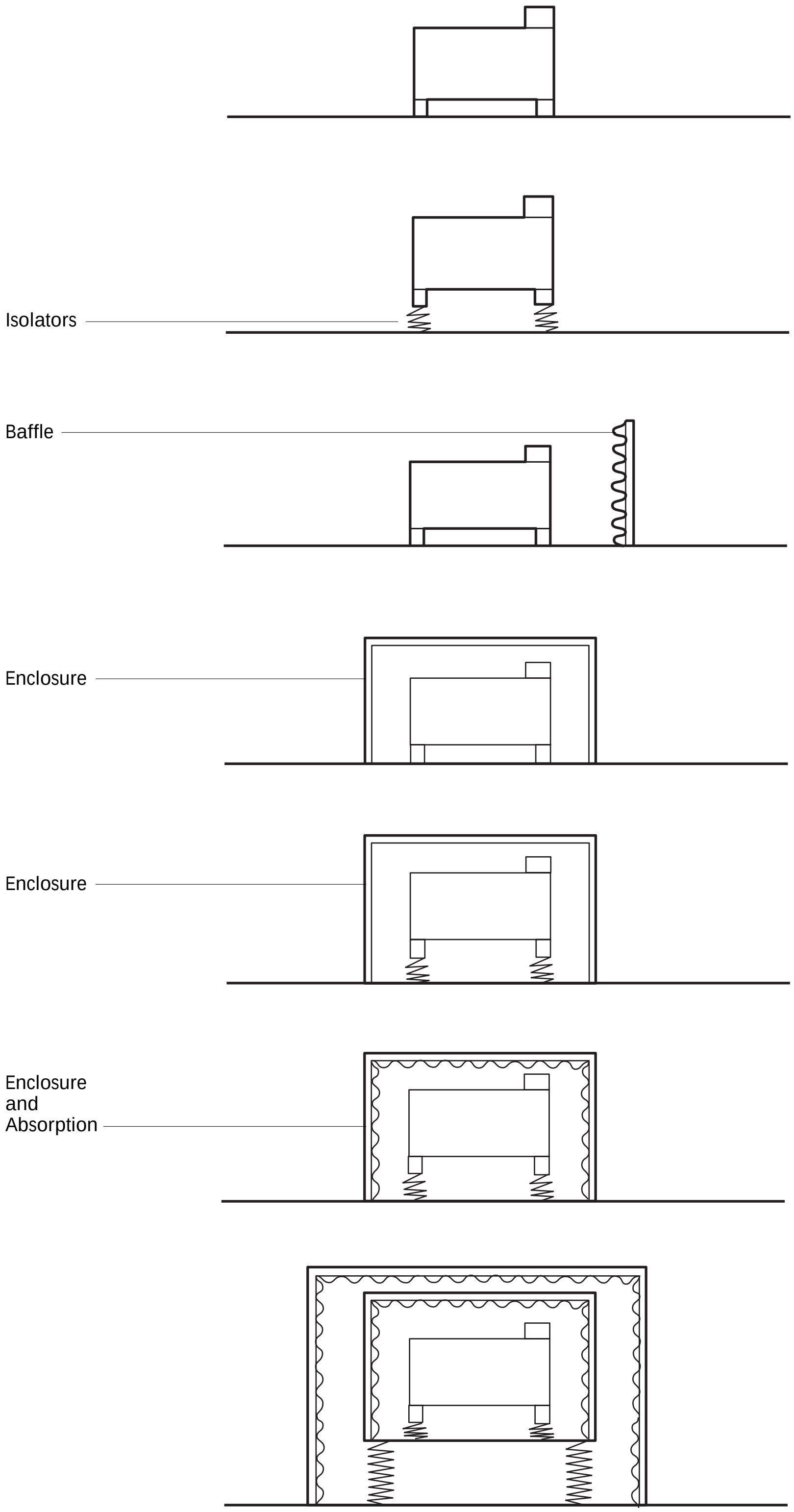
3) Balance the control measures so that the least effective portion of the design does not negate the value of the most effective steps taken. Noise passing over or around a barrier, or through a required opening in a barrier, could reduce its effectiveness to the level of noise allowed by these "flanking paths." (See reference No. 6.) Also, for factories or in-plant noise control with barriers, room reverberation is an important consideration. (See references 6 and 7.)

4) Take into account the often-desirable contributing effect of background sound. Background sound adjusted to the proper level can sometimes "mask" otherwise disturbing noises.

Figure 5 provides a good summary of the main points discussed above. The illustrations relate approximate ranges of sound-level reduction that might be expected for the various measures commonly considered in machine noise control.

Considerably more detail on various Mass Law relationships, and various approximate methods for estimating the sound-transmission loss of single panels is included in reference No. 6, *Noise and Vibration Control.* Also included in this source are design values for special acoustical properties of plywood and other materials; and discussions on the acoustical behavior of complex partitions, layered media (panels composed of two or more solid homogeneous layers), double walls and many other specific design application problems.

FIGURE 5   Comparison of Noise Reduction Methods Applied to a Machine



	Approximate Sound Level (SL) Reduction dBA
1. Original Machine	0
2. Vibration Isolators	2
3. Baffle	5
4. Rigid, Sealed Enclosure	20-25
5. Enclosure and Isolators	30-35
6. Enclosure, Absorption and Isolators	40-45
7. Double Walled Enclosure, Absorption and Isolators	60-80

Glossary

Definitions included here are intended to supplement the information provided previously. The definitions were taken from sources which have reduced specialized terminology into the idiom of the practicing architect and engineer.

Absorption Coefficients, sound – The ratio of sound-absorbing effectiveness (at a specific frequency) of one square foot of absorptive material; usually expressed as a decimal value ranging from 0.00 to 1.00, or as a percentage of the perfectly absorptive material effectiveness.

Acoustical Environment – All of the factors, interior or exterior, which affect the acoustic conditions of the location, space, or structure under consideration.

Airborne Sound – Sound transmitted through air as a medium rather than through solids or structure of a building.

Damping – Any means of dissipating or attenuating vibrational energy within a vibrating medium. Usually the energy is converted to heat.

Decibel (dB) – A unit for measuring loudness of sound. It can be confusing, because it is used in two different ways, one comparative, and the other used as a reference scale.

First, it is the standard unit for measuring relative loudness or intensity of sounds. One decibel is approximately the smallest change in level ordinarily detectable by the human ear.

The second usage is derived from the first. By referring this comparative unit to a "reference intensity level" of 10^{-16} watts per square centimeter, a scale of sound pressure levels is obtained, ranging from 1 (considered the lowest value that the ear can detect) to and beyond 130 (considered the "threshold of pain").

Diffraction – Roughly, the ability of a sound wave to "flow" around an obstruction or through openings, with little loss of energy.

Diffusion – Dispersion of sound within a space so that there is uniform density of sound energy throughout the space.

Flanking paths – Transmission paths which transmit acoustic energy around a sound barrier; paths which "by-pass" the intended barrier.

Frequency – The number of complete cycles per second of a vibration (or other periodic motion). Units are Hertz (Hz), which are numerically equal to cycles per second.

Intensity – The rate of sound energy passing through a unit area.

Insertion loss – The amount by which the sound pressure level at a specific point is reduced – usually due to the use of a barrier or enclosure.

Isolation, sound – Preventing entrance of sound to the "conditioned" area.

Hertz (Hz) – Signifies and supersedes term "cycles per second," or cps.

Leak, sound – Any opening which permits airborne sound transmission.

Logarithm – A mathematical device consisting of the power to which a base number has been raised. For example, the logarithm to the base 10 of 10^2 (10 x 10) is 2. Thus, the logarithm of 100 is 2, of 1,000 is 3, of 10,000 is 4, etc.

Loudness – The effect on the hearing apparatus of varying sound pressures and intensities.

Masking – The use of sound to "drown out" another sound (usually use of a pleasant or neutral sound to "cover" an undesirable sound).

Noise – Any unwanted sound.

Noise reduction – The reduction in level of unwanted sound by any of several means – as determined by the source-path-receiver relationship.

Noise Reduction Coefficient – The arithmetic average of the sound absorption coefficients at 150, 500, 1000 and 2000 Hz.

Phon – A measure of loudness level (on a logarithmic scale) which compares the effect of a sound to the effect of a 1000-Hz tone of a given Sound Pressure Level.

Pitch – The physical response to frequency. The subjective response of the hearing mechanism to changing frequency.

Reflection – The return from surfaces of sound energy not absorbed upon contact with the surfaces.

Resonance – The sympathetic vibration of a volume of air, or an object when subjected to a specific sound frequency. The air volume or object tends to act as a sound source under these conditions.

Reverberation – The persistence of sound within a space after the source has ceased, resulting in a mix of many reflected sounds.

Sabin – A measure of sound absorption of a surface, equivalent to 1 sq. ft. of a perfectly absorptive material. (One sabin/sq. ft. = perfect absorptive material).

Sone – A measure of loudness (on a linear scale) which compares the effect of a sound to the effect of a 1000-Hz tone of 40 decibels sound-pressure level.

Sound – A vibration in an elastic medium; usually in the frequency range capable of producing the sensation of hearing.

Sound Attenuation – The reduction of sound energy as it passes through a conductor, resulting from the conductor's resistance to the transmission.

Sound Transmission Class (STC) – A single-number rating system which compares the Sound Transmission Loss of a test specimen with a standard contour. It is a measure of the effectiveness of assemblies in isolating airborne sound transmission.

Structure-borne Sound – Sound energy transmitted through the solid media of the building structure.

Transmission Loss (TL) – A measure in decibels of the decrease in sound energy during transmission from one point to another (or through a panel, wall, etc.).

References

(1) Harris, Cyril M. Ph.D., *Handbook of Noise Control,* McGraw Hill Book Company, 1957

(2) Yerges, Lyle F., *Sound, Noise, and Vibration Control,* Van Nostrand Reinhold Company, 1969

(3) *Sound Control Construction – Principles and Performance,* U.S. Gypsum, Chicago, Illinois, 1972

(4) Crocker, Malcolm J., *Noise Sources, Noise Measurements and Noise Reduction,* School of Mechanical Engineering, Purdue University, 1972

(5) *Acoustical Absorption Properties of Wood-Base Panel Materials,* U.S. Forest Service Research Paper FPL 104, May, 1969

(6) Beranak, Leo L., *Noise and Vibration Control,* McGraw Hill, 1971

(7) Moreland, J. B., *Use of Barriers For In-Plant Noise Control,* Acoustics and Noise Control Research, Westinghouse Electric Corporation, Research and Development Center, Pittsburgh, Pennsylvania. Paper presented at Noise-Con 73, October, 1973.

We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying APA engineered wood products, get in touch with your nearest APA regional office. Call or write:

WESTERN REGION

7011 So. 19th St. ▪ P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 ▪ Fax: (253) 565-7265

EASTERN REGION

2130 Barrett Park Drive, Suite 102
Kennesaw, Georgia 30144-3681
(770) 427-9371 ▪ Fax: (770) 423-1703

U.S. HEADQUARTERS AND INTERNATIONAL MARKETING DIVISION

7011 So. 19th St. ▪ P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 ▪ Fax: (253) 565-7265

Web Address:
@
www.apawood.org

PRODUCT SUPPORT HELP DESK

(253) 620-7400
E-mail Address: help@apawood.org

(Offices: Antwerp, Belgium; Bournemouth, United Kingdom; Hamburg, Germany; Mexico City, Mexico; Tokyo, Japan.) For Caribbean/Latin America, contact headquarters in Tacoma.

Form No. Y225J
Revised December 1994/0050

A P A

The Engineered Wood Association