FRANK PESCE

M-96-01
II-A-758

NIOSH
TECHNICAL INFORMATION

# COMPENDIUM OF MATERIALS FOR NOISE CONTROL

# COMPENDIUM OF MATERIALS FOR NOISE CONTROL

*Work performed by the*
*Illinois Institute of Technology Research Institute, Chicago, Ill.*

Contract No. HSM 99-72-99


**U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE**
**Public Health Service**
**Center for Disease Control**
**National Institute for Occupational Safety and Health**
**Division of Laboratories and Criteria Development**
**Cincinnati, Ohio 45202**

**June 1975**

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

The contents of this report are reproduced herein as received from the contractor, except for some editorial and technical changes. The opinions, findings, and conclusions expressed are those of the contractor and not necessarily those of NIOSH. Mention of company or product names is not to be considered as an endorsement by NIOSH. The contractor reported the data as received from the manufacturers and the accuracy of these data is not necessarily supported by NIOSH.

IITR Project Director: W. Ernest Purcell
NIOSH Project Officer: Barry L. Lempert
who provided substantive editorial and technical input to this compendium.

**HEW Publication No. (NIOSH) 75—165**

# FOREWORD

The National Institute for Occupational Safety and Health (NIOSH), in 1972 transmitted to the Department of Labor a recommended Federal standard for occupational noise exposure including the criteria upon which the recommendation was based. The recommended standard included administrative and engineering noise control specifications necessary to reduce noise levels.

At that time, only a few professional and trade journals were concerned specifically with noise control and a suitable compendium of noise control product specifications was not available. This compendium of commercial noise-reduction materials aids in solving industrial noise control problems and is designed for purchasers of noise control materials. It can be used to determine what industrial noise control materials are available, their characteristics, and sources of supply.

The information contained in this document, when utilized by those concerned with occupational noise, should serve to contribute to a quieter industrial environment.

John F. Finklea, M.D.
Director, National Institute
for Occupational Safety & Health

# PREFACE

NIOSH developed this compendium of available, commercial noise-reduction materials as a contribution to engineering solutions for industrial noise control problems. The compendium is designed for use by those selecting materials to effect noise control. It can be used to determine availability, characteristics, and sources of materials; especially those useful in industrial noise control. Included are data on both sound absorption and transmission loss of noise control materials as well as a general and technical description of the uses and limitations of these materials.

Similar comprehensive lists of noise control product specifications are not provided by trade and professional journals; however, several existing publications do provide lists of manufacturers who are potential sources of such specifications. The primary sources used to construct our list of manufacturers were "Buyer's Guide," *Sound and Vibration* (July and August, 1972), the Riverbank Acoustical Laboratory client list, *Handbook of Noise Control* (Harris, 1957), *Noise and Vibration Control* (Beranek, 1971), "A Guide to Airborne, Impact and Structure Borne Noise" (HUD, 1967), "The Construction Specifier," "Materials Research and Standards," *Dun and Bradstreet Million Dollar Directory* (1971), *Standard and Poor's Register* (1972), and *Moody's Industrial Manual* (1972).

From the list of manufacturers of noise control products, 823 companies were sent questionnaires (OMB No. 68-S72182), along with 31 related laboratories and special organizations. Product data were solicited and usually received in the form of brochures, specification sheets, and acoustical test laboratory reports. Data for the compendium were provided by 213 manufacturers. Many laboratories and special organizations, as well as some companies, responded with generic data that was suitable for use in the narrative portions of this document. Of the project specifications requested, only the unit cost information was insufficient for equitable delineation in the compendium.

Data are presented as received from the manufacturers and have not been verified by IITRI or NIOSH. Information about a product such as how it was tested and its temperature, relative humidity, and chemical limitations is presented in the footnotes at the end of each table. For various reasons some items are presented with no acoustical data, but these items are included to maintain a broad coverage of available materials. The range of noise control materials that could be listed was essentially unlimited; however, it was decided that unit silencers, such as exhaust mufflers or products specifically designed for vibration damping or vibration isolation, were outside the scope of this compendium.

The data tables of noise control product specifications comprise the principal content of the compendium. The narrative sections provide basic information on the use of noise control materials and nomenclature used in current standard laboratory test procedures. This book is not intended as a noise control manual; however, the pertinent equations and noise control methodology included will benefit those who may not be familiar with noise control. The compendium will provide engineers, architects, acoustical consultants, and others with a ready reference of useful noise control materials.

## ACKNOWLEDGMENTS

The diligence and attention to detail by Dr. Prakash D. Desai of IITRI in the initial preparation of the data tables and the technical assistance of Mary Sims, also of IITRI, are appreciated.

NIOSH expresses sincere thanks to Raymond D. Berendt, National Bureau of Standards; Robert D. Bruce, Bolt Beranek and Newman, Inc.; Dr. Franklin D. Hart, North Carolina State University; Dr. Elmer L. Hixon, University of Texas; Herbert H. Jones, Central Missouri State University; and Dr. Roger L. Kerlin and Dr. Paul L. Michael, Pennsylvania State University; for their expeditious reviews and comments.

Also, NIOSH is grateful to the Bruel and Kjaer Company for permission to reprint their microphone graphs, to EDN Magazine for Figure I-1 depicting the frequency ranges for some common items, and to the Acoustical and Insulating Materials Association (AIMA) for providing the absorption information on the many general building materials shown in Data Table 47. The illustrations in the data table guides are from the many photographs provided in manufacturers' brochures. Specific credit for these illustrations is given at the beginning of Section VI.

## ABSTRACT

This compendium of available commercial, noise-reduction materials was developed for use by plant engineers, industrial hygienists, acoustical consultants, and others engaged in noise control. It can be used to determine the availability of noise control materials, the characteristics and specifications of the materials, and their supply sources. Also included are data on both sound absorption and transmission loss of materials and a general and technical description of the uses and limitations of the materials listed.

## CONTENTS

## CONTENTS Continued

| SECTION | PAGE |
|---|---|

## ILLUSTRATIONS

## TABLES

# COMPENDIUM OF MATERIALS FOR NOISE CONTROL

*Work performed by the*
*Illinois Institute of Technology Research Institute, Chicago, Ill.*

Contract No. HSM 99-72-99

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Laboratories and Criteria Development
Cincinnati, Ohio 45202

June 1975

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

# COMPENDIUM OF MATERIALS FOR NOISE CONTROL

*Work performed by the*
*Illinois Institute of Technology Research Institute, Chicago, Ill.*

Contract No. HSM 99-72-99

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Laboratories and Criteria Development
Cincinnati, Ohio 45202

June 1975

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

# COMPENDIUM OF MATERIALS FOR NOISE CONTROL

## I—ELEMENTS OF SOUND, SOUND MEASUREMENT, AND CONTROL

### I-1—INTRODUCTION

The sounds of industry, growing in volume over the years, have heralded not only technical and economic progress but also the threat of an ever increasing incidence of hearing loss and other noise related disturbances to exposed employees. Noise is not a new hazard. Indeed, noise-induced hearing loss was observed centuries ago. Ramazzini in "De Morbis Artificium Diatriba" in 1700 described how those hammering copper "have their ears so injured by that perpetual din . . . . . that workers of this class become hard of hearing and, if they grow old at this work, completely deaf." Before the Industrial Revolution, however, comparatively few people were exposed to high level workplace noise. It was the advent of steam power in connection with the Industrial Revolution that first brought general attention to noise as an occupational hazard. Workers who fabricated steam boilers were found to develop hearing loss in such numbers that such a malady was dubbed "boilermakers disease." Increasing mechanization in all industries and most trades has since proliferated the noise problem.

Exposures to noise levels found at the workplace, particularly in mechanized industries, are likely to be the most intense and sustained of any experienced in daily living. As such, they represent the severest form of acoustic insult to man and therein pose the greatest harm to human function. The real or alleged effects of occupational noise exposures include the following:

Temporary and permanent losses in hearing sensitivity.

Physical and psychological disorders.

Interference with speech communications or the reception of other wanted sounds.

Disruption of job performance.

Engineering controls for the abatement of environmental noise reduce the intensity of the noise either at the source or in the immediate exposure environment. A number of these procedures require considerable expertise, and it is recommended that employers avail themselves of the services of a competent acoustical engineer in development of a noise abatement program. However, many noise control techniques may be implemented directly by company personnel at relatively little expense. (NOTE: The foregoing discussion was excerpted from "Criteria for a Recommended Standard . . . Occupational Exposure to Noise," DHEW, NIOSH, 1972.)

This document is presented as a guide and data book for anyone attempting to contribute to a quieter environment.

### I-2—SOME BASIC CONCEPTS

#### I-2.1—TERMINOLOGY AND DEFINITIONS

Sound waves are pressure waves traveling in an elastic medium, such as air, with propagation occurring in the direction of the wave motion. The speed at which the sound wave is propagated in air depends on the pressure, temperature, density, and humidity.

A pure tone of sound originates from simple harmonic motion, e.g., the reciprocating motion of a piston in air. The sound wave produced by this motion is a sinusoidal pressure wave whose fluctuation is governed by the dis-

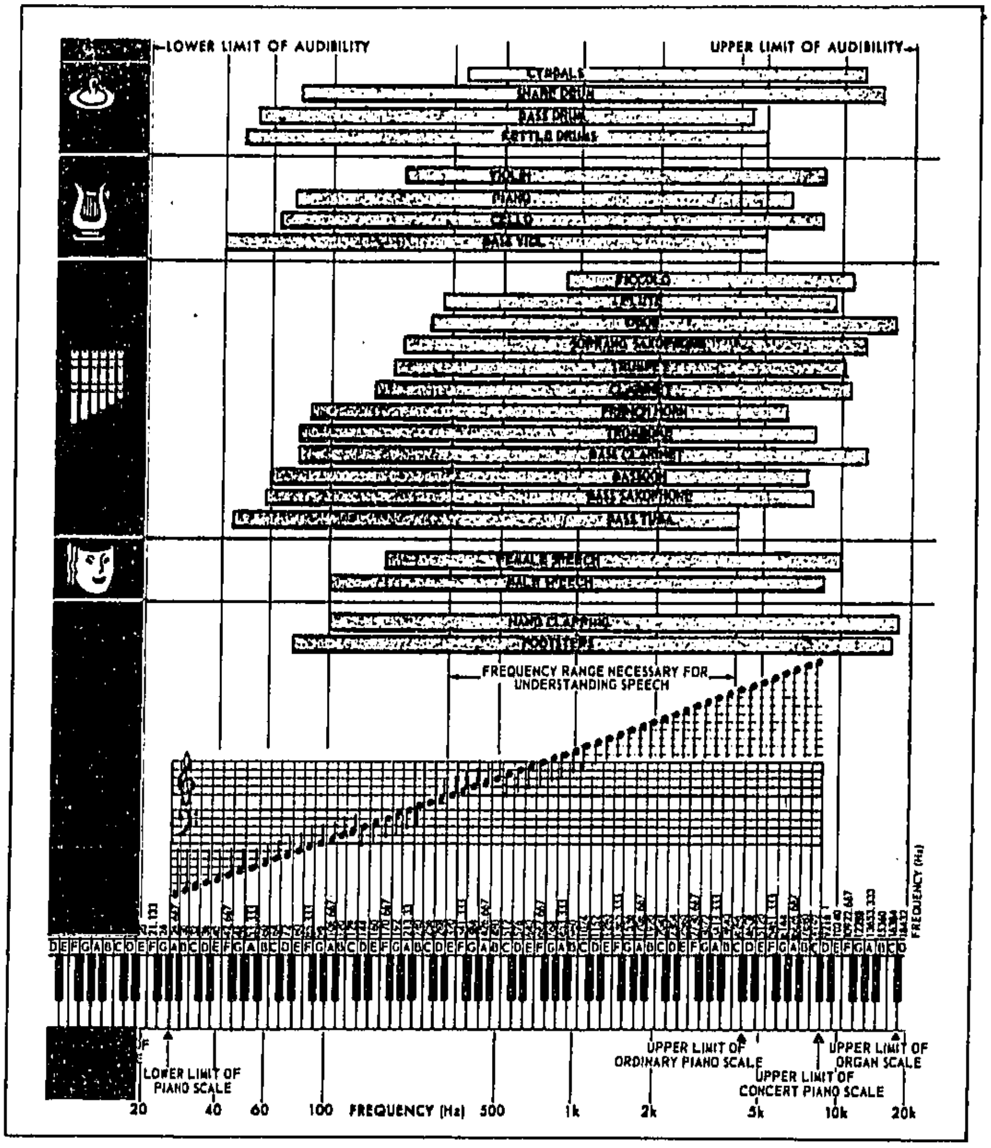



FIGURE I-1.—Audible Sound Frequencies of Some Musical Instruments, Voices, and Other Noises (approximate). (Courtesy of Sonotone Corp., Elmsford, N. Y. Reprinted by permission of *EDN Magazine*, April 1967.)

placement and rate at which the piston moves back and forth. Frequency is defined as the number of times this pressure fluctuation passes through a complete cycle in 1 second (sec), and the units are identified by hertz (Hz). The sound frequencies of some common items are shown in Figure I–1.

Small changes in atmospheric pressure resulting from this compression and rarefaction of the air molecules is called "sound pressure". Physiologically, the sensation of hearing is produced by this pressure variation. Broadband noise may be defined as a combination of sound waves with differing frequencies and amplitudes as distinct from a pure tone of single frequency and amplitude. Thus, broadband noise is a sound wave composed of a number of components combining to yield a resultant complex wave. In noise control work, broadband noise is the most common type of sound. The techniques available for analyzing the components of broadband noise into distinct frequency ranges is referred to as "spectral analysis".

If one were to freeze an oscillating, traveling, pressure fluctuation in time, wavelength is the measured distance between the maximum pressure points or any other analogous points on two successive parts of the wave. The Greek letter lambda ($\lambda$) is the symbol for wavelength, and it is measured in units of feet (ft, English system), or meters (mks system).

The velocity with which the analogous pressure points on successive parts of the wave pass a given point is the speed of sound, and the speed of sound is always equal to the product of the wavelength and the frequency. This speed is dependent on the equilibrium pressure, $p_a$, of the gas through which the sound wave is traveling and on the equilibrium gas density, $\rho$. The constant of proportionality is the well known (Greek gamma) $\gamma$, which is the ratio of the specific heat at constant pressure to the specific heat at constant volume. For air under most conditions $\gamma$ is 1.4 so the speed of sound ($c$) is given by the expression

$$c = \left(\frac{1.4\ p_a}{\rho}\right)^{1/2} \text{ m/sec or ft/sec.} \quad (1)$$

It is assumed that air behaves as an ideal gas. For a temperature ($T$) of 22°C (71.6°F), the speed of sound in air is

$$c = 20.05\ \sqrt{T\ (°\text{K})} = 344 \text{ m/sec.} \quad (2)$$

or

$$c = 49.05\ \sqrt{T\ (°\text{R})} = 1{,}131 \text{ ft/sec.} \quad (3)$$

The propagation of a sound wave in air is a very complex pattern of reflections, absorptions, and transmissions through barriers. To describe the sound field, two extreme cases of a free field and a diffuse or reverberant field are generally employed.

In a free field the sound from a nondirectional point source radiates equally in all directions in the form of a spherical wave. As such, the intensity of the wave follows the usual inverse square law for energy propagation, and the intensity drops to one-fourth its value each time the distance is doubled. Since the sound pressure is proportional to the square root of the intensity, the sound pressure drops by one-half its value. However, this decrease for each doubling of distance only holds for the region defined as the far field (i.e., beyond about two to three wavelengths). Closer to the sound source is the near field, and a special mathematical treatment is required to describe the sound field in this region. In symbolic form the spherical wave in a free field is represented by

$$I = \frac{W}{4\pi r^2} = \frac{p^2_{rms}}{\rho c} \text{ (at distance } r\text{)} \quad (4)$$

where $I$ is the intensity, $W$ is the total acoustic (sound) power radiated by the source in watts, $p^2_{rms}$ is the root-mean-square sound pressure, and $\rho c$ is the product of the density and the speed of sound. This product is called the "characteristic impedance" of the medium through which the sound wave is traveling and is the constant of proportionality that relates the sound pressure squared to the sound intensity.

### I–2.1.1—Units of Sound Measurement

The range of sensation to which the human ear can respond, from the barely discernible to the threshold of pain, is approximately seven orders of magnitude ($10^7$). The level of sensation is usually measured or reported in a smaller range of numbers by use of the logarithm of the ratio of the measured level to some reference level. For this purpose the unit of the Bel has been borrowed from telephone technology. The loudness of a sound is defined in Bels as

$$\text{number of Bels} = \log_{10} (I/I_0) \qquad (5)$$

where $I$ is the intensity of sound and $I_0$ is the reference intensity. Therefore, if $I = I_0$, the number of Bels is 0, and if $I = 10\, I_0$, the number of Bels is 1. The preferred unit for measuring sound has become the minimum difference in loudness that is usually perceptible, one-tenth of a Bel, or 1 decibel, abbreviated dB; thus

$$\text{number of decibels (dB)} = 10 \times (\text{number of Bels}) = 10 \log_{10} (I/I_0). \qquad (6)$$

It is clear from this expression that for each change in the intensity by one order of magnitude (factor of 10), the number of decibels is changed by 10; or, for each change in the intensity of a factor of 2, the number of decibels is changed by 3. Some decibel values for selected intensity ratios are shown in Table I-1.

I-2.1.2—Sound Intensity Level

The intensity of a sound wave can also be expressed in decibels of sound intensity and is then called the sound intensity level ($L_I$); thus

$$L_I = 10 \log \frac{I}{I_0} \text{ dB re } I_0. \qquad (7)$$

If a sound source is omnidirectional, the relationship between sound power and sound intensity, shown in equation (4), yields the reference sound intensity level if

$$I_0 = \frac{W_0}{4\pi r^2} \qquad (8)$$

where $W_0$ is the reference sound power of $10^{-12}$ watts, and the spherical surface around the source has a radius such that the area is equal to 1 meter$^2$:

$$I_0 = \frac{10^{-12} \text{ watt}}{1 \text{ meter}^2}. \qquad (9)$$

The reference sound intensity is therefore, $I_0 = 10^{-12}$ watt/m$^2$.

EXAMPLE 1: Determine the sound intensity at 10 meters of a source radiating uniformly into free space a sound power of 0.38 watts.

**TABLE I-1—SOUND INTENSITY LEVEL RATIOS AND NUMBER OF DECIBELS FOR EACH**

| SOUND INTENSITY RATIO, $I/I_0$ | NUMBER OF DECIBELS (dB = 10 log $(I/I_0)$) |
|---|---|
| 1,000.0 | 30.0 |
| 100.0 | 20.0 |
| 10.0 | 10.0 |
| 9.0 | 9.5 |
| 8.0 | 9.0 |
| 7.0 | 8.5 |
| 6.0 | 7.8 |
| 5.0 | 7.0 |
| 4.0 | 6.0 |
| 3.0 | 4.8 |
| 2.0 | 3.0 |
| 1.0 | .0 |
| .9 | −0.5 |
| .8 | −1.0 |
| .7 | −1.5 |
| .6 | −2.2 |
| .5 | −3.0 |
| .4 | −4.0 |
| .3 | −5.2 |
| .2 | −7.0 |
| .1 | −10.0 |
| .01 | −20.0 |
| .001 | −30.0 |

SOLUTION: Determine the intensity of the sound passing through a spherical surface 10 meters from the source.

$$I = \frac{W}{4\pi r^2} = \frac{0.38}{4\pi (10)^2} = 0.000302 \text{ watt/m}^2.$$

Then calculate the intensity level

$$L_I = 10 \log \frac{I}{I_0} = 10 \log \frac{0.000302}{10^{-12}}$$

$$= 10 \log 3.02 + 10 \log 10^{-4} - 10 \log 10^{-12}$$

$$= 4.8 - 40 + 120 = 84.8 \text{ dB re } 10^{-12} \text{ watt/m}^2.$$

I-2.1.3—Sound Pressure

Since measuring instruments respond to pressure fluctuations, the decibel of sound pressure has become very common. As with sound intensity there is a reference sound pressure, $p_0$, and in this case the interest is in the square of the pressure, or more specifically, the mean squared pressure. Applying equation (4),

$$\frac{I}{I_0}=\frac{\frac{p^2_{rms}}{\rho c}}{\frac{p^2_0}{\rho c}}=\frac{p^2_{rms}}{p^2_0}. \qquad (10)$$

Therefore, the sound pressure level in dB is defined as the logarithm of the ratio of the mean squared pressure to the reference pressure squared:

$$L_p=10\log\frac{p^2_{rms}}{p^2_0}=20\log\frac{p_{rms}}{p_0}\text{dB re } p_0. \qquad (11)$$

Note in this expression that the logarithm of the pressure ratio is multiplied by 20 instead of 10 as for sound intensity level. This is due to the fact that the pressure ratio is squared. Thus, there is a 20 dB change in sound pressure level for an order of magnitude change in the sound pressure, and 40 dB change for an increase of 100 times; and instead of $-3$ dB for the one-half value point, there is a $-6$ dB change in the case of sound pressure level. The reference pressure in Newtons (N) per meter$^2$ is obtained by using equation (4):

$$p^2_0=I_0\rho c$$

$$=406\times10^{-12}\ (\text{N/m}^2)^2$$

$$p_0=2\times10^{-5}\ (\text{N/m}^2) \qquad (12)$$

where $\rho c=406$ mks rayls is the characteristic impedance of the medium for air at $T=22°$ C, and a static pressure of 0.751 meter of Hg.

For a young person with good hearing the faintest sound that can be heard has a mean squared pressure of approximately $2\times10^{-5}$ N/m$^2$. This value was thus chosen as the reference value. The decibel scale for sound pressure therefore begins at $2\times10^{-5}$ N/m$^2$ which is zero decibel level.

### I–2.1.4—Sound Power

Sound power is the amount of energy per unit time that radiates from a source in the form of an acoustic wave. If the source is enclosed by some bounded imaginary surface, then all energy leaving the source must pass through this surface. The larger this surface the less power per unit area will pass through the surface. This relationship can be written as

$$W=I\times S \qquad (13)$$

where $W$ is the sound power, $S$ is the area of the surface enclosing the source, and $I$ is the average intensity per unit area of the surface. If the source is in a free field, and radiates power equally in all directions, then the sound power can be written as

$$W=I(4\pi r^2)\text{ watts} \qquad (14)$$

where the chosen enclosing surface is a sphere of radius $r$ for convenience.

It is difficult to measure sound power directly. The pressure of the sound wave is usually measured. Fortunately, there is a unique relationship between the intensity and the pressure of a spherical sound wave as illustrated by equations (8) and (10).

Thus, for sound power the expression becomes sound power "level" to indicate a logarithm and is given by

$$L_w=10\log_{10}\frac{W}{W_0}\text{ dB re } W_0. \qquad (15)$$

where $W$ is the sound power in watts, and $W_0$ is the reference sound power of $10^{-12}$ watts. (Note: Some earlier texts use $10^{-13}$ watt as the reference value so whenever the power level is reported the reference used must also be stated.)

The relationship between sound power, sound intensity, and sound pressure can be written, using equation (4), as

$$I=\frac{W}{S}=\frac{p^2}{\rho c}$$

and letting $S_0=1$ meter$^2$, 10 times the common logarithm of this expression can be written as

$$10\log\frac{I}{I_0}=10\log\frac{W}{W_0}-10\log S \qquad (16)$$

or

$$L_I=L_w-10\log S. \qquad (17)$$

If spherical radiation in a free field is assumed and $S=4\pi r^2$ then for $L_I$

$$L_I = L_w - 20 \log r - 11 \text{ dB re } 10^{-12} \text{ watts/m}^2 \quad (18)$$

where $r$ must be in meters. If radiation outdoors over the ground is assumed, the power is only radiated into a hemisphere, and the area becomes $2\pi r^2$ with the result that

$$L_I = L_w - 20 \log r - 8 \text{ dB re } 10^{-12} \text{ watt/m}^2 \quad (19)$$

or for $r$ in feet these expressions become

$$L_I = L_w - 20 \log r - 0.7 \text{ dB re } 10^{-12} \text{ watt/m}^2 \text{ (spherical)} \quad (20)$$

and

$$L_I = L_w - 20 \log r + 2.3 \text{ dB re } 10^{-12} \text{ watt/m}^2 \text{ (hemispherical)}. \quad (21)$$

EXAMPLE 2: Determine the sound intensity level at 10 meters of the sound from a source radiating a power level of 116 dB re $10^{-12}$ watt into a free field.

SOLUTION:

$$L_I = L_w - 20 \log r - 11 = 116 - 11 - 20 \log 10 = 85 \text{ dB re } 10^{-12} \text{ watt/m}^2.$$

The relation between sound power level and sound pressure level is actually more useful in practice. Again recalling equation (4)

$$\frac{W}{S} = \frac{p^2_{rms}}{\rho c}$$

or

$$\frac{W}{S} \times \frac{1}{W_0} = \frac{p^2_{rms}}{\rho c} \times \frac{1}{W_0} \times \frac{p^2_0}{p^2_0} = \frac{p^2_{rms}}{p^2_0} \times \frac{p^2_0}{\rho c\, W_0}. \quad (22)$$

Taking 10 times the logarithm gives

$$10 \log \frac{W}{W_0} - 10 \log S = 10 \log \frac{p^2_{rms}}{p^2_0} + 10 \log \frac{p^2_0}{\rho c\, W_0} \quad (23)$$

or

$$L_w = L_p + 10 \log S + 10 \log Z \text{ dB re } 10^{-12} \text{ watt} \quad (24)$$

where

$$Z = L_p / \rho c\, W_0. \quad (25)$$

As before, the value of $\rho c$ is approximately 400 rayls which gives for $Z$

$$Z = \frac{(2 \times 10^{-5})^2}{(400)\ (10^{-12})} = 1 \quad (26)$$

thus giving $10 \log Z = 0$. While $\rho c$ varies around 400 depending on the atmospheric conditions, the value of $10 \log Z$ is generally less than one-quarter of a decibel and can be neglected in most cases. Consequently

$$L_p = L_w - 10 \log S \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2 \quad (27)$$

where square meters are to be used for $S$. This expression for $L_p$ is identical to the expression for $L_I$ shown in equation (17). Thus, in a free field

$$L_p = L_I \quad (28)$$

From the above, it can be seen that for two identical sound sources, the sound power would be twice the sound power of one of the sources which is a 3 dB increase in sound power level. Also for this case the sound pressure level would be 3 dB more for the two sources than for the single source. In this case the sound power is what is doubled and not the sound pressure. A doubling of the sound pressure results in a 6 dB increase. The difference here is that when the power increases by a factor of 2 the sound pressure only increases by a factor of $\sqrt{2}$ since $W$ is proportional to $p^2$. (Note that in the special case of two coherent sound sources, the sound pressure would be doubled.)

EXAMPLE 3: (a) Determine the sound pressure level at 10 meters for the sound source in Example 2 which is radiating 116 dB re $10^{-12}$ watt into a free field. (b) Also determine the sound pressure level for this source over a flat open plane.

SOLUTION: In part (a) the surface chosen is a sphere with a radius of 10 meters; thus,

$$\begin{aligned} L_p = L_w - 10 \log S &= 116 - 10 \log 4\pi(10^2) \\ &= 116 - 10 \log 4\pi - 10 \log 10^2 \\ &= 116 - 11 - 20 \\ &= 85 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2 \end{aligned}$$

which is the result obtained for $L_I$ in Example 2. For part (b) the surface is a hemisphere and so

$$L_p = 116 - 10 \log 2\pi(10^2)$$
$$= 116 - 10 \log 2\pi - 10 \log 10^2$$
$$= 116 - 8 - 20$$
$$= 88 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2.$$

For hemispherical radiation the result is just 3 dB greater than for spherical or free field radiation. This is borne out by the fact that radiation over a flat plane is like the radiation of a light bulb in front of a mirror. All light radiated into the hemisphere which contains the mirror is reflected into the hemisphere with which we are concerned. Or one may consider optically that there is a true source and an imaginary mirror image that is also radiating which in effect gives us two identical sources and a 3 dB increase in sound pressure level.

To relate some of these values to how the human ear responds to sound is a complex process. Generally a change in sound pressure level of 1 dB can be just barely distinguished under proper conditions. A change of 3 dB in sound pressure level is readily discernible and a change of 10 dB would be interpreted as a doubling or halving of the sound. Some common sounds, their sound pressure levels at a few feet, and sound power levels are listed in Table I-2.

### I-2.1.5—COMBINING DECIBELS

In order to show how to combine decibel levels of sound sources when given the power, pressure, etc., the following examples are presented.

EXAMPLE 4: Two sources are radiating noise into a free field. One source has a sound power level of 123 dB and the other source has a sound power level of 117 dB re $10^{-12}$ watt. What is the combined sound power level of the two sources?

SOLUTION:

$$L_w = 10 \log \frac{W}{W_0}$$

or

$$W = W_0 \text{ antilog } L_w/10$$

Source 1: $W_1 = 10^{-12} \text{ antilog } \frac{123}{10}$

$$= 10^{-12} \times 1.996 \times 10^{12} = 1.996 \text{ watt}$$

Source 2: $W_2 = 10^{-12} \text{ antilog } \frac{117}{10}$

$$= 10^{-12} \times 5.012 \times 10^{11} = 0.5012 \text{ watt}$$

$$\text{Total} = 2.4972 \text{ watt}$$

$$L_w \text{ total} = 10 \log [2.4972 \times 10^{12}]$$
$$= 3.9743 + 120$$
$$= 124 \text{ dB re } 10^{-12} \text{ watt}$$

The same process can be used for sound intensity level or sound pressure level.

EXAMPLE 5: Suppose the sound pressure level of each of the three individual noise sources is measured at a point such that with only the first source running, the sound pressure level is 86 dB re 2 x $10^{-5}$ N/m², with only the second source running it is 84 dB re 2 x $10^{-5}$ N/m², and with only the third source it is 89 dB re 2 x $10^{-5}$ N/m². What will be the sound pressure level at this point with all three sources running?

SOLUTION:

$$p^2_{tot} = p^2_0 \left[ \text{antilog} \frac{L_{p1}}{10} + \text{antilog} \frac{L_{p2}}{10} + \text{antilog} \frac{L_{p3}}{10} \right]$$
$$= p^2_0 [\text{antilog } 8.6 + \text{antilog } 8.4 + \text{antilog } 8.9]$$
$$= p^2_0 [3.982 + 2.512 + 7.944] \times 10^8$$
$$= p^2_0 \times 14.438 \times 10^8.$$
$$Lp_{tot} = 10 \log \frac{p^2_{tot}}{p^2_0} = 10 \log [1.4438 \times 10^9]$$
$$= 1.58 + 90$$
$$= 91.6 \text{ dB.}$$

EXAMPLE 6: Add 85 dB and 88 dB (see Figure I-2).

SOLUTION: $L_L - L_S = 88 - 85 = 3$ dB. Enter row *a* to 3 and read row *b* to get 4.8 to be added to smaller level;

$$L_{Tot} = 85 + 4.8 = 89.8 \text{ dB.}$$

Or, enter row *a* to 3 and read value of row *c* to get 1.8 dB to be added to larger level;

$$L_{Tot} = 88 + 1.8 = 89.8 \text{ dB.}$$

To subtract levels enter row *b* or *c*, whichever corresponds to the difference between the levels, then read value in row *a* which must be added (subtracted) to (from) the smaller (larger) value to obtain the unknown value.

EXAMPLE 7: Subtract 83 dB from 87 dB (see Figure I-2).

**TABLE I-2—LEVELS OF SOME COMMON SOUNDS**

| SOUND POWER, WATTS | SOUND POWER LEVEL, dB re $10^{-12}$ WATT | SOUND PRESSURE, N/m² | SOUND PRESSURE LEVEL dB re $2 \times 10^{-5}$ N/m² | SOUND SOURCE |
|---|---|---|---|---|
| 3,000,000.0 | 200 | 1 atmosphere | 194 | Saturn rocket. |
| | 185 | 20000.0 | 180 | |
| | 175 | | 170 | |
| 30,000.0 | 165 | 2000.0 | 160 | Ram jet. |
| | 155 | | 150 | Turbo jet. |
| 300.0 | 145 | 200.0 | 140 | Propeller aircraft. |
| | | | 135 | Threshold of pain. |
| | 135 | | 130 | Pipe organ. |
| 3.0 | 125 | 20.0 | 120 | Riveter, chipper. |
| | 115 | | 110 | Punch press. |
| .03 | 105 | 2.0 | 100 | Passing truck. |
| | 95 | | 90 | Factory. |
| .0003 | 85 | .2 | 80 | Noisy office. |
| | 75 | | 70 | |
| .000003 | 65 | .02 | 60 | Conversational speech. |
| | 55 | | 50 | Private office. |
| .00000003 | 45 | .002 | 40 | Average residence. |
| | 35 | | 30 | Recording studio. |
| .0000000003 | 25 | .0002 | 20 | Rustle of leaves. |
| | 15 | | 10 | Threshold of good hearing. |
| .000000000003 | 5 | .00002 | 0 | Threshold of excellent youthful hearing. |

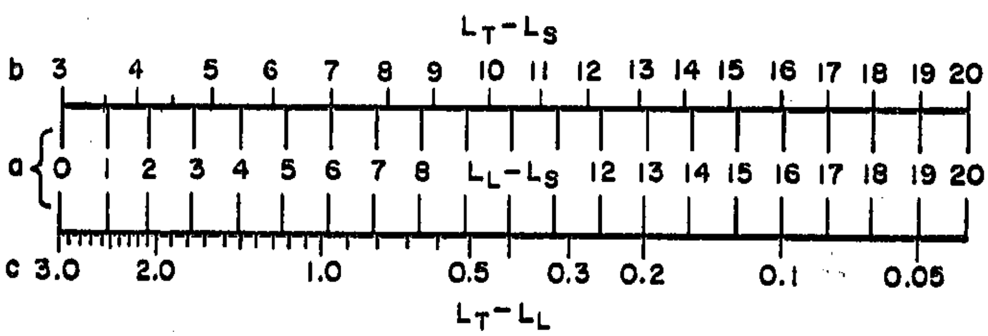



**FIGURE I-2.—Chart for Adding or Subtracting Decibels. Upper row *b* shows the difference between the total and smaller values. Bottom row *c* shows the difference between the total and larger values, and center row *a* shows the difference between the large and small values. (Chart good for any decibels—pressure, power, or intensity.) Use of this chart is shown in EXAMPLES 6-8.**

SOLUTION: $L_T - L_B = 87 - 83 = 4$ dB. Enter row *b* to 4 and read value in row *a* of 1.7 which must be subtracted from the larger value of 87 dB to obtain the unknown value of 85.3.

EXAMPLE 8: Add the three sound pressure levels of Example 5 using the chart in Figure I–2.

SOLUTION:

86 dB ] 88.15 dB ]
84 dB ]          ] 91.6 dB re 2 x $10^{-5}$ N/m²
89 dB ---------- ]

which is the same result we obtained with the more lengthy procedure shown in Example 5.

### I–2.1.6—Sound Pressure Weighting and Filtering

Thus far only the magnitude of sound has been discussed. Sound is generally not composed of a single frequency oscillating wave—sound can be made up of any and all frequencies, all existing simultaneously. A young, healthy ear is sensitive to the sound frequency range from about 20 to 20,000 Hz. This range narrows with age of the listener plus any possible hearing loss that may have occurred, such that for a normal adult the upper frequency limit may be approximately 14,000 Hz. Also the ear response varies with different frequencies; the least sensitivity in the lower frequency range and the greatest sensitivity in the range 2,000 to 4,000 Hz. This difference in sensitivity with frequency tends to become less as the intensity of the sound increases. Consequently, to build an instrument that responds to sound in a manner similar to the human ear, acousticians have developed four frequency weighting networks for measuring sound. These correspond to the A-, B-, C-, and D-weighting curves, and are electronic filters which attenuate the signal versus frequency as shown in Figure I–3. The specific attenuation versus frequency is shown in Table I–3.

Other filters used to analyze sound pass a narrower range of frequencies than the A-, B-, C-, or D-curves. These filters are of two types—the first, a constant bandwidth filter,

**TABLE I–3—A-, B-, AND C-WEIGHTING NETWORKS FOR SOUND LEVEL METERS AS SPECIFIED BY ANSI S1.4–1971**

| FREQUENCY, Hz | A-WEIGHTING RELATIVE RESPONSE, dB | B-WEIGHTING RELATIVE RESPONSE, dB | C-WEIGHTING RELATIVE RESPONSE, dB |
|---|---|---|---|
| 10 | −70.4 | −38.2 | −14.3 |
| 12.5 | −63.4 | −33.2 | −11.2 |
| 16 | −56.7 | −28.5 | − 8.5 |
| 20 | −50.5 | −24.2 | − 6.2 |
| 25 | −44.7 | −20.4 | − 4.4 |
| 31.5 | −39.4* | −17.1 | − 3.0 |
| 40 | −34.6 | −14.2 | − 2.0 |
| 50 | −30.2 | −11.6 | − 1.3 |
| 63 | −26.2* | − 9.3 | − 0.8 |
| 80 | −22.5 | − 7.4 | − 0.5 |
| 100 | −19.1 | − 5.6 | − 0.3 |
| 125 | −16.1* | − 4.2 | − 0.2 |
| 160 | −13.4 | − 3.0 | − 0.1 |
| 200 | −10.9 | − 2.0 | 0 |
| 250 | − 8.6* | − 1.3 | 0 |
| 315 | − 6.6 | − 0.8 | 0 |
| 400 | − 4.8 | − 0.5 | 0 |
| 500 | − 3.2* | − 0.3 | 0 |
| 630 | − 1.9 | − 0.1 | 0 |
| 800 | − 0.8 | 0 | 0 |
| 1,000 | 0 * | 0 | 0 |
| 1,250 | + 0.6 | 0 | 0 |
| 1,600 | + 1.0 | 0 | − 0.1 |
| 2,000 | + 1.2* | − 0.1 | − 0.2 |
| 2,500 | + 1.3 | − 0.2 | − 0.3 |
| 3,150 | + 1.2 | − 0.4 | − 0.5 |
| 4,000 | + 1.0* | − 0.7 | − 0.8 |
| 5,000 | + 0.5 | − 1.2 | − 1.3 |
| 6,300 | − 0.1 | − 1.9 | − 2.0 |
| 8,000 | − 1.1* | − 2.9 | − 3.0 |
| 10,000 | − 2.5 | − 4.3 | − 4.4 |
| 12,500 | − 4.3 | − 6.1 | − 6.2 |
| 16,000 | − 6.6 | − 8.4 | − 8.5 |
| 20,000 | − 9.3 | −11.1 | −11.2 |

*Values used for converting octave-band readings into A-weighted sound levels.

This type of filter generally has a narrow bandwidth of a few hertz which does not change as the operating frequency changes. The second type of filter is more commonly used in acoustics and is a constant percentage filter. The width of the band being utilized is a fixed percent of the frequency at which the instrument is operating.

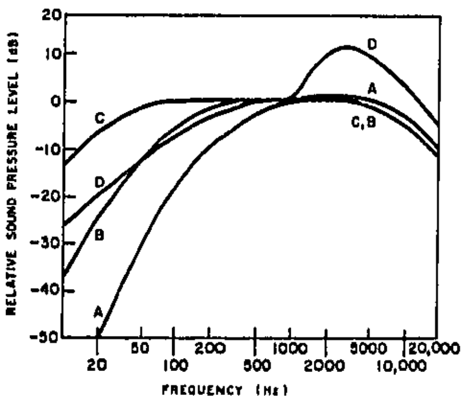



**FIGURE I-3.—Standard A-, B-, and C-Weighting Curves for Sound Level Meters; Also Proposed D-Weighting Curve for Monitoring Jet Aircraft Noise.**

For example, a 6 percent bandwidth filter would have a bandwidth of 60 Hz when it is set to operate at 1,000 Hz, and a bandwidth of 120 Hz when operating at 2,000 Hz.

The constant percentage filters most often used in acoustics are octave band filters or some submultiple of an octave such as one-half octave, one-third octave, or one-tenth octave. The logarithmic difference between each upper frequency limit, $f_2$, and the corresponding lower frequency limit, $f_1$, for constant percentage filters is also a constant. For octave band filters, this difference by definition is

$$\log f_2 - \log f_1 = \log \frac{f_2}{f_1} = \log 2; \qquad (29)$$

and

$$f_2 = 2f_1. \qquad (30)$$

If each filter has a frequency range equal to a submultiple, $k$, of an octave, then the constant difference is

$$\log f_2 - \log f_1 = \frac{\log 2}{k} = \log 2^{1/k} \qquad (31)$$

and

$$f_2 = 2^{1/k} f_1. \qquad (32)$$

Note: In the special case of one-third octave bands ($k=3$), since $2^{1/3}=1.25992$ and $10^{1/10}=1.25893$, $f_2=10^{1/10} f_1$ is used in practice for computational convenience.

The center frequency, $f_c$, of a constant percentage filter is the logarithmic or geometric mean of $f_1$ and $f_2$

$$f_c = \text{antilog} \frac{\log f_1 + \log f_2}{2} = (f_1 f_2)^{1/2}, \qquad (33)$$

$$f_c = (2^{1/k} f_1 f_1)^{1/2} = 2^{1/2k} f_1 = 2^{-1/2k} f_2 \qquad (34)$$

and

$$f_1 = 2^{-1/2k} f_c, \qquad (35)$$

$$f_2 = 2^{1/2k} f_c. \qquad (36)$$

The constant percentage, $P_k$, for a set of filters is thus

$$P_k = 100 \frac{(f_2 - f_1)}{f_c} = 100\ (2^{1/2k} - 2^{1/2k}),$$
$$k = 2, 3, \ldots \qquad (37)$$

The most common constant percentages used are 70.7 percent of the center frequency for octave band filters and 23.2 percent for one-third octave bands.

For a broadband sound the octave band sound pressure level will be just the sum of the three one-third octaves that make up the octave band. Similarly, if measurements are made in one-tenth octaves then 10 of these will add up to the sound pressure level in the octave band. This addition must be made of the mean sound pressures squared and then converted to decibels or the decibels can be added using Figure I-2. For example, if the three one-third octave levels are 65, 68, and 70 dB we get 72.9 dB for the octave band. The preferred series of octave band and one-third octave band center frequencies, as specified by ANSI S1.6, along with upper and lower frequency limits are shown in Table I-4.

## I-2.2—INSTRUMENTS FOR NOISE MEASUREMENTS

### I-2.2.1—MICROPHONES

The basic sensing instrument for measuring sound pressure in air is the microphone. These sensors come in a variety of sizes and types but they all have one thing in common. The basic sensor is a diaphragm which is forced to vibrate as the sound wave impinges upon it. This vibratory motion is then converted into an electrical signal in any one of a number of ways.

**TABLE I-4 — CENTER AND CUTOFF FREQUENCIES FOR PREFERRED SERIES OF CONTIGUOUS OCTAVE AND ONE-THIRD OCTAVE BANDS AS SPECIFIED BY ANSI S1.6**

| FREQUENCY, Hz | | | | | |
|---|---|---|---|---|---|
| OCTAVE | | | ONE-THIRD OCTAVE | | |
| LOWER BAND LIMIT | CENTER | UPPER BAND LIMIT | LOWER BAND LIMIT | CENTER | UPPER BAND LIMIT |
| | | | 11.2 | 12.5 | 14.1 |
| 11 | 16 | 22 | 14.1 | 16 | 17.8 |
| | | | 17.8 | 20 | 22.4 |
| | | | 22.4 | 25 | 28.2 |
| 22 | 31.5 | 44 | 28.2 | 31.5 | 35.5 |
| | | | 35.5 | 40 | 44.7 |
| | | | 44.7 | 50 | 56.2 |
| 44 | 63 | 88 | 56.2 | 63 | 70.8 |
| | | | 70.8 | 80 | 89.1 |
| | | | 89.1 | 100 | 112 |
| 88 | 125 | 177 | 112 | 125 | 141 |
| | | | 141 | 160 | 178 |
| | | | 178 | 200 | 224 |
| 177 | 250 | 354 | 224 | 250 | 282 |
| | | | 282 | 315 | 354 |
| | | | 354 | 400 | 447 |
| 354 | 500 | 707 | 447 | 500 | 562 |
| | | | 562 | 630 | 707 |
| | | | 707 | 800 | 891 |
| 707 | 1,000 | 1,414 | 891 | 1,000 | 1,122 |
| | | | 1,122 | 1,250 | 1,414 |
| | | | 1,414 | 1,600 | 1,778 |
| 1,414 | 2,000 | 2,828 | 1,778 | 2,000 | 2,239 |
| | | | 2,239 | 2,500 | 2,828 |
| | | | 2,828 | 3,150 | 3,548 |
| 2,828 | 4,000 | 5,656 | 3,548 | 4,000 | 4,467 |
| | | | 4,467 | 5,000 | 5,656 |
| | | | 5,656 | 6,300 | 7,079 |
| 5,656 | 8,000 | 11,312 | 7,079 | 8,000 | 8,913 |
| | | | 8,913 | 10,000 | 11,220 |
| | | | 11,220 | 12,500 | 14,130 |
| 11,312 | 16,000 | 22,624 | 14,130 | 16,000 | 17,780 |
| | | | 17,780 | 20,000 | 22,390 |

One of the ways to transduce sound is to use the diaphragm as one side of a capacitor. Any movement in the diaphragm results in a change in the capacitance and an electrical signal is generated when a large polarizing voltage to charge the capacitor is applied.

A second type of microphone is one in which the diaphragm is attached directly to a piezoceramic material. Motion of the diaphragm causes strain in the ceramic which results in the generation of an electronic signal. These microphones are generally less sensitive than the capacitor types since the diaphragm is mounted directly to the ceramic, although a polarization voltage is not required.

A third type is the dynamic (moving coil) microphone. In this type the diaphragm is attached to a coil which is forced to move through a magnetic field as the diaphragm moves. The movement of the coil through the magnetic field causes a current to flow in the coil. These microphones have a lower electrical impedance. However, because of the mass of the coil, these microphones are more sensitive to vibration, the magnetic field makes them susceptible to external magnetic fields, and their low frequency response is limited due to the larger excursions of the coil as the frequency is lowered.

A newcomer to the microphone arena is the electret microphone. These are capacitor microphones but the air gap between the capacitor plates is replaced with a prepolarized dielectric. This construction offers the quality of the capacitor microphone but eliminates the need for the direct current bias voltage. These microphones are of more simple and rugged construction, and have a higher capacitance which simplifies some of the electrical problems associated with the very small capacitance of the capacitor type microphones.

The sensitivity of a microphone is generally dependent on frequency, direction of the incident sound wave, and size of the diaphragm. The sensitivity at a given frequency is defined as the ratio of the root mean square output voltage to the root mean square sound pressure and is given in units of volts per Newtons/meter$^2$ or other similar units.

If the sound pressure is applied uniformly over the surface of the diaphragm the response is called *pressure response.*

The *free field response* at a given frequency is defined as the ratio of the root mean square voltage to the root mean square sound pressure that existed at the microphone location prior to the insertion of the microphone.

These two definitions are identical for a microphone with negligible dimensions. However, when the wavelength of the sound wave becomes comparable to the dimensions of the diaphragm, the microphone acts as a reflector which causes an increase in pressure on the diaphragm and a corresponding increase in output voltage. This reflection effect also depends on the angle of incidence of the sound wave on the diaphragm.

Since it is impossible to make a microphone with zero dimensions there will always be some effect on the sound field when the microphone is inserted. Therefore, to obtain the pressure that exists at that point before the microphone is inserted one must apply a correction to the sensitivity of the microphone. In Figure I–4 some corrections are shown that

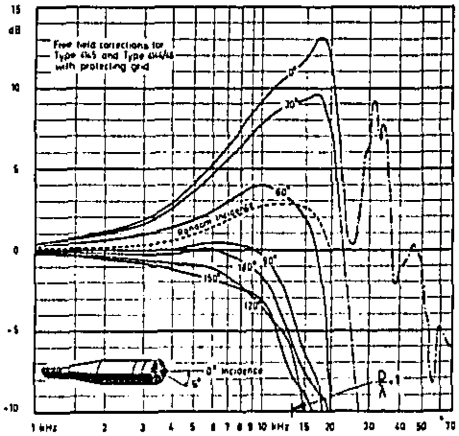



**FIGURE I-4.—Free Field Correction for Microphone With Protecting Grid (electrostatic actuator method of pressure calibration). (Courtesy Bruel & Kjaer Instruments Inc.)**

must be applied to the microphone sensitivity as a function of frequency in kilohertz (kHz) and angle of incidence on the diaphragm. As previously mentioned the increase in pressure at the diaphragm for wavelengths comparable to the dimensions of the diaphragm shows up very clearly in the sensitivity correction that must be applied when the sound wave is incident normally on the diaphragm. Note how close the peak in the zero incidence correction curve comes to the frequency where the wavelength equals the diameter of the diaphragm (shown in this figure as $D/\lambda = 1$).

Another view of the dependence of sensitivity on frequency and angle of incidence is shown in Figure I-5. In this figure the relative response for five frequencies through the full 360 degrees (deg) of possible incidence are shown. For the microphone shown, the circular symmetry makes the response symmetric about the axis of the diaphragm.

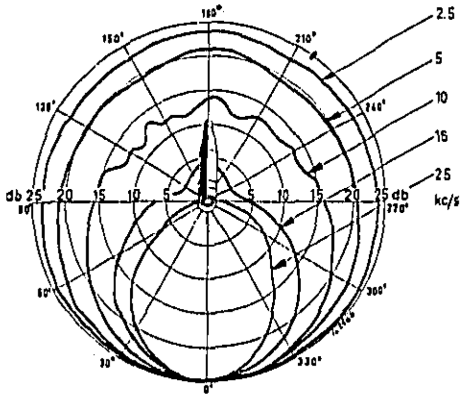



**FIGURE I-5.—Typical Directional Characteristics for 1-inch Microphone with Protecting Grid. (Courtesy Bruel & Kjaer Instruments Inc.)**

To reduce the complexity of applying these corrections when using a microphone the manufacturers have designed microphones with proper tension and damping on the diaphragm so that either a free field response may be obtained directly or a pressure response will result. Figure I-6 shows the response of a typical "pressure" microphone (Bruel & Kjaer 1-inch microphone). If the 90 deg curve of Figure I-4 is applied to this microphone the response will remain unchanged to beyond 10 kHz for sound waves striking the diaphragm at grazing incidence (90 deg). This type of microphone should be pointed at right angles to the source of the sound to obtain the proper flat frequency response.

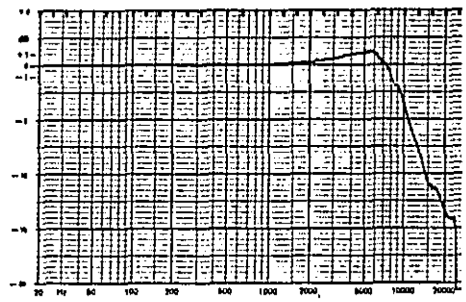


**FIGURE I-6.—Frequency Response Curve Supplied by B&K Instruments with 1-inch Pressure Microphone Type 4144. (Courtesy Bruel & Kjaer Instruments Inc.)**

To produce a so-called "free field" microphone, this manufacturer has constructed the diaphragm so that the pressure response is as shown in the lower curve in Figure I-7. If the microphone is pointed at the sound source so that the sound wave impinges normally (zero) on the diaphragm the top correction curve

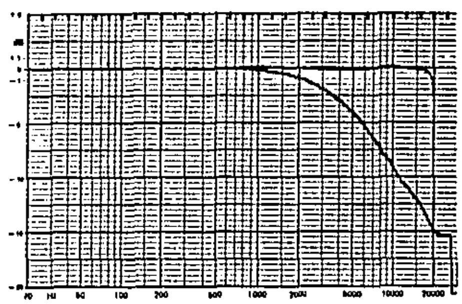


**FIGURE I-7.—Frequency Response Curve Supplied by B&K Instruments with 1-inch Free Field Microphone Type 4145. (Courtesy Bruel & Kjaer Instruments Inc.) Lower curve: Microphone pressure response. Upper curve: Microphone pressure response with correction added for zero angle of incidence giving the free field response.**

(zero incidence) of Figure I-4 when applied to the pressure response will result in the upper microphones. If one desires to use a microphone has a flat frequency response when it is pointed at the sound source whereas the pressure microphone has a flat frequency response when pointed 90 deg to the sound source. For either of these microphones the corrections for angles other than zero or 90 deg still must be applied as required.

These general characteristics hold for most microphones. If one desires to use a microphone which qualifies as a precision instrument he can take assurance in the fact that standards for the performance of such microphones are published by the American National Standards Institute (ANSI), for example, ANSI S1.12-1967, "Specifications for Laboratory Standard Microphones". When purchasing such a microphone the manufacturer will supply the buyer with a calibration curve, stating to which appropriate standard the microphone complies and this calibration will be traceable to the National Bureau of Standards (refer to standard ANSI S1.10-1966, "Method for the Calibration of Microphones").

I-2.2.2—Sound Level Meters

In its basic form a sound level meter (SLM) is simply a microphone mounted on an amplifier with a meter to indicate the level of the sound pressure at the microphone. Such a simple process is no longer in use, and all SLM's should read the same value when exposed to the same sound pressure. Consequently, ANSI has another standard for sound level meters — ANSI S1.4-1971, "Specification for Sound Level Meters". This standard clearly points out the tolerances within which the meter must be able to measure sound pressure levels.

As discussed in Subsection I-2.1.6, sound is composed of both amplitude and frequency, and the A-, B-, C-, and D-weighting curves were introduced along with band pass filters. A typical SLM may incorporate some or all of these filters such as shown in Figure I-8. The "typical" SLM has the microphone mounted on the front and the output is amplified and fed to one of the filter circuits as selected by a switch. Band pass filters are usually of the constant percentage or fractional octave type.

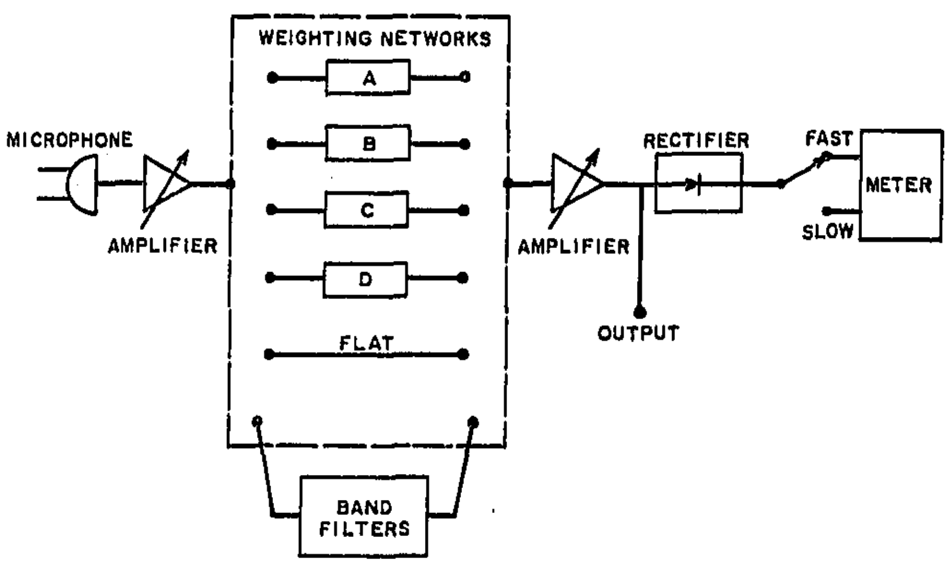



**FIGURE I-8.—Block Diagram of a Sound Level Meter.**

Constant bandwidth filters are not usually provided on portable meters.

After passing through the selected filter network the signal is again amplified. At this point an output jack is provided so that the signal may be recorded on tape or fed to some other signal analyzing device. After being amplified the signal goes to a mean square rectifier and the value is displayed on a meter in decibel units. Note here that the meter may have either a fast or a slow response which is switch selectable. The fast response provides an averaging time of 200 to 250 milliseconds. The slow response position averages the signal for a greater period of time.

Each of the blocks shown in Figure I-8 is covered in the specifications of ANSI S1.4-1971, including the response time of the meter. While this standard does not specify which of the filter circuits a SLM must have it does specify how accurately the weighting curves must correspond to the attenuations shown in Table I-3. The accuracy requirements are divided into three groups

Type 1—Precision SLM (most stringent)
Type 2—General purpose SLM
Type 3—Survey SLM (least stringent)

A fourth type called special purpose SLM includes those which have only a portion of the variations possible. These special purpose meters must meet the standard for those features they do incorporate.

Only sound levels that are reasonably steady in time have been considered thus far. Another noise type which must be considered is the so-called "impulse" noise. This is a sound of short duration such as a gunshot or the noise produced by a hammer striking an object. To measure such sounds the SLM described is not very well equipped because the meter simply cannot respond fast enough. These sounds can best be measured by connecting the SLM output to a storage oscilloscope and reading the peak amplitude from the display. However, there are some instruments available which incorporate a "peak hold" feature. This is an instrument that has a very fast response electrical circuit which measures the peak of the sound pressure pulse and holds the value long enough for the meter to display the value that is held. The meter then holds this value until the operator resets the instrument.

At this time few instruments have this peak hold feature and it is also under discussion just how such noises should be measured so that the instrument will display a value that has meaning as related to how the ear responds to such sounds. Currently in use in Europe and being considered here and by international standards groups is another meter response time called "impulse" response. This impulse measurement is between the meter fast response time and the true peak measurement (see *S/V Sound and Vibration*, March 1974).

I-2.2.3—Calibration of Sound Level Meters

Although a sound level meter comes from the factory calibrated and is provided with the appropriate traceability to the National Bureau of Standards, its performance must be checked on a regular basis. Several devices are available for this purpose. The most common of these is a calibrator which fits directly over the microphone and generates a known pressure level within the closed volume by the motion of a piston back and forth or with a small loudspeaker. These devices are not intended to replace proper laboratory procedures for microphone calibration. If an instrument cannot be adjusted in the field to indicate the proper sound pressure level of the calibrator, the problem should be first corrected and a recalibration performed by an agency qualified to do so.

I-2.2.4—Frequency Analyzers

Since a sound level meter is a small portable device it cannot incorporate all of the capabilities to analyze sounds which an engineer may desire. This is the reason for the output jack. With this output the engineer can either record the sounds on tape or he may connect the sound level meter directly to some other signal analysis device.

Some of the devices which find particular use in acoustics are frequency analyzers which can produce frequency spectra in real time in almost any desired bandwidth or type. These "real time analyzers" are generally of two types. The first is the multiple filter in which the electronic signal is fed to many filters simultaneously and the output of each is displayed in suitable fashion. The second type uses a time compression technique and feeds the signal through a single variable filter at a speed such that the result appears to have been obtained in real time. Either of these analyzers are rather large expensive devices and are therefore not on the equipment list of the average individual or small company. The types of analysis that can be performed with these or other even more sophisticated instruments are too many and too varied to be included here.

## I-2.3—METHODS OF NOISE CONTROL

The basic idea behind the techniques for limiting a person's exposure to noise is very simple and straightforward. The reference frame dealt with in noise reduction is composed of a sound SOURCE, the sound wave PATH, and a sound wave RECEIVER which, in common circumstances, is an ear or a microphone that is used for measurement.

The best and most satisfying means of reducing noise levels is to reduce the source sound output. This approach may require major modifications to the noisy device. Some of these modifications include better quality control, closer tolerances on moving parts, better balancing of rotating parts, and sometimes even a complete redesign of the technique utilized to perform the job for which this machine is intended. Since something vibrating causes compression and rarefaction of the air which is observed as sound, the abovementioned and many other modifications to a sound source are all aimed toward reducing the vibration of any part to the lowest possible level. Normally these modifications are not within the capability of the user and therefore must be left to the equipment manufacturers. Fortunately for those directly affected, manufacturers are beginning to make these changes. There is, however, one set or kind of modification that the user can perform. A particular piece of machinery may be the driving force to produce vibrations but it often is the floor, wall, or other support member that is doing much of the sound radiating. This kind of vibration problem can be effectively reduced by proper use of vibration isolation or vibration damping treatment.

Essentially vibration isolation means that the connection between the driving force and the driven member is such that the vibration is not transmitted through the connection. Any device which behaves as a spring can be utilized for this purpose. Vibration isolators can be made with actual steel springs, or with rubber pads. Vibration isolators are also made out of coils of cable laid on their side or even air can be used when properly contained. The selection of which vibration isolator to use depends on the forces involved, the frequency of the driving force, and the possible natural frequencies of the support member itself. If not properly selected, a vibration isolator can make a problem situation worse.

Vibration damping is the dissipation of energy in a vibrating system. This dissipation of energy results in a lower vibration level with the consequent reduction in noise power output. All materials exhibit some damping naturally but the amount of natural damping in most metals is too low to be of any significance. Common lead has a reasonable amount of natural damping, and some special metals designed for high damping can also be effective.

Vibration damping usually is the application of some viscoelastic material such as rubber and plastics, etc., to the vibrating member. The most suitable substances are the high-molecular weight polymers, and application of these to a surface can increase the energy dissipation significantly. Materials for vibration damping can be obtained in several forms. Some can be sprayed or painted on, some come laminated to the metal part, and others are in sheet or roll form and can be glued on.

It is not the authors' intention to present a course in vibration isolation or damping, but a decent discussion cannot overlook what is called "constrained layer" damping. In this technique the damping material is sandwiched between the panel to be damped and a backing plate of some rigid material. The backing plate is firmly held in place by bonding the layers together with adhesive or bolting the sandwich together. This technique further increases the energy dissipative processes and provides for greater reduction in vibration levels.

At the other end of the noise control frame is the receiver. The method of controlling noise exposure at the receiving end usually means removing the affected person from the sound field. When this cannot be done the alternative is to have the person wear ear muffs or ear plugs. This procedure is actually a control on the path of the noise but since it is incorporated directly with the receiver it is considered a receiver application.

The middle course of action is modification to the path the sound takes from the source to the receiver. Although this document is not intended to be a noise control manual, it is with controls on the sound path that most of the items listed herein are concerned. Consequently it is beneficial to take a detour at this point and briefly describe some of the processes that occur when a sound wave comes into contact with some surface.

Sound can reach a listener's ears by several different routes. The most obvious for internal noise sources is the direct path. In a given room, reflections from walls, ceiling, floor, or any obstacles may contribute equally or more to the sound pressure level than the direct path. As sound travels through solids and air, it may travel an indirect route through floors and walls and arrive at the receiver after reradiation.

Paths for external sound include penetration through and/or around open or closed doors, partitions, walls, windows, roofs, ceilings and floors. The effectiveness of a well-designed acoustical wall can be largely destroyed by relatively small openings.

Basically the two different acoustic environments that are employed in evaluating noise sources or the effectiveness of acoustic insulation are the free field and diffuse field. As previously mentioned a free field is defined as a homogenous, isotropic medium, free from boundaries.

A reverberant field exists when sound from the source bounces back and forth from the hard surfaces of the room such that the sound pressure level at any one point is composed of many such reflected waves. In an ideal reverberant field the sound waves are perfectly reflected with no loss in intensity and a diffuse condition exists where the sound pressure level is equal everywhere.

In actual conditions when a sound wave strikes a surface it is partially reflected, partially transmitted through the surface, and partially absorbed. The sound absorbing quality of a material is described by an absorption coefficient, $\alpha$, which is defined as the ratio of the total energy incident on a surface minus the energy reflected from the surface, to the energy incident upon the surface. As such the absorption coefficient can vary between zero and one. When the energy is perfectly reflected the ratio is zero and when the energy is completely absorbed this ratio is 1.

The mechanism of sound absorption is that the acoustic energy of the wave is converted to some other form of energy, usually heat. Three major means of converting the acoustic energy are by using porous absorptive materials, diaphragmatic absorbers, and resonant or reactive absorbers.

Porous absorptive materials are the best known of the acoustical absorbers. These are usually fuzzy, fibrous materials, perforated board, foams, fabrics, carpets, and cushions, etc. In these materials the sound wave causes motion of the air in the spaces surrounding the fibers or granules, the frictional energy losses occur as heat, and the acoustic energy is reduced. Because this is the mechanism by which these materials absorb sound, it is easy to see that a "too loose" material will not cause enough frictional energy losses and will be a poor absorber. On the other hand, a material which is too dense will not permit enough air motion to generate sufficient friction and will also be a poor absorber. The latter type of material is more of a reflector than an absorber.

In a diaphragmatic absorber the panel oscillates at the same frequency as the sound wave impinging upon it (or at some harmonic). Since no material is perfectly elastic, the natural damping will absorb some of the incident energy. This type of absorber is usually more effective at lower frequencies since the higher frequencies tend to be reflected. Since the absorption coefficient of this absorber type is very dependent on mass, rigidity, size, shape, and mounting methods, it is difficult to forecast how any particular panel will operate in practice. Usually it is necessary to test prototypes for each specific application.

Resonant or reactive absorbers (often called Helmholtz resonators) are cavities which confine a volume of air which is connected to the atmosphere by a small hole or channel in the cavity. If the cavity is very small compared with the wavelength of the incident sound wave, the air in the connecting channel is forced to oscillate into and out of the cavity.

The air inside the cavity acts as a spring and the kinetic energy of the vibration is essentially that of the air in the channel moving as an incompressible and frictionless fluid. This type of absorber has a very narrow frequency band where absorption takes place and as such its use is somewhat limited. This narrow band of absorption can be broadened by insertion of a porous type of absorber into the cavity. Also, the absorption peak is usually in the lower frequencies and as such this principle is useful for increasing the low frequency performance of common porous type absorbers.

Commercial panels are available which have many small holes in the face and the appropriate dimensions of absorber and air gap behind the faces to increase the low frequency absorption. This principle requires that the face plate have an opening of approximately 5 percent or less to effect any tuning. Common perforated absorption panels usually have a much higher open area, since the large closed surface acts to reflect the higher frequencies.

The portion of the sound wave that is not absorbed or reflected when the sound wave strikes a surface is transmitted through to the other side. The fraction of the incident energy that is transmitted through the partition is defined to be the transmission coefficient ($\tau$). This transmission coefficient is related to the transmission loss ($TL$) such that the transmission loss is equal to 10 times the common logarithm of the reciprocal of the transmission coefficient, or

$$TL = 10 \log \frac{1}{\tau} \text{dB} \qquad (38)$$

and the transmission loss is obtained directly in decibels.

Just as with the absorption coefficient the transmission coefficient depends on frequency and equation (38) indicates the transmission loss is also frequently dependent. Since a complete list of transmission coefficient versus frequency is required to describe the transmission loss characteristics of a given material a means of simplifying this has been developed. By fitting the actual test performance curve to standard curves this list can be reduced to a single number which is called the STC of the partition.

The mechanism of transmission loss is similar to that of a diaphragmatic absorber. The incident sound wave causes the partition to vibrate. This vibration in turn causes the air on the other side of the partition to be set into motion and sound is radiated as though this partition were now a sound source. However, this new sound field will be much lower in energy since much of the energy of the incident wave was spent in forcing the partition to vibrate. If the basic laws of motion are considered the force required to accelerate the massive partition is given by

Force = mass x acceleration.

The kinetic energy of this vibrating mass is given by

$$1/2\, MV^2$$

where $M$ = mass of the partition and $V$ = velocity of the partition.

For higher frequencies more force (pressure) is required to vibrate the partition and the greater the mass the greater is the force (pressure) or energy required to vibrate the partition at any given frequency. Specifically, if the frequency is doubled the energy increases four times, since the energy is proportional to the square of the velocity. If the mass is doubled the force (pressure) required to give it the same acceleration is doubled. Since the energy is also proportional to the square of the pressure, the energy also increases fourfold if the mass is doubled. Thus either a doubling of the frequency or of the mass produces a 6 dB increase in the transmission loss. Note, however, that this relationship only holds for a limp mass that moves back and forth such as a piston.

This 6 dB increase in transmission loss for each doubling of the mass for a limp panel is known as the "mass law". This is shown as

$$TL = 20 \log W + 20 \log f - 33 \text{ dB} \qquad (39)$$

where W is the weight per unit area (lb/ft$^2$) and f is the frequency in hertz. In practice, a partition is not truly limp and does not behave in the theoretical manner. Generally the transmission loss increases more slowly than 6 dB per octave of frequency below 1,000 Hz, and approximately at the rate of 6 dB per octave above this frequency. Some notable exceptions to this are due to stiffness, resonances, and coincidence effects.

Resonance occurs when the frequency of the incident sound wave corresponds to a natural frequency of the partition. At this frequency very little energy is required to force the panel to vibrate, and the high amplitude of this vibration produces a correspondingly high sound pressure level on the opposite side of the panel. In some instances the sound wave passes through the panel almost as if it were not there. To avoid the effects of resonance it is desirable to have the lowest natural frequency possible. This condition can best be met by using panels which are as limp and as massive as possible.

A condition similar to resonance can occur when sound waves are incident on a panel at an oblique angle. At certain frequencies the phases of the incident wave will coincide with the phase of the panel's flexural waves as shown in Figure I-9.

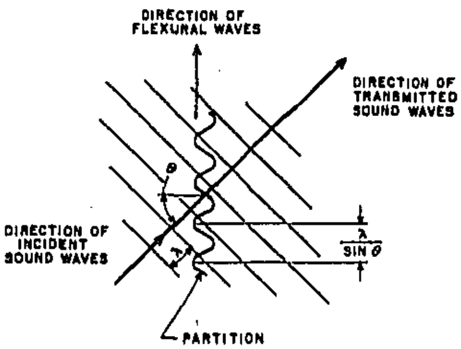



**FIGURE I-9.—Coincidence of Incident Wave and Flexural Wave in a Wall.**

If the wavelength of sound in air is $\lambda$, and the wave impinges on the panel at an angle $\theta$, then when $\lambda/\sin\theta$ is equal to the wavelength of the flexural wave the intensity of the transmitted wave approaches that of the incident wave. Wave coincidence can only occur when the wavelength of the sound in air is less than the wavelength of sound in the panel. Thus, coincidence can only occur at a frequency above a certain critical frequency which is determined by the material and thickness of the panel.

In practice the sound wave is usually not incident from a single direction but is more omnidirectional. A typical panel will have studs, braces, discontinuities, etc., and the effect of coincidence can usually be neglected. If, however, this effect is encountered it can usually be reduced by using very stiff and thick walls or by heavy walls with small stiffness. In general, the transmission properties of a wall behave more like the typical performance shown in Figure I-10.

It should be emphasized that sound absorbent materials due to their soft, porous structure offer only low resistance to a sound wave and permit the passage of the wave through to the other side relatively unattenuated. Only when these materials are very dense or very thick will they appreciably reduce the amplitude of a sound wave as it passes through. Thus, a sound absorbing material is a poor sound barrier. Remember that if air can pass through the material, so can sound.

On the other hand, typical sound barrier materials are hard, heavy, and very reflective. These materials generally follow the mass law and as such offer a high resistance to the passage of a sound wave. A sound barrier material is a poor absorber and an absorbent material is a poor barrier. Therefore the best acoustical treatment almost always uses some combination of these two types of materials.

## I-3—MEASUREMENT OF MATERIAL NOISE-REDUCTION PROPERTIES

### I-3.1—ABSORPTION (RANDOM INCIDENCE COEFFICIENTS)—RE ASTM C423-66

#### I-3.1.1—Test Method

In the laboratory the absorption coefficient of a test specimen is determined by measuring the rate of decay of a sound in a reverberant room. It may be shown theoretically and experimentally that when a sound source is turned off, the rate of decay of the sound level (in decibels per second) is a constant which is dependent upon room geometry and the amount of absorbent material present. This enables one to define the "reverberation time" of a room as the time required for the sound level to decrease by 60 dB. The test procedure for the measurement of random in-

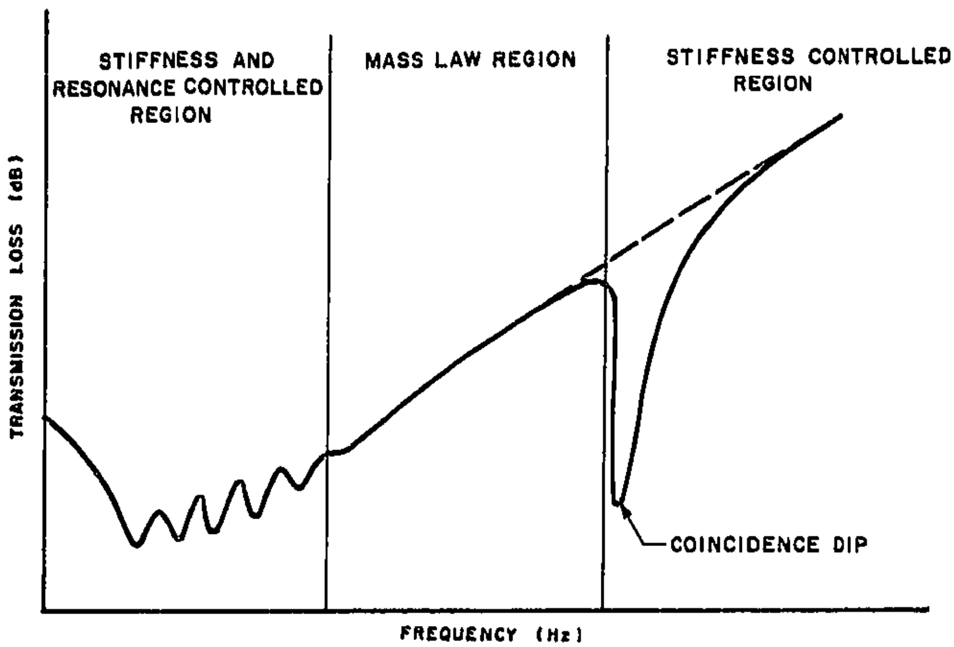



**FIGURE I-10.—Typical Practical Performance of a Wall Relating to the Transmission of Sound Showing Three Separate Regions.**

cidence absorption coefficients is specified by, and described in ASTM Standard C423–66, "Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms".

The total absorption in the room is first measured without the specimen by turning on a sound source long enough to come to a steady state level and then measuring the rate of decay of the sound pressure level when the sound source is suddenly turned off. The total absorption of the room is then given by the Sabine equation

$$A = 0.9210\frac{Vd}{c} \qquad (40)$$

where

$V$ is the volume of the room in ft³,

$d$ is the rate of decay of the sound field in dB/sec,

$c$ is the speed of sound in ft/sec,

$A$ is the total absorption in sabins (ft²).

If the volume of the room is in meters³ and the speed of sound in meters/sec, then the absorption will be in metric sabins (meters²).

After measuring the total absorption in the room the specimen is brought into the room and the total absorption is again measured in the same manner. The absorption added to the room by the test specimen is then determined by taking the difference, thus

$$A_{\text{specimen only}} = A_{\text{with specimen}} - A_{\text{without specimen}} = 0.9210\, V(d_{\text{with}} - d_{\text{without}})/c. \qquad (41)$$

The absorption coefficient is then determined by dividing the total absorption by the area of the specimen

$$\alpha = A/S \qquad (42)$$

where $\alpha$ is the absorption coefficient and $S$ is the area of the specimen in either meters² or ft² as required.

There are several important factors to note about this standard laboratory procedure. First, the room must be very hard and be able to support a reverberant (diffuse) sound field very close to the ideal. Also, the room must be sufficiently large so that the introduction of a highly absorbing specimen will not destroy this diffuse field. Because of the second limitation the specimen must be small enough to not interfere with the diffuseness of the sound field but it must also be large enough so that accurate data may be obtained. The size of the specimen also introduces other effects such as the fact that smaller specimens will generally measure higher values of absorption coefficient than a larger area of the same material. To avoid variations from different laboratories the standard specifies that the specimen size is to be at least 72 $ft^2$, which is the customary size.

### I-3.1.2—Absorption Coefficients Exceeding Unity

In this method of testing the diffuse sound field measures absorption for all angles of incidence and not just for normal incidence. The method of measuring absorption coefficients using the decay rate of the sound field can yield absorption coefficients as high as 1.2 to 1.3 (the absorption coefficient by definition must be between zero and 1). Although it has been shown theoretically that the absorption coefficient cannot exceed 1 these higher values do not cause problems in practice.

The principal reasons that the measured values of absorption coefficients sometimes exceed unity are diffraction effects and the size of the specimen. Diffraction probably accounts for most of the difference in the lower frequencies while specimen size is more responsible for the effects at higher frequencies, since the theory which relates absorption to the decay rate of the sound field is based on an infinite size sample in a diffuse field.

An additional factor affecting the absorption in a reverberation room is that the air is also an absorber, the extent of which is dependent on temperature and relative humidity, especially at the higher frequencies. Since this phenomenon cannot be precisely accounted for, the laboratory measurement of absorption is usually made in a room where these values are maintained within narrow limits. (Temperature and humidity controls should be included in the laboratory report of a test.)

### I-3.1.3—Mountings for Absorption Tests

Another item that affects the absorption properties of a material is the method of mounting. For a porous type absorber the space between it and the wall will increase the absorption somewhat as the space is increased. Consequently, to maintain standard mountings for testing, the Acoustical and Insulating Materials Association (AIMA) specifies seven standard mountings which should be used for testing sound absorbing materials. These mountings are shown in Figure I-11. Laboratories making absorption tests will always include in their report which of these mountings were used for the test.

### I-3.1.4—Dependence of Absorption Coefficient on Frequency

Only the magnitude of sound absorption has been discussed but as with the other properties of sound the absorption also depends on frequency. Some typical sound absorption coefficients versus frequency are shown in Figure I-12. Notice the increase in absorption coefficient with increasing frequency and increasing thickness.

The frequency dependence of the absorption coefficient is obtained by measuring the absorption as described above in six one-third octave bands centered at 125, 250, 500, 1,000, 2,000 and 4,000 Hz. The laboratory report will therefore show six absorption coefficients and the frequencies at which they were measured. Note that these numbers are rounded to the nearest integral multiple of 0.01 as specified in the standard.

It is somewhat cumbersome to compare absorbers if one must be looking at six numbers for each of them. To simplify such comparisons and to provide a means of rating the sound absorbing properties of a material, a one-number rating is employed which is called the Noise Reduction Coefficient (NRC). The average of the absorption coefficients at the four measuring frequencies of 250, 500, 1,000, and 2,000 Hz, rounded to the nearest multiple of 0.05, is the NRC. For example, if the absorption coefficients at the six frequencies were 0.16, 0.26, 0.68, 0.99, 1.11, and 1.22 and the

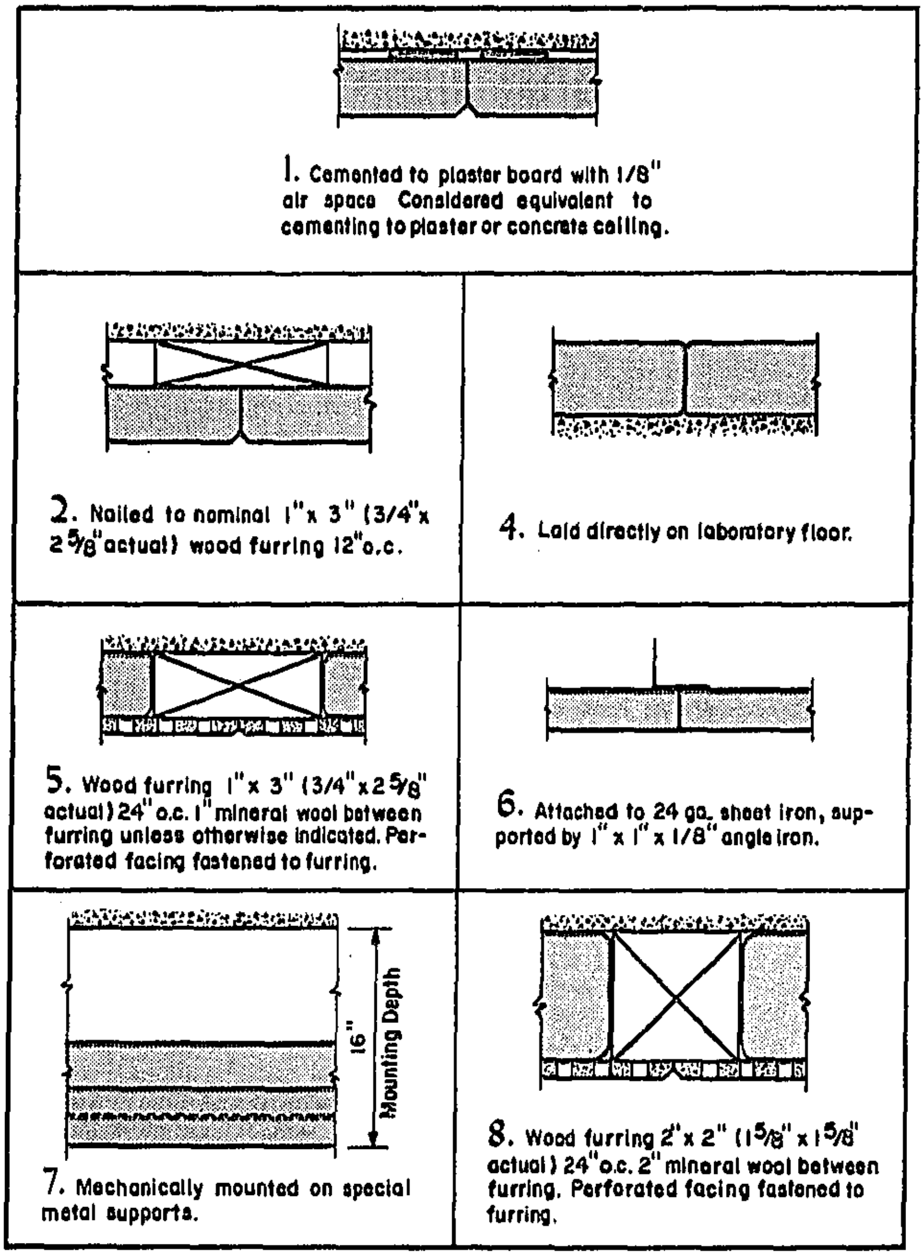



**FIGURE I-11.**—Mountings Used in Sound Absorption Tests. (from *AIMA Bulletin*, "Performance Data, Architectural Acoustical Material")

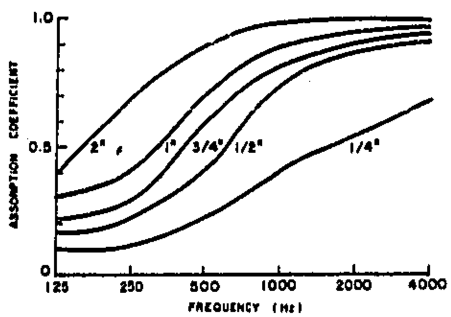



**FIGURE I-12.—Sound Absorption Coefficients versus Frenquency for Some Types of Sound Absorbing Materials.**

average of the four is 0.7625, the report would show the results as follows:

| Frequency, Hz | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 | NRC |
|---|---|---|---|---|---|---|---|
| Absorption Coefficients | 0.16 | 0.26 | 0.69 | 0.99 | 1.11 | 1.22 | 0.75 |

## I-3.2—ABSORPTION (NORMAL INCIDENCE COEFFICIENTS)—RE ASTM C384-58

Another test procedure used to determine sound absorption coefficients is performed using an impedance tube. The test procedure is governed by ASTM standard C384-58, "Test for Impedance and Absorption of Acoustical Materials by the Tube Method". Absorption coefficients ($\alpha_n$) are determined for normal incidence only and an NRC is not computed. In effect, a small sample of the material to be tested is placed at one end of a closed tube and a pure tone sound is generated within the tube. By measuring the maxima and minima of the sound pressure inside the tube the absorption coefficients can be determined. For this test, pure tones are utilized, the frequency of which corresponds to the center frequency of an octave band, (i.e., 125, 250, 500, 1,000, 2,000, or 4,000 Hz).

Often a laboratory or the manufacturer will measure the normal incidence absorption coefficients in an impedance tube and then estimate a value for the Noise Reduction Coefficient.

### I-3.2.1—Relationship Between Random and Normal Incidence Coefficients

It is important to realize that a concrete theoretical relationship has not yet been developed to relate $\alpha_n$ to $\alpha$, and that any estimate made is based on empirical relationships. A rule of thumb for relating $\alpha_n$ to $\alpha$ (Section V-1, ASTM C384) is that $\alpha_n$ is about one-half of $\alpha$ for small values of $\alpha$ and as $\alpha$ becomes large $\alpha_n$ becomes almost equal to $\alpha$. The maximum difference occurs for intermediate values and can be as large as 0.25 to 0.35. In general $\alpha_n$ is always smaller than $\alpha$. (See Figure I-13)

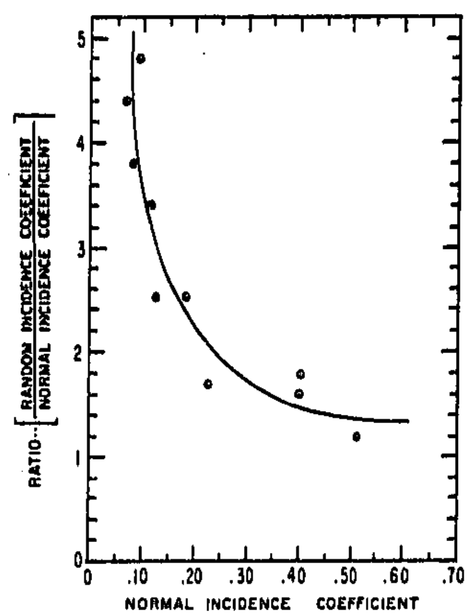



**FIGURE I-13.—Relationship of Random to Normal Incidence Absorption Coefficients at a Test Frequency of 500 Hz. (A. London, *JASA*, 1950)**

## I-3.3—TRANSMISSION LOSS MEASUREMENTS

### I-3.3.1—Test Method—re ASTM E90-70

The test procedure for measurement of transmission loss of materials is specified by, and described in, ASTM Standard E90-70, "Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". The measurement of transmission loss properties in the laboratory is a much more straightforward procedure than that used for absorption. Transmission loss in decibels is 10 times the logarithm of the inverse of the transmission coefficient; as shown in Equation (38) of Subsection I-2.3,

$$TL = 10 \log \frac{1}{\tau} \text{dB}$$

where $\tau$ is the transmission coefficient and is defined as the ratio of the sound power transmitted to the sound power incident on the partition.

To measure the transmission loss of a specimen it is simply mounted in the connecting opening between two reverberation rooms. Care is taken to assure that the only sound path between the two rooms is through the specimen. A sound source is operated in the source room and sound pressure levels in the source room and the receiving room are then measured in each of 16 contiguous one-third octave bands from 125 through 4,000 Hz. The tranmission loss is then computed from the relationship

$$TL = NR + 10 \log S - 10 \log A \qquad (43)$$

where $TL$ is the transmission loss in decibels, $S$ is the total area of the sound transmitting surface of the test specimen, $A$ is the total absorption in the receiving room (expressed in units consistent with $S$), and

$$NR = L_{p_s} - L_{p_r} \qquad (44)$$

is the noise reduction between the two reverberation rooms. The sound pressure level in the source room is $L_{p_s}$, and $L_{p_r}$ is the sound pressure level in the receiving room. Note that the absorption, $A$, in the receiving room is measured in the same manner as absorption measurements described in Subsection I-3.1.1.

I-3.3.2—Dependence of Transmission Loss on Frequency

Since once again there is a situation where the acoustical properties of an item are frequency dependent and there are 16 numbers to describe these properties it is desirable to reduce this amount of data to a single number. In the case of transmission loss properties this single-number rating is called Sound Transmission Class (STC). The STC is determined by comparing the set of transmission losses at all 16 frequencies to a set of standard contours as described in ASTM Standard E413-70T, "Tentative Classification for Determination of Sound Transmission Class". Briefly stated, the $TL$ curve must fit the standard contour in such a way that in no event is the $TL$ curve more than 8 dB below the STC contour at any frequency, and the sum of the deviations of the $TL$ values which are below the contour shall not exceed 32 dB. The highest contour to which the specimen $TL$ curve can satisfy these requirements is used as the STC curve. The value of this curve at 500 Hz is then chosen as the STC of the specimen. The specific values of transmission loss versus frequency as given by this classification are shown in Table I-5.

The STC values of some common materials are shown in Table I-6. The values shown in Table I-6 are representative because the weights and densities of these materials vary and some of the items are porous even though they are heavy.

In general these curves provide a good comparison between specimens, but due to the way deviations from the standard curve are handled poor comparisons can be made as shown in Figure I-14. The partition shown by the solid line has transmission loss values that are higher than those for the dashed curve except between about 600 to 2,000 Hz and yet has a STC 5 dB lower than for the dashed curve. This only points out that STC is a convenience and should not be used as the basis for selection of any particular item.

I-3.3.3—Test Facility Requirements

A few comments are in order at this point about the characteristics of the reverberation rooms used for testing partitions for transmission loss. One of these is that the rooms should be large enough to support a diffuse field in the lower frequencies. The size should be such that

| 9 | | 7 | | 3 | | 1 | | 0 | |
|---|---|---|---|---|---|---|---|---|---|

| 125 | 250 | 500 | 1K | 2K | 4K |
|---|---|---|---|---|---|
| 13 | 22 | 29 | 32 | 33 | 33 |
| 12 | 21 | 28 | 31 | 32 | 32 |
| 11 | 20 | 27 | 30 | 31 | 31 |
| 10 | 19 | 26 | 29 | 30 | 30 |
| 9 | 18 | 25 | 28 | 29 → | 29 |
| 8 | 17 | 24 | 27 | 28 | |
| 7 | 16 | 23 | 26 | 27 | |
| 6 | 15 | 22 | 25 | 26 | |
| 5 | 14 | 21 | 24 | 25 | |
| 4 | 13 | 20 | 23 | 24 | |
| 3 | 12 | 19 | 22 | 23 | |
| 2 | 11 | 18 | 21 | 22 | |
| 1 | 10 | 17 | 20 | 21 | |
| 0 | 9 | 16 | 19 | 20 | |
| — | 8 | 15 | 18 | 19 | |
| — | 7 | 14 | 17 | 18 | |
| — | 6 | 13 | 16 | 17 | |
| — | 5 | 12 | 15 | 16 → | |
| | 4 | 11 | 14 | 15 | |
| | 3 | 10 | 13 | 14 | |
| | 2 | 9 | 12 | 13 | |
| | 1 | 8 | 11 | 12 | |
| | 0 | 7 | 10 | 11 | |
| | — | 6 | 9 | 10 | |
| | — | 5 | 8 | 9 | |
| | | 4 | 7 | 8 | |
| | | 3 | 6 | 7 | |
| | | 2 | 5 | 6 | |
| | | 1 | 4 | 5 | |
| | | 0 | 3 | 4 | |
| | | — | 2 | 3 | |
| | | — | 1 | 2 | |
| | | — | 0 | 1 | |
| | | — | 0 | 0 → | 0 |

### TABLE I-5 — TRANSMISSION LOSS VERSUS FREQUENCY FOR A RANGE OF SOUND TRANSMISSION CLASS CONTOURS

Note: A particular contour is identified by its *TL* value at 500 Hz.
(From ASTM E413)

Sound Transmission Loss

| Hz | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1,000 | 1,250 | 1,600 | 2,000 | 2,500 | 3,150 | 4,000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 44 | 47 | 50 | 53 | 56 | 59 | 60 | 61 | 62 | 63 | 64 | 64 | 64 | 64 | 64 | 64 |
| | 43 | 46 | 49 | 52 | 55 | 58 | 59 | 60 | 61 | 62 | 63 | 63 | 63 | 63 | 63 | 63 |
| | 42 | 45 | 48 | 51 | 54 | 57 | 58 | 59 | 60 | 61 | 62 | 62 | 62 | 62 | 62 | 62 |
| | 41 | 44 | 47 | 50 | 53 | 56 | 57 | 58 | 59 | 60 | 61 | 61 | 61 | 61 | 61 | 61 |
| | 40 | 43 | 46 | 49 | 52 | 55 | 56 | 57 | 58 | 59 | 60 | 60 | 60 | 60 | 60 | 60 |
| | 39 | 42 | 45 | 48 | 51 | 54 | 55 | 56 | 57 | 58 | 59 | 59 | 59 | 59 | 59 | 59 |
| | 38 | 41 | 44 | 47 | 50 | 53 | 54 | 55 | 56 | 57 | 58 | 58 | 58 | 58 | 58 | 58 |
| | 37 | 40 | 43 | 46 | 49 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 57 | 57 | 57 | 57 |
| | 36 | 39 | 42 | 45 | 48 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 56 | 56 | 56 | 56 |
| | 35 | 38 | 41 | 44 | 47 | 50 | 51 | 52 | 53 | 54 | 55 | 55 | 55 | 55 | 55 | 55 |
| | 34 | 37 | 40 | 43 | 46 | 49 | 50 | 51 | 52 | 53 | 54 | 54 | 54 | 54 | 54 | 54 |
| | 33 | 36 | 39 | 42 | 45 | 48 | 49 | 50 | 51 | 52 | 53 | 53 | 53 | 53 | 53 | 53 |
| | 32 | 35 | 38 | 41 | 44 | 47 | 48 | 49 | 50 | 51 | 52 | 52 | 52 | 52 | 52 | 52 |
| | 31 | 34 | 37 | 40 | 43 | 46 | 47 | 48 | 49 | 50 | 51 | 51 | 51 | 51 | 51 | 51 |
| | 30 | 33 | 36 | 39 | 42 | 45 | 46 | 47 | 48 | 49 | 50 | 50 | 50 | 50 | 50 | 50 |
| | 29 | 32 | 35 | 38 | 41 | 44 | 45 | 46 | 47 | 48 | 49 | 49 | 49 | 49 | 49 | 49 |
| | 28 | 31 | 34 | 37 | 40 | 43 | 44 | 45 | 46 | 47 | 48 | 48 | 48 | 48 | 48 | 48 |
| | 27 | 30 | 33 | 36 | 39 | 42 | 43 | 44 | 45 | 46 | 47 | 47 | 47 | 47 | 47 | 47 |
| | 26 | 29 | 32 | 35 | 38 | 41 | 42 | 43 | 44 | 45 | 46 | 46 | 46 | 46 | 46 | 46 |
| | 25 | 28 | 31 | 34 | 37 | 40 | 41 | 42 | 43 | 44 | 45 | 45 | 45 | 45 | 45 | 45 |
| | 24 | 27 | 30 | 33 | 36 | 39 | 40 | 41 | 42 | 43 | 44 | 44 | 44 | 44 | 44 | 44 |
| | 23 | 26 | 29 | 32 | 35 | 38 | 39 | 40 | 41 | 42 | 43 | 43 | 43 | 43 | 43 | 43 |
| | 22 | 25 | 28 | 31 | 34 | 37 | 38 | 39 | 40 | 41 | 42 | 42 | 42 | 42 | 42 | 42 |
| | 21 | 24 | 27 | 30 | 33 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 41 | 41 | 41 | 41 |
| | 20 | 23 | 26 | 29 | 32 | 35 | 36 | 37 | 38 | 39 | 40 | 40 | 40 | 40 | 40 | 40 |
| | 19 | 22 | 25 | 28 | 31 | 34 | 35 | 36 | 37 | 38 | 39 | 39 | 39 | 39 | 39 | 39 |
| | 18 | 21 | 24 | 27 | 30 | 33 | 34 | 35 | 36 | 37 | 38 | 38 | 38 | 38 | 38 | 38 |
| | 17 | 20 | 23 | 26 | 29 | 32 | 33 | 34 | 35 | 36 | 37 | 37 | 37 | 37 | 37 | 37 |
| | 16 | 19 | 22 | 25 | 28 | 31 | 32 | 33 | 34 | 35 | 36 | 36 | 36 | 36 | 36 | 36 |
| | 15 | 18 | 21 | 24 | 27 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 35 | 35 | 35 | 35 |
| | 14 | 17 | 20 | 23 | 26 | 29 | 30 | 31 | 32 | 33 | 34 | 34 | 34 | 34 | 34 | 34 |

$$V = 4\lambda^3 \qquad (45)$$

where $V$ is the room volume and $\lambda$ is the wavelength of the lowest frequency of interest in units consistent with $V$. For example if a room has a volume of 6,300 ft$^3$ it should not be used for measurements below about 97 Hz.

A second requirement is that the sound field in the two reverberation rooms be sufficiently diffuse so that measurements can be made such as to ensure that the mean value of the noise reduction can be known to within 1 dB with 90-percent confidence. To accomplish this, laboratories use special, very hard rooms, with both fixed and rotating panels (vanes) to increase the diffuseness of the sound field.

A further requirement on the laboratory is the reduction of flanking path transmission to the point where it no longer interferes with the measurements. Flanking transmission occurs

TABLE I-6 — SOUND TRANSMISSION CLASS OF SOME COMMON BUILDING MATERIALS

| MATERIAL | STC |
|---|---|
| 24-gauge steel | 26 |
| ⅛-inch plate glass | 28 |
| ¼-inch plate glass | 30 |
| 3/16-inch steel plate | 35 |
| 4-inch two-cell concrete block | 41 |
| 4-inch two-cell concrete block (filled with sand) | 43 |
| Two layers of ⅝-inch gypsum board on 2 x 4-inch studs 16 inches on center | 43 |
| 8-inch lightweight hollow concrete block | 46 |
| 8-inch hollow core concrete block | 50 |
| 4-inch brick wall with ½-inch plaster | 50 |
| 8-inch brick wall | 52 |
| 6-inch dense concrete | 54 |
| 12-inch brick wall | 59 |

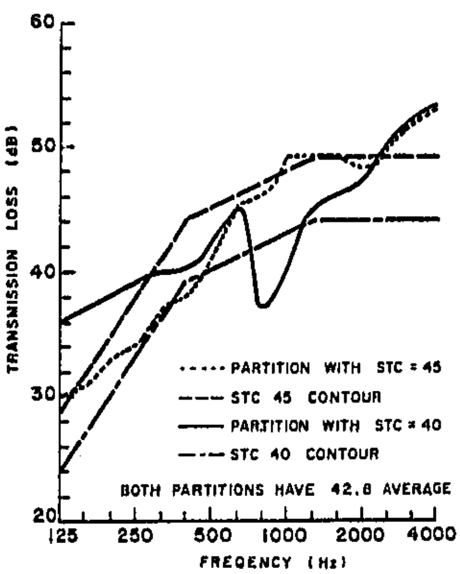



**FIGURE I-14.—Determination of Sound Transmission Class.**

when the sound travels from the source room to the receiving room by some route other than through the test specimen. Some of these paths are through cracks or gaps around the specimen, into the floor or wall in the source room, through the connecting floor and wall, or any other route the sound may take as shown in Figure I–15.

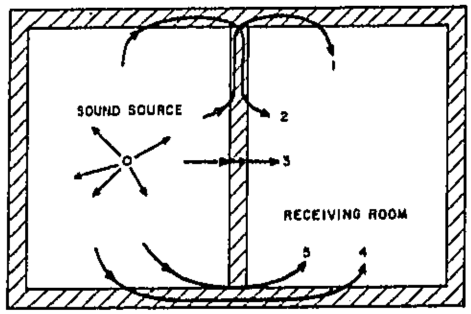



**FIGURE I-15.—Possible Routes for Sound Travel from One Room to Another. For paths 1 through 4 the sound travels some portion of the path in solid material. Path 5 represents transmission through any crack, gap, or other opening in the wall.**

Finally, the ASTM standard for measuring transmission loss recommends that the minimum dimensions of the test specimen be at least 8 ft with the exception that doors, windows, and other smaller items should be their normal size. This is because the full effects of stiffness, resonances, etc., will be different if the specimen is different from what will be constructed in actual use.

## I-3.4—IMPACT SOUND TRANSMISSION RE ASTM E492-73T (RM14-4)

NOTE: *The term "Impact Sound" as used here should not be confused with hazardous "Impact Noise" as defined by OSHA regulations. The tests described below are used to measure transmission of footsteps and similar sounds and have little relevance to control of industrial impact noise.*

The described tests for sound transmission are useful for many objects such as walls, floors, doors, windows, specialized panels, or any other item that may be used to block a sound path. In the case of floors, however, not all noise in the space below the floor is due to airborne sound transmission through the floor. Some of the noise below the floor is due to sliding objects across the floor, footsteps, dropping objects, etc. These occurrences and the sounds they produce in the space below are covered by testing the floor for impact sound transmission. The recommended method for this test procedure has been published by ASTM as RM14-4, "Proposed Method of Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".

This test for impact sound transmission utilizes a standard impact source which is known as a "tapping machine". With this machine making fixed amplitude impacts on the floor the sound pressure level produced in the room below is measured in 16 contiguous one-third octave bands from 100 Hz through 3,150 Hz. The sound pressure levels thus measured are affected by the absorption in the receiving room so these values are normalized to a reference room which has an absorption of 108 sabins or 10 metric sabins. This normalization is obtained through the relationship

$$L_N = L_p - 10 \log (A_0/A_2) \quad \text{dB re } 2 \times 10^{-5}\ \text{N/m}^2 \qquad (46)$$

where

$L_p$ is the mean square measured sound pressure level,

$A_2$ is the measured absorption in the receiving room measured as described for absorption tests, and

$A_0$ is the reference absorption in the same units as $A_2$.

There is still much debate over the use of the tapping machine as an impact source. Many feel that this excitation is not representative of footsteps, sliding furniture, etc.

Just as with absorption and transmission data the impact data make comparisons between products difficult. There is another one-number rating called the Impact Insulation Class (IIC), which is obtained by comparing the normalized sound pressure levels at each of the 16 one-third octave bands to a set of standard contours as in the case of the STC for transmission loss. These contours however, have a different shape, and the normalized sound pressure level curve in this case must fit the standard contour in such a way that in no event is the $L_N$ curve more than 8 dB *above* the IIC contour at any frequency, and the sum of the deviations of the $L_N$ values which are *above* the IIC contour shall not exceed 32 dB. The lowest contour to which the specimen $L_N$ curve can satisfy these requirements is used as the IIC curve, and again, the value of this curve at 500 Hz is then chosen as the number to use as the IIC of the specimen. A few of the standard contours are shown in Figure I-16.

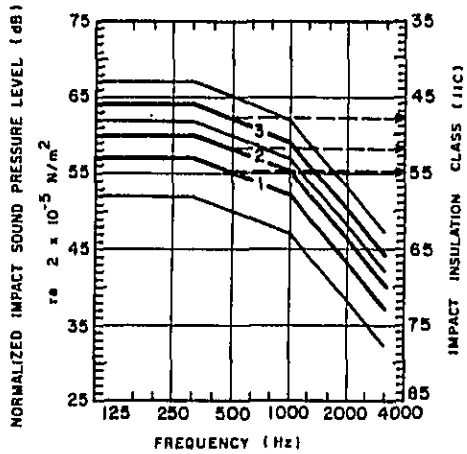



**FIGURE I-16.—Impact Insulation Class Contours. Contour 1, IIC=55; Contour 2, IIC=52; Contour 3, IIC=48.**

An older single-number rating for impact insulation which was used by the Federal Housing Administration is known as the Impact Noise Rating (INR). This rating is based on the same contours, but a standard floor was given an INR=0. Thus, the first contour above this had a rating of −1 (higher sound pressure level=poorer floor) and the first contour below had a rating of +1. Consequently the INR can take on positive and negative values. This standard floor compares to the contour which has a value of 51 at 500 Hz; thus, this standard floor has an IIC of 51 and any value of IIC can be obtained from the INR by adding 51. That is,

$$IIC = INR + 51. \qquad (47)$$

### I-3.5—INSERTION LOSS

The tests described above are designed for sound barrier items such as walls, floors, doors, windows, etc., but do not apply to such items as ducts, mufflers, pipe lagging, etc. The measurement procedure for these is simply to measure the noise radiating from some pipe or duct work, and then apply (insert) the specimen and measure the sound pressure levels again. The difference in sound pressure levels is due to the insertion of the device under test and is called the "insertion loss". This is a before-and-after type measurement as opposed to the simultaneous measurement on two sides of a partition for noise reduction and transmission loss.

### I-3.6—NOISE REDUCTION

A particular measurement where the difference in two simultaneous sound pressure level measurements is obtained, is referred to as Noise Reduction (*NR*). For example, the sound pressure level inside an enclosure, $L_1$, and the sound pressure level outside the enclosure, $L_2$, may be measured simultaneously. The difference in these two levels is the *NR* value. If the noise source is inside the enclosure the *NR* is given by $L_1 - L_2$, or *NR* is $L_2 - L_1$ if the noise source is outside the enclosure.

The *NR* can differ significantly from the transmission loss for a specimen since the absorption in the two regions where measurements are made is not included in the calculation. Whenever this value is presented in the data tables it is pointed out so the user will be aware of the difference.

The measurement of *NR* is not only used for enclosures, but for any case where the difference in two sound pressure levels is determined. One should also be aware that the *NR* of a specimen bears no relation to the NRC of an absorber material. The *NR* relates to the ability of a specimen to block sound whereas the NRC is a sound absorption property.

## I-4—USE OF NOISE CONTROL PRODUCTS

The practical approach to noise control takes into account the noise sources, paths, and receivers. The following items must be determined successively to accomplish noise control:

(1) Noise criteria for each occupied space.

(2) Sound power level of the noise produced by each source.

(3) Noise levels at typical employee positions in that space.

(4) Attenuation of the noise by walls, ducts, etc., between each source and the space in question.

(5) Required additional attenuation (item 3 minus item 1).

(6) Identify major noise sources and select noise control treatment.

(7) Any special mountings of the devices necessary to control flanking noise.

(8) Any vibrating elements whose vibrations may be transmitted to some other member causing it to become a noise radiator.

(1) *Criteria*—The first of these items, criteria for the space, is not part of the scope of this compendium. In a factory the criteria are determined by some federal agency such as the Occupational Safety and Health Administration (OSHA). In an office environment or concert hall the factors determining acoustic criteria are more numerous and complex than just a requirement for reduction of the sound pressure level to conserve hearing.

(2) *Sound Power*—The second item is more straightforward. If at all possible one should obtain from the manufacturer of a noisy device the sound power levels that have been measured in the laboratory. Fortunately, more and more manufacturers are taking such measurements and data are becoming available. Barring this course one must make his own measurements of sound power, which is very difficult if not completely impossible, on a large piece of machinery in a factory environment. One usually is forced to make sound pressure level measurements at many locations around the noise source and attempt to guess at the sound power. The effects of other machinery, the room itself, background noises, etc., preclude a very accurate determination.

The procedure for determining sound power is basically simple. Make enough measurements on a hemisphere around the source in a quiet anechoic space. If one is careful to choose his points on this hemisphere such that each measurement represents an equal area of the surface, then the sound power is computed as follows. (Note: the measurements and the following calculations are made in each of the 16 contiguous one-third octave bands.)

The average sound pressure level of the measurements made is determined by arithmetic averaging procedures if the variations do not exceed about 6 dB. If the variations exceed 6 dB, then the decibels must be converted to pressure squared ($p^2$) as previously discussed. These are then averaged and the logarithm is taken of the average $p^2$.

The sound power level in decibels is then given by equation (27)

$$L_w = L_p + 10 \log S$$

$$\text{dB re } 10^{-12} \text{ watt} \qquad (48)$$

where $S$ is the area of the hemisphere in meters$^2$, which is $2\pi r^2$ with $r$ in meters. It is important to realize that this procedure only produces accurate results if the measurements are made in a free field environment. When performed in a factory the results are far from accurate but provide an estimate of the sound power.

Since the sound source is radiating into a hemisphere, only the sound that is radiated downward toward the solid floor is reflected back into the measuring hemisphere and the measured sound pressures are twice as high when compared to measurements made in a complete free field. The sound power thus determined is twice the true sound power. This can be accounted for by subtracting 3 dB from the final result obtained.

Now consider another aspect of the noise source; does the sound radiate equally in all directions? If not, then one must be concerned with the directionality of the noise. Directionality of a sound source is defined as the directivity factor $Q_\theta$ which is the ratio of the mean square sound pressure $(N/m^2)^2$ at an angle $\theta$ and distance $r$ from an actual sound source radiating $W$ watts of acoustic power, to the mean square sound pressure that would be measured at the same distance from a source which radiates $W$ watts uniformly in all directions. Expressed as an equation $Q_\theta$ is given by

$$Q_\theta = p^2_\theta / p^2_s = \text{antilog} \frac{L_{p\theta} - L_{p_s}}{10} \qquad (49)$$

$L_{p\theta}$ = the sound pressure level measured at distance $r$ and angle $\theta$ for the source in question, and

$L_{p_s}$ = sound pressure level that would exist at distance $r$ for a source with the same acoustic power $W$ radiating into anechoic space.

Note that in practice one uses $\overline{L_{p\theta}}$ (the average value of the measured sound pressure levels) to determine $W$. Or conversely, which is equivalent, $W_\theta$ is determined for each $L_{p\theta}$ then $\overline{W}$ is obtained. This is the value to use for obtaining $L_{p_s}$ and we see that $L_{p_s}$ is equal to $\overline{L_{p\theta}}$. In practice $L_{p_s}$ can be replaced by $\overline{L_{p\theta}}$ The sound power equation shown earlier should be modified to include this possibility.

Thus for $L_{p\theta}$

$$\overline{L_{p\theta}} = L_w - 10 \log S + 10 \log Q_\theta \qquad (50)$$

where $S$ is in meters$^2$.

EXAMPLE: What is the sound pressure level in the 1,000 Hz band at 10 meters in the direction of position 1 for a noise source when the free hemispherical field sound pressure levels measured in the 1,000 Hz band at 3 meters are

| Position | $L_p$ | Position | $L_p$ | Position | $L_p$ |
|---|---|---|---|---|---|
| 1 | 100 | 5 | 89 | 9 | 101 |
| 2 | 94 | 6 | 90 | 10 | 100 |
| 3 | 97 | 7 | 93 | 11 | 97 |
| 4 | 93 | 8 | 96 | 12 | 95 |

SOLUTION: Since the spread is greater than 6 dB we must obtain $\overline{L_{p\theta}}$ by averaging mean square pressures. Thus,

$$p^2_1 = p^2_0 \text{ antilog } L_{p_1}/10 = 2 \times 10^5 \ (N/m^2)^2$$
$$p^2_2 = 0.5024 \times 10^5$$
$$p^2_3 = 1.0024 \times 10^5$$
$$p^2_4 = 0.3991 \times 10^5$$
$$p^2_5 = 0.1589 \times 10^5$$
$$p^2_6 = 0.2000 \times 10^5$$
$$p^2_7 = 0.3991 \times 10^5$$
$$p^2_8 = 0.7962 \times 10^5$$
$$p^2_9 = 2.5179 \times 10^5$$
$$p^2_{10} = 2.0000 \times 10^5$$
$$p^2_{11} = 1.0024 \times 10^5$$
$$p^2_{12} = 0.6325 \times 10^5$$

$$\text{Total} = 11.6109 \times 10^5$$
$$\text{Average} = 0.9676 \times 10^5$$

$$\overline{L_{p\theta}} = 10 \log \frac{p^2_{avg}}{p^2_0} = 10 \log \frac{0.9676 \times 10^5}{2 \times 10^{-5}}$$

$$\overline{L_{p\theta}} = 96.85 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2$$

The sound power level $L_w$ is now determined from equation (48)

$$L_w = \overline{L_{p\theta}} + 10 \log S - 3 \text{ dB}$$
$$= 96.85 + 10 \log 4\pi(3)^2 - 3 \text{ dB}$$
$$= 117.4 - 3 \text{ dB}$$
$$= 114.4 \text{ dB re } 10^{-12} \text{ watt.}$$

Now determine $Q_\theta$ for position 1 from equation (49)

$$Q_\theta = \text{antilog } \frac{L_{p_1} - \overline{L_{p\theta}}}{10} = \text{antilog } \frac{100 - 96.85}{10} = 2.065$$

The sound pressure level at 10 meters in the direction of position 1 can be found using equation (50)

$$L_{p_1} = L_w - 10 \log S + 10 \log Q_\theta$$
$$= 117.4 - 10 \log 2\pi(10)^2 + 10 \log 2.065$$
$$= 117.4 - 28.0 + 3.1$$
$$= 92.5 \text{ dB re } 2 \times 10^{-5} \ N/m^2.$$

To compare the results of averaging mean pressures with averaging sound pressure levels in this case $\overline{p^2}$ gives a value for $\overline{L_p}$ of 96.85 dB. By simply averaging the decibel values we would have obtained $\overline{L_p} = 95.4$ which is about 1.5 dB low. This example points out the difference in the values obtained between arithmetic averaging of the decibel levels and averaging of the true values. Whenever a set of decibel levels of any sort must be averaged a simple arithmetic averaging process will yield a result that is lower than the true average of the measured value. This holds true for decibel sound power, decibel sound intensity, decibel sound pressure, or any other decibel numbers.

(3) *Noise Levels* — The sound pressure levels must be measured at all locations where it is desirable to reduce the noise. These measurements must include an A-weighted sound pressure level, dBA, and they should also include measurements in each of the octave bands. For engineering analysis of machine noise sources a narrow band analysis of the noise can also be of value if the presence of pure tones is observed. This frequency analysis is an aid in determining the source of the noise as well as being necessary to be able to make a proper selection of the noise control item. The best choice of noise control item is made by obtaining the closest fit possible between the noise spectrum and the noise reduction spectrum of the noise control device.

(4) and (5) *Noise Attenuation*—Having measured the sound pressure levels and knowing the criteria that must be met, the noise level now must be reduced by the required amount. The fourth and fifth items can best be handled at the same time. When attempting to reduce the noise levels one is faced with the fact that the presently existing attenuation is not sufficient and more must be done. If the attenuation is sufficient this will be evident when the noise levels are measured at the desired locations.

Absorption data are given in terms of the absorption coefficient versus frequency in one-third octave bands; also, products are rated with an NRC which is an average value of the absorption coefficients for the 250, 500, 1,000, and 2,000 Hz octave bands. Although the absorption coefficient of any given material varies with the angle of incidence of the sound wave, the usual technique for measuring absorption coefficients is to use a reverberant field which results in a statistical average over all angles of incidence.

The absorption of sound by a surface is given by the product of the absorption coefficient and the area. The unit of absorption is the sabin where the absorption of 1 ft² of perfectly absorbing surface is 1 sabin. The average absorption of a room or enclosure is determined by the sum of absorptions of each area as

$$\bar{\alpha}=\frac{\sum_i \alpha_i S_i}{\sum_i S_i} \tag{51}$$

where $\alpha_i$ is the random incidence absorption coefficient of the i-th surface and $S_i$ is the area of that surface in square feet. The total absorption in the room is given by the numerator or

$$A=\sum_i \alpha_i S_i=S\bar{\alpha} \tag{52}$$

where $S$ is the total surface area.

The reverberation time of the room (as discussed in Section I–3.1.1) is then calculated using the Sabine formula

$$T=\frac{0.049\ V}{A}=\frac{0.049\ V}{S\bar{\alpha}} \tag{53}$$

where $V$ is the volume of the room,

$\bar{\alpha}$ is the average absorption coefficient, and

$S$ is the total area of the room in square feet.

Another method which can be used to determine the average absorption of a room can be derived from the modified reverberation time equation developed by Fitzroy (*JASA*, 1959)

$$T'=\frac{0.049\ V}{S}\left(\frac{x}{S\,\bar{\alpha}_x}+\frac{y}{S\,\bar{\alpha}_y}+\frac{z}{S\,\bar{\alpha}_z}\right) \tag{54}$$

where $x$ = total floor-ceiling areas with average absorption coefficient $\bar{\alpha}_x$,

$y$ = total side wall areas with average absorption coefficient $\bar{\alpha}_y$, and

$z$ = total end wall areas with average absorption coefficient $\bar{\alpha}_z$.

Thus,

$$\bar{\alpha}=S/\left(\frac{x}{\bar{\alpha}_x}+\frac{y}{\bar{\alpha}_y}+\frac{z}{\bar{\alpha}_z}\right). \tag{55}$$

As illustrated in Table I–7, the calculated reverberation times using equation (54) more closely approximate the true reverberation times, $T_{actual}$, especially in cases where room absorption is not evenly distributed. Thus, *effective* average room absorption coefficients are also more closely approximated using Equation (55).

A number which is sometimes convenient to use is the room constant, $R$, defined as

$$R=\frac{S\bar{\alpha}_e}{(1-\bar{\alpha}_e)} \tag{56a}$$

where $\bar{\alpha}_e$ is the geometric mean energy absorption coefficient. To define $R$ in terms of the random incidence or Sabine absorption coefficient, the relationship

$$\bar{\alpha}_e=(1-e^{-\bar{\alpha}})$$

as presented by Young (*JASA*, 1959) can be used; thus,

$$R=\frac{S(1-e^{-\bar{\alpha}})}{e^{-\bar{\alpha}}}=S(e^{\bar{\alpha}}-1) \tag{56b}$$

Frequently it is impractical or even impossible to determine the room constant by directly calculating $\bar{\alpha}$. In this case the room constant can be determined by first measuring the reverberation time of the room. The average absorption coefficient can then be derived from equation (53) such that when

$$T=\frac{0.049\ V}{S\bar{\alpha}},$$

$$\bar{\alpha}=\frac{0.049\ V}{T\,S}$$

and the room constant, thus, is

$$R=S\left(e^{\frac{0.049V}{TS}}-1\right) \tag{56c}$$

TABLE I-7 — REVERBERATION TIME DATA FOR 500 Hz TEST FREQUENCY

| ROOM DIMENSIONS, ft | | | SURFACE AREAS, ft² | | | ABSORPTION = $S\bar{\alpha}$, sabins | | | ABSORPTION COEFFICIENTS, sabin/ft² | | | REVERBERATION TIMES, sec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height | Length | Width | $x=2HW$ | $y=2LW$ | $z=2HL$ | $A_x$ | $A_y$ | $A_z$ | $\bar{\alpha}_x$ | $\bar{\alpha}_y$ | $\bar{\alpha}_z$ | $T$ | $T'$ | $T_{actual}$ |
| 12 | 30 | 36 | 960 | 2,284 | 720 | 29 | 890 | 22 | 0.03 | 0.39 | 0.03 | 0.63 | 2.62 | 2.55 |
| 12 | 15½ | 17 | 432 | 512 | 304 | 12 | 211 | 9 | .03 | .41 | .03 | .59 | 2.47 | 2.47 |
| 12 | 9 | 192 | 4,605 | 3,456 | 216 | 335 | 1,175 | 6 | .07 | .34 | .03 | .61 | 1.13 | 1.24 |
| 14½ | 55 | 57 | 1,936 | 6,270 | 1,540 | 265 | 2,532 | 46 | .14 | .40 | .03 | .64 | 1.73 | 1.70 |
| 12 | 30 | 31 5/12 | 756 | 1,890 | 720 | 34 | 485 | 133 | .05 | .26 | .19 | .77 | 1.31 | 1.28 |
| 20 | 54 | 81 | 3,240 | 8,748 | 2,160 | 657 | 1,291 | 617 | .20 | .15 | .29 | 1.51 | 1.62 | 1.57 |

(From Fitzroy, D. *JASA*, 31, pp 893-897, 1959.)

The effect of the room absorption and distance from the noise source on the sound pressure level can be seen in Figure I–17 where the relative sound pressure level in decibels is plotted versus distance from a noise source of sound power level $L_w$ for several values of the room constant. If the room constant is near zero (perfectly reflecting surfaces) the sound pressure level does not differ anywhere in the room and an ideal reverberation field exists. On the other hand as the room constant becomes very large the sound pressure field approaches that of a free field. This information can be very important when considering sound treatment for a room.

In many cases, the operator of a piece of machinery is probably affected more by the direct field of the noise source rather than the reverberant field. Consequently, absorption treatment on the walls and ceiling will not reduce the noise of this machine at the operator's position. It can be seen in Figure I–17 that the sound pressure level can never be below the straight line corresponding to the free field $1/r^2$ decrease.

Employees a little further from the machine will probably be in a region that can be called a semireverberant field, i.e., where the sound pressure level is made up of some combination of the direct and reflected sound. Figure I–17 can be used as a quick guide to determine if sound absorption treatment reduces the noise level at a given location.

Suppose it is desired to reduce the sound pressure level at a particular operator's position which is 8 m from the sound source with a sound power level of $L_w$. If the room constant is determined to be about 1,000, any absorbent material on the walls will have a negligible effect on the sound pressure level at this position. If, however, the room constant is significantly below 1,000, an absorption treatment of the surfaces of the room (e.g. $R=R'=1{,}000$ after treatment) can have an appreciable effect which would be equal to $[(L_p-L_w)_{R<1{,}000}]-[(L_p-L_w)_{R'=1{,}000}]$.

Thus, in practice, one must first determine when absorption treatment will be useful. It is important to look at the equations upon which Figure I–17 is based. In a free field the sound pressure ($p_F$) obeys the inverse square law and by Equation (4)

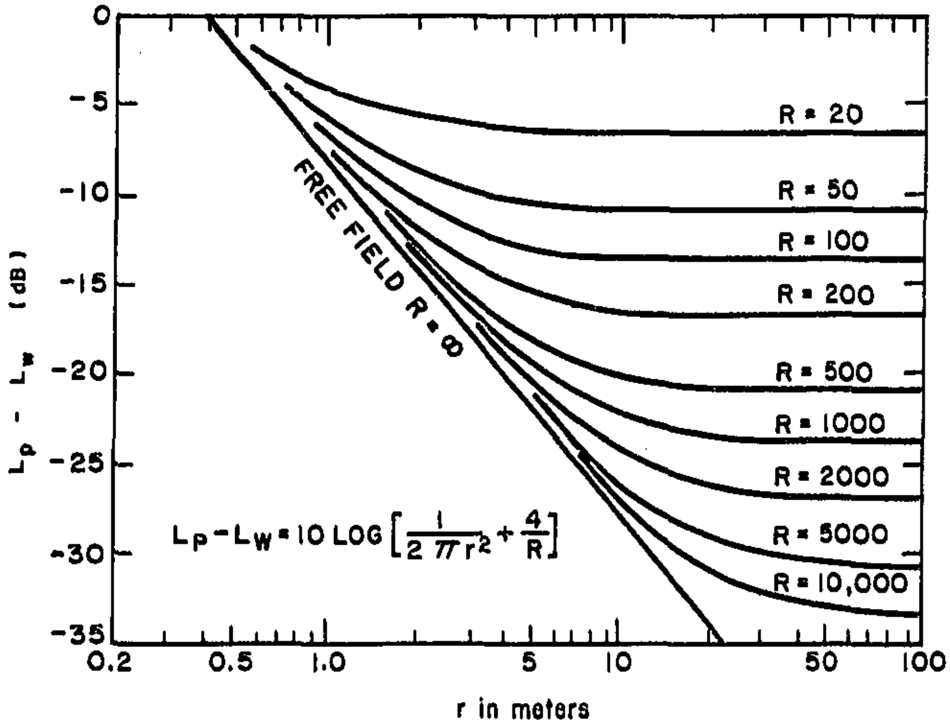



**FIGURE I-17.—Relative Sound Pressure Level versus Distance from the Source for Semi-reverberant Fields.** $r$=distance from acoustic center; $R$=room constant.

$$I=\frac{W}{4\pi r^2}=\frac{p^2_{rms}}{\rho c}$$

or

$$p^2_F=\frac{W\rho c}{4\pi r^2}. \qquad (57)$$

Also one must describe the sound field when there are walls and objects which cause reflections and the sound field has a reverberant character. The reverberant field sound pressure ($p_R$) depends on the total absorption, and it can be shown that

$$p^2_R=\frac{4W\rho c(1-\bar{\alpha}_e)}{S\,\bar{\alpha}_e} \qquad (58a)$$

where $\bar{\alpha}_e$ is the geometric mean energy absorption coefficient, and by equation (56),

$$R=\frac{S\,\bar{\alpha}_e}{1-\bar{\alpha}_e}=S(e^{\bar{\alpha}}-1)$$

where $R$ is the room constant and $\bar{\alpha}$ is the random incidence (Sabine) absorption coefficient, thus

$$p^2_R=\frac{4W\rho c}{R} \qquad (58b)$$

The total squared sound pressure is just the sum of the component pressures squared:

$$p^2_{tot}=p^2_F+p^2_R=\frac{W\rho c}{4\pi r^2}+\frac{4W\rho c\,(1-\bar{\alpha})}{S\,\bar{\alpha}} \qquad (59)$$

$$p^2=W\rho c\,\left(\frac{1}{4\pi r^2}+\frac{4}{R}\right) \qquad (60)$$

in terms of sound pressure level for a free field, and by equations (25) and (26)

$$L_p=L_w+10\log\left(\frac{1}{4\pi r^2}+\frac{4}{R}\right) \qquad (61a)$$

where $r^2$ and $R$ are in meters².

For a free field above a reflecting plane this relationship becomes

$$L_p=L_w+10\log\left(\frac{1}{2\pi r^2}+\frac{4}{R}\right) \qquad (61b)$$

The more general form of this expression includes the directivity Q such that

$$L_p = L_w + 10 \log \left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) \quad (61c)$$

Note that equations (61a, b, and c) are identical except for the first term in the argument of the logarithm. Equations 61a and 61b can be obtained readily from 61c if one notes that for a nondirectional source in a free field $Q=1$ and for the same nondirectional source in a free field over a reflecting plane $Q=2$. (See Beranek, "Acoustics," pp 311-322, 1957, for the development and discussion of equation (61).)

Clearly the larger $R$ becomes, the lower the sound pressure level. To determine the decrease in sound pressure level when absorption is added to a room, which increases the room constant $R$, one could calculate the value of $L_p$ from equation 61 for $R$ before treatment and again for $R'$, the room constant after treatment, or by the equivalent relation

$$\text{Reduction in dB} = (L_p - L_w) - (L'_p - L_w) \quad (62)$$

$$L_p - L'_p = 10 \log \left[ \left(\frac{Q}{S} + \frac{4}{R}\right) / \left(\frac{Q}{S} + \frac{4}{R'}\right) \right]$$

where $L'_p$ is the sound pressure level after acoustic treatment. The use of this equation is illustrated by the following example.

EXAMPLE: The dimensions of a room are 50 ft (length), 25 ft (width), and 12 ft (height). The absorption in the room is shown below using absorption coefficients provided by AIMA in Table I-8.

| Room component | $S_i$, ft² | $\alpha_i$, @ 500 Hz | $A_i$, sabins |
|---|---|---|---|
| Floor, linoleum | 1,150 | 0.03 | 34.5 |
| 10 occupants seated at desks | 100 | .55 | 55.0 |
| Ceiling, plaster | 1,250 | .06 | 75.0 |
| Side walls, gypsum | 1,000 | .05 | 55.0 |
| board, windows | 100 | .10 | 10.0 |
| End walls, gypsum | 450 | .05 | 22.5 |
| board, doors | 150 | .18 | 27.0 |
| Floor-ceiling, using eq (51) | 2,500 | .066 | 164.5 |
| Side walls | 1,200 | .054 | 65.0 |
| End walls | 600 | .082 | 49.5 |

Given these initial room conditions:

(a) Can absorption treatment be effective in reducing the 500 Hz octave band sound level of a newly installed machine at a position 8 meters from an observer?

(b) How much reduction of the sound level from this source will be achieved using absorption treatment?

SOLUTION: Since the absorption in the room is fairly evenly distributed, the average absorption can be calculated using equation (51)

where $\bar{\alpha} = \frac{\Sigma S_i \alpha_i}{\Sigma S_i} = \frac{164.5 + 65 + 49.5}{4,300} = 0.065$

or for comparison by equation (55)

$$\bar{\alpha} = \frac{S}{\frac{x}{\alpha_x} + \frac{y}{\alpha_y} + \frac{z}{\alpha_z}} = \frac{4,300}{\frac{2,500}{0.066} + \frac{1,200}{0.054} + \frac{600}{0.082}} = 0.064$$

and, thus, the room constant

$$R = 4,300 \times (e^{0.065} - 1)$$

$$= 4,300 \times 0.067 = \underline{289 \text{ ft}^2}$$

or

$$R = 4,300 \ (\times 0.093 \text{ m}^2/\text{ft}^2) \times 0.067$$

$$= 400 \times 0.067 = \underline{27 \text{ m}^2}$$

Observing Figure I-17, a room constant corresponding to 27 m² is well above the free field curve at $r=8$ meters. Absorption can thus be effective for this position. Note, however, that for a given room constant, absorption treatment will have less of an effect as the distance from the machine, or $r$, decreases. Also, the use of absorber materials can never reduce the sound to a level below that of the free field radiation. At best, a sound absorber can reduce the reflections to zero which is the same as removing the surface entirely (i.e., no surface = no reflection = perfect absorber).

From the data tables of Section VI, an acoustical wall treatment with an absorption coefficient of 0.95 at 500 Hz and a type of mineral fiber ceiling panels with an absorption coefficient of 0.90 at 500 Hz are selected for absorption treatment. The following room components are used to calculate the effects of absorption treatment.

## TABLE I-8 — COEFFICIENTS OF GENERAL BUILDING MATERIALS AND FURNISHINGS

Complete tables of coefficients of the various materials that normally constitute the interior finish of rooms may be found in the various books on architectural acoustics. The following short list will be useful in making simple calculations of the reverberation in rooms.

| MATERIALS | COEFFICIENTS, Hz | | | | | |
|---|---|---|---|---|---|---|
| | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 |
| Brick, unglazed | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.07 |
| Brick, unglazed, painted | .01 | .01 | .02 | .02 | .02 | .03 |
| Carpet, heavy, on concrete | .02 | .06 | .14 | .37 | .60 | .65 |
| Same, on 40 oz hairfelt or foam rubber | .08 | .24 | .57 | .69 | .71 | .73 |
| Same, with impermeable latex backing on 40 oz hairfelt or foam rubber | .08 | .27 | .39 | .34 | .48 | .63 |
| Concrete Block, coarse | .36 | .44 | .31 | .29 | .39 | .25 |
| Concrete Block, painted | .10 | .05 | .06 | .07 | .09 | .08 |
| Fabrics: | | | | | | |
| Light velour, 10 oz per sq yd, hung straight, in contact with wall | .03 | .04 | .11 | .17 | .24 | .35 |
| Medium velour, 14 oz per sq yd, draped to half area | .07 | .31 | .49 | .75 | .70 | .60 |
| Heavy velour, 18 oz per sq yd, draped to half area | .14 | .35 | .55 | .72 | .70 | .65 |
| Floors: | | | | | | |
| Concrete or terrazzo | .01 | .01 | .015 | .02 | .02 | .02 |
| Linoleum, asphalt, rubber or cork tile on concrete | .02 | .03 | .03 | .03 | .03 | .02 |
| Wood | .15 | .11 | .10 | .07 | .06 | .07 |
| Wood parquet in asphalt on concrete | .04 | .04 | .07 | .06 | .06 | .07 |
| Glass: | | | | | | |
| Large panes of heavy plate glass | .18 | .06 | .04 | .03 | .02 | .02 |
| Ordinary window glass | .35 | .25 | .18 | .12 | .07 | .04 |
| Gypsum Board, ½" nailed to 2 x 4's 16" o.c. | .29 | .10 | .05 | .04 | .07 | .09 |
| Marble or Glazed Tile | .01 | .01 | .01 | .01 | .02 | .02 |
| Openings: | | | | | | |
| Stage, depending on furnishings | | | .25 — .75 | | | |
| Deep balcony, upholstered seats | | | .50 — 1.00 | | | |
| Grills, ventilating | | | .15 — .50 | | | |
| Plaster, gypsum or lime, smooth finish on tile or brick | .013 | .015 | .02 | .03 | .04 | .05 |
| Plaster, gypsum or lime, rough finish on lath | .14 | .10 | .06 | .05 | .04 | .03 |
| Same, with smooth finish | .14 | .10 | .06 | .04 | .04 | .03 |
| Plywood Paneling, ⅜" thick | .28 | .22 | .17 | .09 | .10 | .11 |
| Water Surface, as in a swimming pool | .008 | .008 | .013 | .015 | .020 | .025 |
| Air, Sabins per 1000 cubic feet @ 50% RH | | | | .9 | 2.3 | 7.2 |

ABSORPTION OF SEATS AND AUDIENCE, *sabins per square foot of seating area or per unit*

| | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 |
|---|---|---|---|---|---|---|
| Audience, seated in upholstered seats, per sq ft of floor area | 0.60 | 0.74 | 0.88 | 0.96 | 0.93 | 0.85 |
| Unoccupied cloth-covered upholstered seats, per sq ft of floor area | .49 | .66 | .80 | .88 | .82 | .70 |
| Unoccupied leather-covered upholstered seats, per sq ft of floor area | .44 | .54 | .60 | .62 | .58 | .50 |
| Wooden Pews, occupied, per sq ft of floor area | .57 | .61 | .75 | .86 | .91 | .86 |
| Chairs, metal or wood seats, each, unoccupied | .15 | .19 | .22 | .39 | .38 | .30 |

(Reprinted Courtesy of *AIMA*.)

| Room Component | $S_i$ | $\alpha_i$ | $A_i$ |
|---|---|---|---|
| Floor-ceiling: | | | |
| No treatment | 2,500 | 0.066 | 164 |
| W/treatment (to ceiling only) | 2,500 | .486 | 1,215 |
| Side walls: | | | |
| No treatment | 1,200 | .054 | 65 |
| W/treatment | 1,200 | .950 | 1,140 |
| End walls: | | | |
| No treatment | 600 | .082 | 49 |
| W/treatment | 600 | .950 | 510 |

The reduction in sound level for applications of the absorption materials are calculated using equation (62), with a directivity constant $Q=2$,

Reduction in dB

$$=10\log\left[\left(\frac{1}{2\pi r^2}+\frac{4}{R}\right)\Big/\left(\frac{1}{2\pi r^2}+\frac{4}{R'}\right)\right]$$

where $r=8$ meters and the 'untreated' room constant $R=27\ m^2$. The results are presented in Table I-9 for the average absorption coefficient as calculated using equation (51) and in Table I-10 calculated using equation (55) which is more representative of the effective absorption.

**TABLE I-9. — AVERAGE ABSORPTION COEFFICIENT CALCULATED USING EQUATION (51).**

| Condition | Absorption Treated Components | Floor-Ceiling $\bar{\alpha}_x$ | Side Walls $\bar{\alpha}_y$ | End Walls $\bar{\alpha}_z$ | Absorption Coefficient $\bar{\alpha}$, overall | $R'$, $m^2$ | Reduction, dB |
|---|---|---|---|---|---|---|---|
| 1 | Side and End Walls | 0.066 | 0.950 | 0.950 | 0.436 | 219 | 8.6 |
| 2 | Ceiling | .486 | .054 | .082 | .309 | 145 | 7.0 |
| 3 | Ceiling and End Walls | 486 | .054 | .950 | .430 | 215 | 8.5 |
| 4 | Ceiling and Side Walls | .486 | .950 | .082 | .559 | 300 | 9.8 |
| 5 | Ceiling, Side, and End Walls | .486 | .950 | .950 | .680 | 390 | 10.7 |

**TABLE I-10. — AVERAGE ABSORPTION COEFFICIENT CALCULATED USING EQUATION (55).**

| Condition | Absorption Treated Components | Floor-Ceiling $\bar{\alpha}_x$ | Side Walls $\bar{\alpha}_y$ | End Walls $\bar{\alpha}_z$ | Absorption Coefficient $\bar{\alpha}$, overall | $R'$, $m^2$ | Reduction, dB |
|---|---|---|---|---|---|---|---|
| 1 | Side and End Walls | 0.066 | 0.950 | 0.950 | 0.108 | 46 | 2.2 |
| 2 | Ceiling | .486 | .054 | .082 | .124 | 53 | 2.8 |
| 3 | Ceiling and End Walls | .486 | .054 | .950 | .154 | 66 | 3.8 |
| 4 | Ceiling and Side Walls | .486 | .950 | .082 | .313 | 147 | 7.1 |
| 5 | Ceiling, Side, and End Walls | .486 | .950 | .950 | .611 | 337 | 10.2 |

For room conditions 1, 2, and 3 it is evident that the absorption in the room is not evenly distributed. Therefore, an inflated estimate of the sound level reduction results if the average absorption coefficient does not take into account the component distribution of absorption. Thus, with these conditions, the significantly more accurate estimate of noise reduction is 2 to 4 dB, as calculated using equation (55). Room conditions 4 and 5 indicate sound level reductions of 7 to 10 dB where, especially for condition 5, the absorption treatment is more evenly distributed than for the other conditions, and most of the surface area of the room has a fairly high absorption coefficient. A note of caution should be heeded here, however, because a reduction on the order of 7 to 10 dB is difficult to achieve in practice, with a reduction of 4 to 7 dB being more realistic. Also, it is usually advisable to perform the above calculations for each octave band, which is necessary for the determination of noise level reduction in dBA.

(6) *Noise Control Devices*—This item concerns the selection and use of noise reducing devices, and because this is the subject that occupies most of the latter portion of the compendium, it is only defined at this point.

(7) *Mountings*—When the desire is to keep noise from traveling, any possible path should not be overlooked. Normally one thinks of sound traveling through the air but this certainly is not the only medium that will support sound waves. In fact, sound travels very well in most solids.

Therefore when one deals with flanking and transmission problems it must be remembered that the hard materials being used are very good conductors of sound. The aid in reducing sound transmitted through these objects is the mismatch of impedances at boundary surfaces such as from air to steel, or steel to wood. Just as with electrical power transmission, the greater the mismatch of impedances the more reflection of energy and loss in power transfer results. As in electronics, the optimum power is transferred when the impedances of the two items are equal. The same holds true for acoustics. Therefore, flanking paths can be greatly reduced by introducing materials in the path of the sound which have poorly matching impedance. For example, place pieces of rubber or cork between structural steel members, mount items on a material different from the main support, etc.

The most commonly occurring flanking path is an actual opening in the partition. A direct leak such as this can completely destroy the effectiveness of any sound barrier.

(8) *Vibration*—While the same principle of impedance mismatching also applies to vibration isolation and vibration damping, we are not dealing with the conduction of sound but with coupled vibrational forces. This topic was not included in the scope of this work. Anyone interested in this problem area may refer to the literature relating to vibration.

## I-4.1—NOISE CONTROL BY ABSORPTION

### I-4.1.1—Ceilings

The main purpose of acoustical ceilings is for the absorption of sound. In the earlier examples, it was shown how the absorption added to a room can reduce the sound pressure level in the reverberant sound field region of a room.

There are many types of acoustical ceilings, ranging from the attractive tiles seen in homes and offices to the thicker sturdier panels that can be used in an industrial atmosphere. The range of absorption ability of modern acoustical ceilings extends from an NRC of about 0.30 to over 0.90. The ceiling used in the example had an NRC of 0.90. From a sampling of the tests performed at one acoustical testing laboratory the most common value for NRC is about 0.55 to 0.70 as can be seen in Figure I–18. This sampling includes ceilings made of wood fiber, glass fiber, and other mineral fibers. It also includes the full range of densities and thicknesses that are common to ceilings. This figure shows the relative number of ceiling materials whose NRC lies in the indicated range. Since a mean value is about NRC=0.60 one can say that typical noise reduction effects will be obtained with NRC =0.60 items, not with NRC=0.90 items.

Note that ceilings are usually tested with the number 7 mounting (16-inch plenum behind material). The effect of this mounting is to increase the absorption in the lower frequency range over what would be obtained

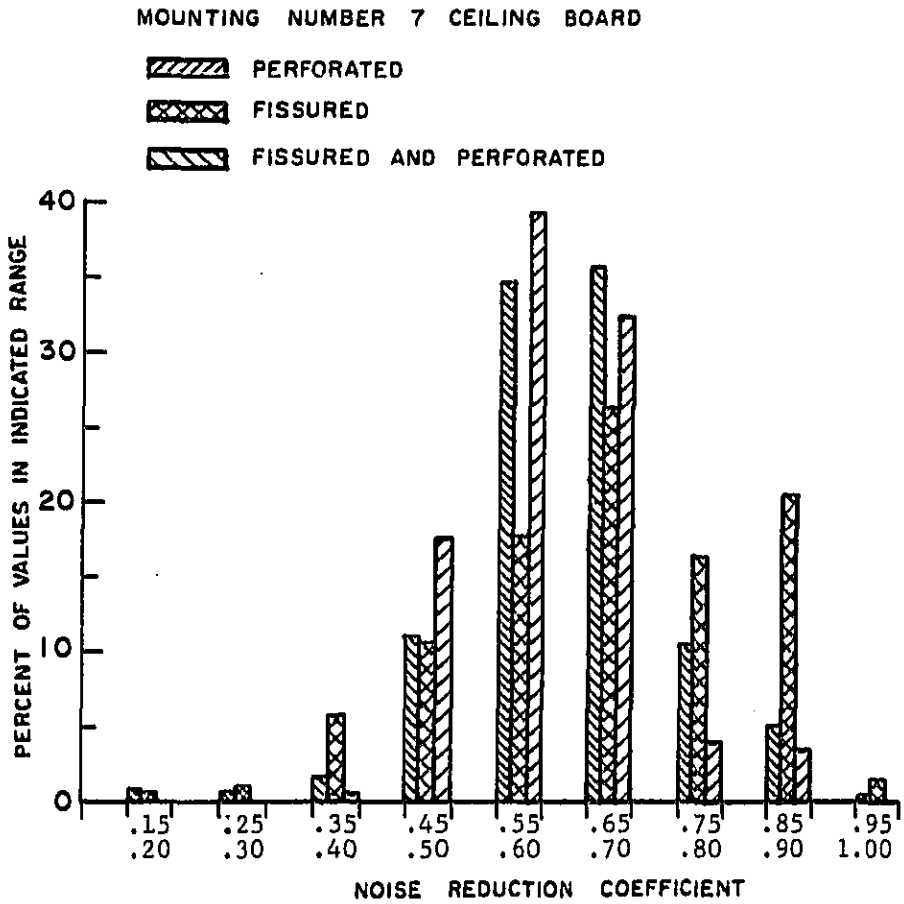



**FIGURE I-18.—Relative Distribution of Absorption Qualities of Acoustical Ceiling Materials.**

if the material were mounted directly to the surface. What one can expect from ceilings for absorption is NRC=0.55 to 0.70. The typical shape of the curve of sound absorption coefficient versus frequency can be seen in Figure I-19. In this figure, three "typical" absorption coefficient versus frequency curves are shown. Note the increase in low frequency absorption, and reduction in high frequency absorption for the absorbing material covered with a perforated metal facing tested using mounting number 7. Note also that while the thicker material will usually have a better low frequency absorption the two shown here for mounting number 4 appear to contradict this. However, the thicker one does have an overall higher absorption level and this further points out that there is no such thing as "typical". These data once again reemphasize that the NRC should not be used as the basis for selecting any acoustical treatment. The full set of frequency data should be utilized and the chosen product matched to the noise spectrum in the space where it is to be used.

One note of caution on ceilings should be heeded. Since acoustic absorption takes place when the sound penetrates into the pores or openings in the material, care should be taken when the ceiling is painted. If the paint is not applied properly, it can plug the openings so that sound cannot enter into the material. The result is that sound is reflected from the

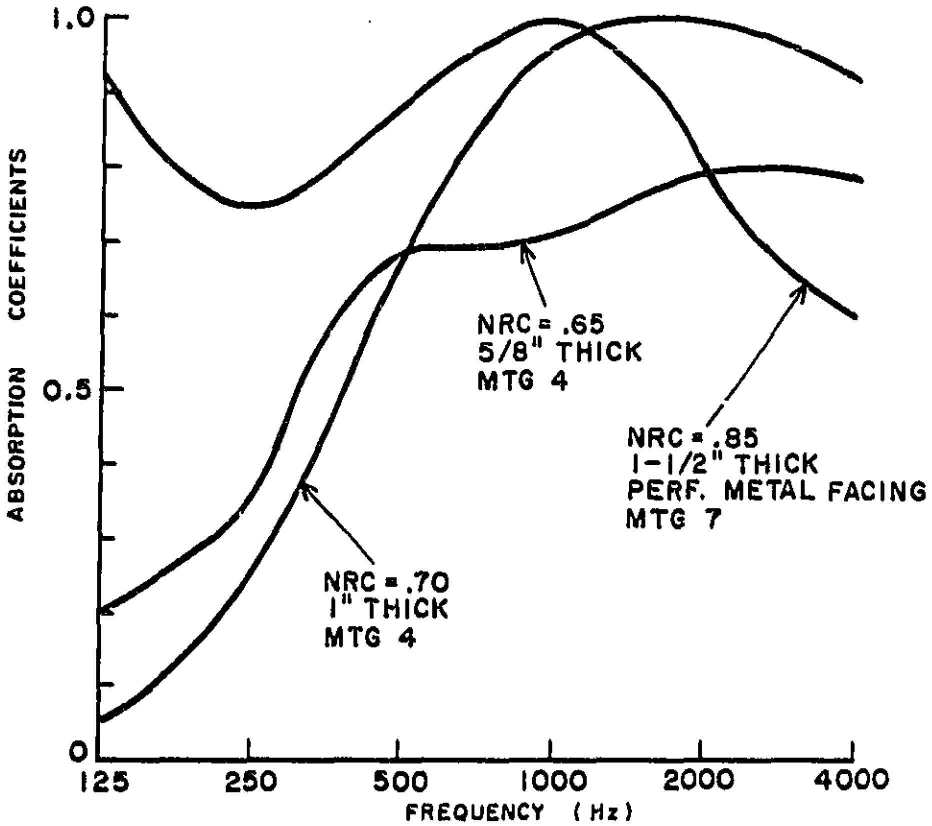



**FIGURE I-19.—Typical Absorption Data for Acoustical Ceilings.**

surface, and the absorbent capability is completely destroyed. If it becomes necessary to paint an acoustical ceiling the manufacturer should be contacted for his recommended method which will preserve the acoustical qualities. If it is known before purchasing a ceiling that painting will be required in the future, the "paintability" of the ceiling should be considered, as some ceiling materials are better able to withstand painting than others. Again, check with the manufacturer for his recommendations.

I-4.1.2—Walls

Normally walls are considered to be sound barriers, but as seen in the example, the applications of absorbent materials to the walls of a room aid in the reduction of noise levels in a noisy space.

I-4.1.3—Ducts

One subject area which has not been mentioned thus far is the sound path through ductwork which often connects spaces which would otherwise be sound isolated from each other. In particular, the noise of a fan or blower can travel great distances along the ductwork and be heard in many areas of a building.

Figure I-20 illustrates interconnection through ducts. The fan in room A produces vibrations which enter room B through the floor and it produces noise which may enter room B through the air diffuser or by vibration

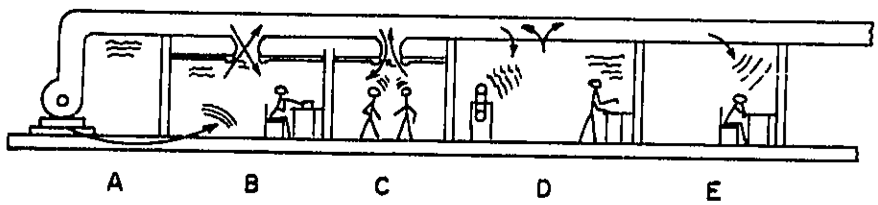



FIGURE I-20.—Interconnections between Noise Sources, Paths, and Receivers.

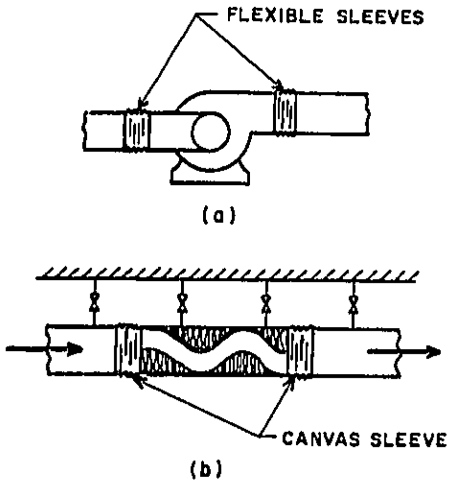



**FIGURE I-21.—Uses of Flexible Couplings in Ducts.**
**(a) Canvas or flexible molded rubber and fabric sleeves serve as vibration breaks between fan and connecting ductwork.**
**(b) Canvas or molded rubber connectors between ductwork and high-attenuation devices such as aircoustat package sound attenuators prevent short-circuiting of noise through duct walls. Vibration-isolating hangers should be used where objectionable amounts of noise may short-circuit through supports and building structure.**

of the duct walls. The noise may travel to all other rooms through the duct. The men talking in room C produce noise in room B. Noise from the shop D may travel through the ducts to rooms B, C, and E.

Figure I-21 shows the use of flexible couplings between ducts and blower and between ducts and a noise attenuation package, as well as the use of vibration-isolating hangers. Figure I-22 shows the noise sources in a simple duct system with the spectra of the sources and the attenuation of a lined duct, an attenuation package, a bend, and the end reflection losses.

A very good description of the propagation of sound as related to ductwork can be found in the "ASHRAE Guide and Data Book Systems, 1970". The following discussion presents some of the pertinent information taken from Chapter 33 of the book.

Although the attenuation of sound in a lined duct is very complicated, theoretically the following empirical relation can be used to estimate the sound attenuation if the proper limitations on its use are observed.

$$\text{Attenuation (dB)} = 12.6\, l \frac{P}{S} \alpha^{1.4} \tag{63}$$

where $l$=length of lined duct in feet; $P$=perimeter of the duct inside the lining, inches; $S$=cross-sectional area of the duct inside the lining, square inches; and $\alpha$=absorption coefficient of the lining (frequency dependent). Some limitations on the use of equation (63) are:

1) smallest duct should be between 6 and 18 inches;

2) duct width to height ratio should be less than 2;

3) equation should not be used where air-flow velocities are greater than 4,000 ft/minute; and

4) line of sight propagation of the higher frequencies is not accounted for by this equation. (In a straight 12-inch

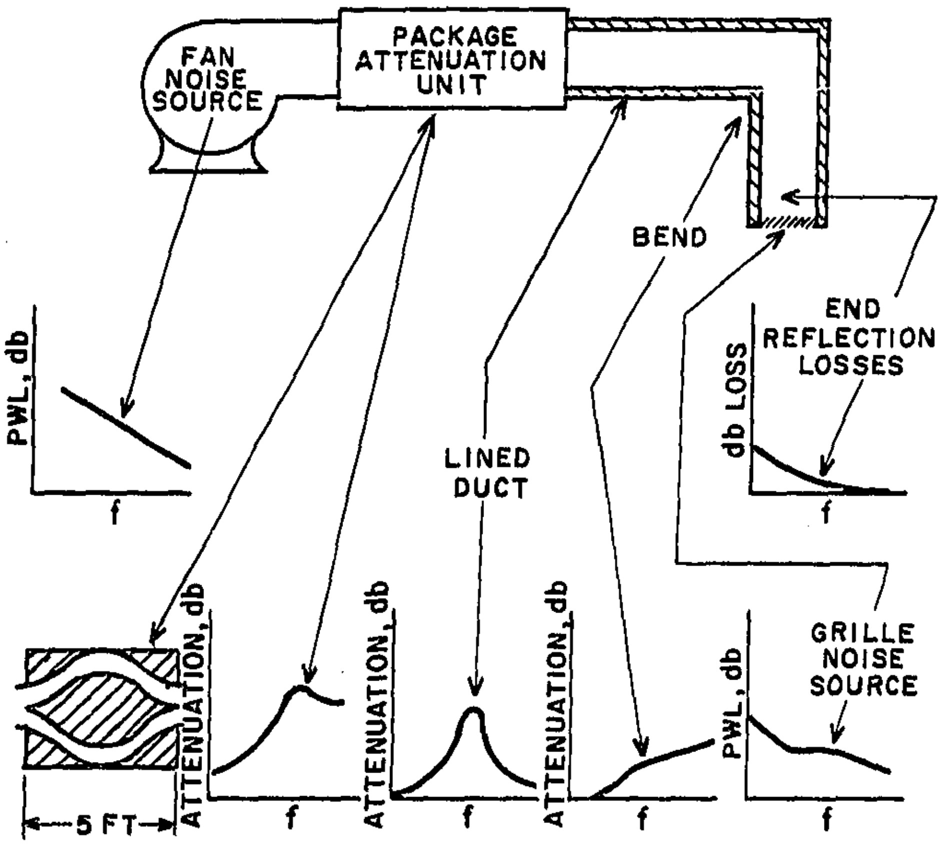



FIGURE I-22.—Noise Sources and Attenuation in a Simple Duct System. The sources are the fan and the grille. Attenuation is provided by a package attenuation unit, a lined duct, a bend, and by reflection of low-frequency waves backward at the end of the duct.

duct the attenuation in the 8,000 Hz octave band will be only about 10 dB for any lining length over 3 ft. The attenuation in the next lower octave band, 4,000 Hz, will be about midway between 10 dB and the value calculated from equation (63). The frequency above which the 10 dB limit applies is inversely proportional to the shortest dimension of the duct.)

Some actual measurements have indicated that the sound level drops much faster than predicted by equation (63) for the first 5 ft of the duct. After that the rate of sound level dropoff is much slower than predicted by equation (63). This is mainly due to flanking transmissions where the sound enters the duct wall and is transmitted along the wall itself. This flanking appears to be the limiting factor in any instance where the predicted sound attenuation exceeds 2 dB/ft. To reduce this flanking it is therefore recommended that flexible vibration couplings be inserted in the ductwork for every 25 dB of lining attenuation required in any frequency band.

If additional attenuation is still required then the attenuation can be increased by increasing the absorbing surface in the lined duct as shown, for example, in Figure I-23.

Another means of reducing the noise in a duct is by using a sound absorption plenum, shown in Figure I-24, which is sometimes the most

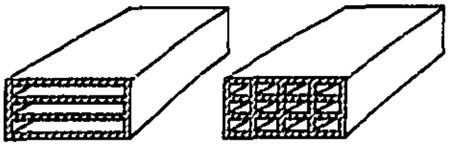


**FIGURE I-23.—Increase of Absorbing Surface in Lined Ducts.**

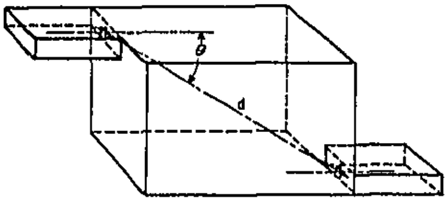



**FIGURE I-24.—Sound Absorbing Plenum.**

economical arrangement. The attenuation provided by such a plenum can be determined by the empirical expression

$$\text{Attenuation (dB)} = 10 \log \left[ \frac{1}{S_e \left( \frac{\cos\theta}{2\pi d^2} + \frac{1-\alpha}{\alpha S_w} \right)} \right] \quad (64)$$

where

- $\alpha$ = absorption coefficient of the lining (frequency dependent),
- $S_e$ = plenum exit area (ft²),
- $S_w$ = plenum wall area (ft²),
- $d$ = distance between entrance and exit (ft),
- $\theta$ = the angle of incidence at the exit, i.e., the angle $d$ makes with the normal to the exit opening (degrees).

As an example of the attenuation a plenum can provide, suppose we build a box 10 ft on a side which attaches to a 2-ft square duct. Now line the plenum with a sound absorbing liner such as foam or fiberglass, which has an absorption coefficient in the 1,000 Hz octave band of 0.6.

For the 1,000 Hz band,

$\alpha = 0.6$,

$S_e = 4$ ft²,

$S_w = 6 \times (10^2) - 4 = 596$ ft²,

$d = \sqrt{8^2 + 10^2} = 12.8$ ft,

$\theta = \tan^{-1}(8/10) = 38.7$ degrees,

Attenuation (dB) =

$$10 \log \left[ \frac{1}{4 \left( \frac{\cos 38.7}{2\pi (12.8)^2} + \frac{1-0.6}{0.6 \times 596} \right)} \right] = 21.2 \text{ dB}.$$

This result is fairly accurate as the predictions obtained with equation (64) normally are within a few decibels for frequencies where the wavelength is less than the plenum dimensions, (in this case the wavelength is just over a foot). For the lower frequencies this equation can be conservative by 5 to 10 dB since the abrupt change in the duct dimensions acts to reflect these longer wavelengths.

It may be necessary to purchase a prepackaged silencer, which can be installed as part of the ductwork, and acoustically treated grills where the ducts terminate in rooms. The attenuation of these devices as with airflow silencing application is dependent on the flow rate, the pressure drop, and the noise frequency content, etc. Specific data for each application should be obtained directly from the manufacturer of these items.

The dependence of absorption NRC on thickness is shown in Figure I-25. This figure shows the range of typical NRC's for any given thickness. The frequency dependence varies as with any absorbing material on the type and spacing of the pores, any covering such as mylar, perforated metal, etc. Again the specific product and thickness should be se-

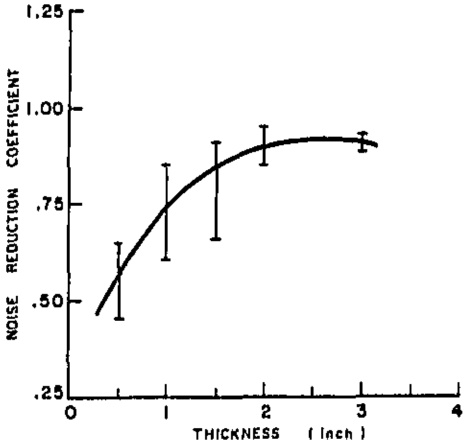



**FIGURE I-25.—Dependence of Noise Reduction Coefficient of Duct Lines on Thickness.**

lected on the basis of the full range of frequency data and not just on NRC.

I-4.1.4—Furnishings

The use of general furnishings, such as chairs, draperies, carpets, etc., can be used to provide absorption of the sound in the room. As seen in the earlier example, absorption can be very effective in reducing noise levels. For offices, homes, schools, etc., the noise control should also be attractive. Modern sound absorption wall and ceiling treatments are available in many colors and patterns. But just using these is not quite enough. If the wall and ceiling treatment is selected for good sound absorption and the effect of general furnishings is overlooked, the finished area may be too dead and unpleasant. It is necessary to have absorption data on these items. The coefficients shown in Table I-8 were obtained from the *AIMA Bulletin* which was also used for the example.

It is appropriate to note here the data usage for some of the special wall applications or landscape screens which are being used in some of the new open plan offices. Since the screens are obviously sold as a preformed unit and the size of the specimen will affect the absorption, the measured absorption is reported directly in sabins per unit and is not reduced to a coefficient. Some of the special wall treatments that do not cover the entire wall, but do place individual ornamental pieces in some unconnected arrangement, will also yield different absorption values depending on the surface area. The data for these may be reported as sabins per unit or as an absorption coefficient. If the absorption coefficient is reported the exact number, surface area covered, and relative placement of the individual pieces must be known.

The absorption of curtains and draperies depends on spacing from the wall, how close and deep the pleats are, size, and the material used. Some coefficients for these items can be found in the data tables.

Carpets serve the dual purposes of floor covering and noise reduction. Noise reduction is achieved in two ways: carpets absorb the incident sound energy; and sliding and shuffling movements on carpets produce less noise than on bare floors. *The Carpet and Rug Institute* has published a report on "Sound Conditioning with Carpet" and some of their findings are:

1) NRC of carpets laid directly on bare concrete floor ranged from 0.25 to 0.55;
2) fiber type has virtually no influence on sound absorption;
3) cut pile provides greater noise reduction than loop pile;
4) the NRC increased as pile weight and/or pile heights were increased;
5) carpet pads have considerable effects on sound absorption as shown in Table I-11;
6) permeability of backing results in higher NRC. In one test a carpet with a coated backing had an NRC of 0.40 and the same carpet with an uncoated backing had an NRC of 0.60; and
7) carpets and pads provide significant improvements in impact noise ratings of floors. Table I-12 shows the results of tests made on a concrete slab using a woven, 44 oz wool carpet with various pads.

**TABLE I-11 — EFFECTS OF PADDING ON CARPET NOISE REDUCTION COEFFICIENT**

| PAD WEIGHT, OZ | PAD MATERIAL | NRC |
|---|---|---|
| — | None | 0.35 |
| 32 | Hair | 0.50 |
| 40 | Hair | 0.55 |
| 86 | Hair | 0.60 |
| 32 | Hair jute | 0.55 |
| 40 | Hair jute | 0.60 |
| 86 | Hair jute | 0.65 |
| 31 | Foam rubber, ⅜-inch | 0.60 |
| 44 | Sponge rubber | 0.45 |

**TABLE I-12 — EFFECTS OF CARPETS AND PADS ON IMPACT NOISE**

| FLOOR COVERING | INR | IIC |
|---|---|---|
| None | −17 | 34 |
| Carpet only | +14 | 65 |
| Carpet with 40-oz hairfelt pad | +21 | 72 |
| Carpet with urethane foam pad | +24 | 75 |
| Carpet with 44-oz sponge rubber | +25 | 76 |
| Carpet with 31-oz, ⅜-inch foam rubber | +28 | 79 |
| Carpet with 80-oz sponge rubber | +29 | 80 |

## I-4.2—NOISE CONTROL BY BARRIER

### I-4.2.1—Natural Objects

Controlling noise by barrier is simply a matter of providing some form of wall or other heavy dense object between the source of the sound and the receiver, i.e., its path is blocked.

One of the most inexpensive and easiest to accomplish ways of providing a barrier is to locate a source or a receiver behind an already existing barrier. For example, if a new apartment is to be constructed near an expressway and the landscape is hilly, build with a hill between the apartment and expressway. When this is not possible, bedrooms or other spaces where quiet is desired should be on the far side of the building. Hallways, elevators, etc., should be on the side facing the noise. In this way much of the special acoustical treatment can be completely eliminated.

In a factory the noisy machinery should not be in the same room with quieter objects. If noisy equipment is to be located outdoors, it should be placed on the side away from the area where quiet is desired. If the plant is located near a residential neighborhood the noisy activities such as loading docks should be on the side away from the homes. A little thought before the installation of some noise source can save a lot of time and money later.

### I-4.2.2—Ceilings

The use of ceilings as sound barriers is not a normal application. Yet it is frequently through the ceiling, and the open plenum above into the next room and down through the ceiling of the adjoining room, that sound travels. This is just one flanking path that can seriously degrade the sound isolation between rooms.

There are several alternatives for reducing the noise transmitted in this way. One method is to place a barrier in the ceiling plenum between the two rooms. This may be difficult sometimes due to piping, wiring, ductwork, etc., that is probably in this space.

A second way is to place some barrier material such as gypsum board on top of the ceilings. However, one must be careful because enclosing the space above the ceiling may decrease the absorption coefficient of the ceiling and reduce the absorption of the room below.

The third method is to use a ceiling that has both the proper absorption and sound transmission loss properties. For this reason ceilings are tested for their transmission from one room to another as well as for sound absorption. This test provides a *sound attenuation factor* for the ceiling. A two-room test procedure has been developed for this purpose (see figure for Data Table 34, Ceiling Sound Transmission Factor).

### I-4.2.3—Walls

The most common means of blocking a sound path is to build a wall between the source and the receiver. A wall may be outdoors such as a high fence or it may close off the space between two rooms.

I-4.2.3.1—*Freestanding Wall* A freestanding wall is defined here as a solid fence, with no bounding surface above the wall so that sound waves can pass freely over the wall.

As with all sound control systems the amount of attenuation provided by a freestanding wall depends on the frequency as well as many other factors. For low frequencies where the sound wavelength is of the same order of magnitude as the wall dimensions, the sound diffracts around the edges and over the top of the wall with very little attenuation (zero to 5 dB) on the other side. The higher frequencies can be very effectively attenuated with reductions of 20 dB being quite possible.

The attenuation of an infinitely long, freestanding wall can be determined from Figure I-26 and the relationship

Attenuation (dB) = 20 (log 2.5) $N + 5$ dB

$N \geq 1$, for where (65)

$$N = \left[\frac{2}{\lambda}(A+B-d)\right]^{½}, \quad (66)$$

$\lambda$ = wavelength of sound, meters,

$d$ = straight line distance from source to receiver in meters,

$A+B$ = shortest path length of wave travel over the wall between source and receiver.

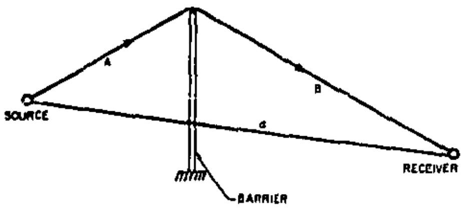



**FIGURE I-26.—Geometry for Determining Sound Attenuation by a Freestanding Wall.**

Attenuations range from a low of about 5 dB to a maximum of about 24 dB. This attenuation can then be subtracted from the sound pressure level that would exist at the point of the receiver if the wall were not there.

The obvious maximum attenuation occurs when $A+B >> d$ and/or when $\lambda$ is very small (high frequency), i.e., for $N$ large.

As an example in the use of equation (65), the attenuation in the 1,000 Hz octave band for a freestanding wall 4 meters high can be determined in the following manner. Assume the wall long enough so that the sound diffracting around the ends can be neglected. Also assume the point noise source is 1.7 meters from the ground and the receiver is a human ear also 1.7 meters from the ground. Locate the wall such that the source is 3 meters from the wall and the receiver 6 meters from the wall. Then

$$N=\left[\frac{2f}{c}(3.78+6.43-9)\right]^{1/2}=\sqrt{7.24}=2.7,$$

and

$$\text{Attenuation}=20\log(2.5)(2.7)+5\text{ dB}$$
$$=21.6\text{ dB re }2\times10^{-5}\text{ N/m}^2$$

On the other hand, how high must the wall be built to obtain a specified attenuation? For example, for the same case as above, how high must the wall be to obtain 15 dB attenuation in the 125 Hz octave band? By rearranging equation (65),

$$N=0.4\text{ antilog}\frac{\text{dB}-5}{20}. \quad (67)$$

The value of A+B can be derived from equation (66) as

$$A+B=N^2\lambda/2+d.$$

The wall height can then be determined on a trial and error basis or graphically; in this case, A+B is 11.2 meters, which corresponds to a wall height of 5 meters. (Further discussion of the attenuation of sound by freestanding walls can be found in *J. Acoust. Soc. Amer. 55*(3), pp 504-518, March 1974.)

The wall should be constructed of a material such that transmission through the wall does not degrade its performance since the above equations assume no transmission through the wall. This can be readily accomplished if the surface density of the wall is at least about 2 lbs/ft$^2$.

One final note on the use of a freestanding wall is that the noise from the source will reflect off the wall so that to an observer on the same side of the wall, the sound pressure level will be higher than if the wall were not there.

I-4.2.3.2—*Walls as Partitions Between Spaces*
When using a wall as a sound barrier between two spaces the principal concern is with the transmission loss and flanking paths. The transmission loss ($TL$) of a partition is given by equation (38)

$$TL=10\log\frac{1}{\tau}\text{ dB}$$

where $\tau$ is the transmission coefficient and is a function of frequency. Also the transmission loss is measured between two reverberation rooms and calculated from equation (43) as

$$TL=NR+10\log S/A$$

where $NR=L_{p_s}-L_{p_r}$ is the difference in sound pressure levels between the two rooms, $S$ is the transmitting area of the specimen, and $A$ is the total absorption in the receiving room.

Thus, to determine what the sound level in a room would be after a barrier wall has been erected, this equation can be reversed to obtain

$$NR=TL-10\log S/A$$

and it can then be seen that the noise reduction is dependent on the total absorption in the receiving room. This is understandable if one remembers what reverberation does to the sound field. The noise that comes through the wall bounces around in the receiving room so the level is not what it would be if a free field existed on the receiving side.

EXAMPLE: The sound pressure level on one side of a 10 ft by 14 ft wall is measured 95 dB in the 500 Hz octave band. If the transmission loss of the wall is 47 dB in this band and the absorption in the receiving room is 1,000 sabins, what will the sound pressure level be in the receiving room?

SOLUTION:

$$NR = L_{p_s} - L_{p_r} = TL - 10 \log S/A$$

or

$$\begin{aligned} L_{p_r} &= L_{p_s} - TL + 10 \log S/A \\ &= 95 - 47 + 10 \log \frac{10 \times 14}{1{,}000} \\ &= 39.5 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2, \end{aligned}$$

and the absorption in the receiving room has reduced the sound level by 8.5 dB more than what is predicted by simply subtracting the transmission loss value from the sound level in the source room. Note that if the receiving room is very hard such that $S > A$, then the opposite is true.

In the general case of using a partition as a sound barrier, the partition may be a wall with a door and windows and may even be built in several sections each with a different transmission loss. It is necessary to know the average transmission loss of the entire assembly. This is found by first determining an average transmission coefficient $\bar{\tau}$ as

$$\bar{\tau} = \frac{\sum_i \tau_i S_i}{\sum_i S_i} = \frac{\tau_1 S_1 + \tau_2 S_2 + \tau_3 S_3 + \ldots + \tau_n S_n}{S_1 + S_2 + S_3 + \ldots + S_n} = \frac{T}{S}, \tag{68}$$

and

$$TL_{avg} = 10 \log S/T, \tag{69}$$

where $T$ is the total transmittance, $S$ is the total surface area of the barrier system, $S_i$ is the area of the $i^{th}$ section of the partition, and $\tau_i$ is the transmission coefficient of the $i^{th}$ section of the partition which is determined by rearranging equation (38):

$$\tau_i = \text{antilog}\left(-\frac{TL_i}{10}\right). \tag{70}$$

Now the noise reduction of this partition can be determined by combining equation (69) with equation (43) as

$$\begin{aligned} NR &= TL - 10 \log S/A \\ &= 10 \log S/T - 10 \log S/A \end{aligned}$$

or

$$NR = 10 \log A/T \text{ dB} \tag{71}$$

As an example, the noise reduction of a partition that is one wall of the room used in the example of absorption material application can be determined for the 500 Hz octave band. (See Section I-4, item (5).) Let the wall be made of concrete with a transmission loss of 50 dB at this frequency, a door with a transmission loss of 25 dB, a window with a transmission loss of 30 dB, and a leak under the door 0.25 inch high. The areas and transmission coefficients for each as determined from equation (70) are

| Item | Dimension | Area, ft² | TL, dB | $\tau_i$ | $\tau_i S_i$, ft² |
|---|---|---|---|---|---|
| Wall | 12 ft x 100 ft | 1200 | 50 | 0.00001 | 0.0120 |
| Door | 7 ft x 3.5 ft | 24.5 | 25 | .00316 | .0775 |
| Window | 4 ft x 6 ft | 24 | 30 | .00100 | .0240 |
| Leak | 0.25 inch x 3.5 ft | 0.88 | 0 | 1.00000 | .8800 |
| | | | | Total transmittance, $T$ | .9935 |

(Note the largest transmittance is through the 0.25-inch leak under the door.) The noise reduction of this wall can now be determined using equation (71) and the total absorption in the room. Thus

$$NR = 10 \log \frac{278}{.9935} = 24 \text{ dB}.$$

Due to the sections with lower transmission loss values (especially the leak) and the hardness of the receiving room, the 50 dB wall results in a noise reduction of only 24 dB.

If the same absorbent treatment as in the absorption example is used, we will have a noise reduction of

$$NR = 10 \log \frac{2865}{.9935} = 35 \text{ dB}.$$

The noise reduction increased, by 11 dB to 35 dB which indicates the leak should have been fixed first. If the leak is plugged with a seal that provides a transmission loss of 50 dB, the total transmittance is reduced to

0.1135. Consequently, the noise reduction of 24 dB is increased to

$$NR = 10 \log \frac{278}{0.1135} = 34 \text{ dB},$$

which is almost as much as the sound absorbing treatment provided.

Now the whole job, sealing the leak and adding absorption materials to the room, results in a noise reduction of

$$NR = 10 \log \frac{2865}{0.1135} = 44 \text{ dB},$$

which is 20 dB greater than the 24 dB obtained with the leak and without additional absorption. To improve this even more, it can be seen from the calculated transmittances that the door and the window are still the weakest links. Also, the transmittances of these two sections are seven times as high as the rest of the wall even though their total area is only a little more than 3 percent of the total surface area.

Before discussing complete enclosures around noise sources, a brief detour should be taken at this point to discuss the behavior of walls as sound barriers. Referring to equation (39), the transmission loss of a barrier behaves according to the "mass law".

Basically this mass law states that if the weight is doubled, the transmission loss will increase by 6 dB. This, however, does not hold strictly true in practice. In the real world a doubling of the mass of the wall will increase the transmission loss only by about 4 or 5 dB. The real world mass law, which is obtained from empirical results can be stated as

$$TL = 23 + 14.5 \log m \text{ dB} \tag{72a}$$

where $m$ is expressed in lb/ft² or

$$TL = 13 + 14.5 \log m \text{ dB} \tag{72b}$$

where $m$ is expressed in kg/m². The increase predicted from this expression for a doubling of the mass is about 4.4 dB (Harris, Chapter 20).

If proper construction techniques are used, it is possible to get more than a 6 dB increase in transmission loss by doubling the mass. The main factor in achieving greater than the mass law prediction is to construct what is referred to as a "double wall". In a double wall arrangement the two sides of the wall are independent of each other (there are no connecting braces, and each side uses its own set of studs.)

In general, walls can be classified as non-load-bearing partition type walls, load-bearing, and masonry type walls. Masonry walls are made up of bricks, or various types of concrete and may be plastered or painted.

I-4.2.3.3—*Plasterboard Walls* Plasterboard walls are relatively light, inexpensive, and easy to erect. A typical plasterboard wall consists of two plasterboard leaves, separated by an air space and a system of studs or framing members. The sound transmission loss of such a wall depends on the transmission losses of the individual leaves and on the degree of coupling introduced by the intervening air space and stud system. The studs can sometimes act as vibration conductors and thus may degrade the performance of a wall assembly. If the studs have low torsional rigidity (e.g., steel channels) transmission via the studs appears to be negligible. Figure I-27 shows the transmission losses of three wall assemblies as functions of frequencies. Wall assembly number 1 has the lowest STC even though its density is slightly higher than the other two assemblies. It can be seen from the figure that a significant increase (14 dB in this case) in transmission loss can be achieved by separating the two leaves of a wall and putting a sound absorbent batt in the wall cavity.

I-4.2.3.4—*Concrete and Brick Walls*

Load-bearing walls made from concrete or bricks are heavier than the plasterboard wall and consequently they can provide increased sound attenuation. For instance, the Brick Institute reports STC's from 39 to 59 for specific walls made from structural clay tiles or bricks, with their weights ranging from 22 to 116 lb/ft². Concrete walls also provide similar attenuation and in general the dense, heavy-weight concrete walls perform better than the lightweight concrete walls—particularly at low frequencies.

It should also be noted that unpainted lightweight concrete blocks have good sound absorption but painting or spraying the wall will result in reduced absorption. This is summarized in Table I-13.

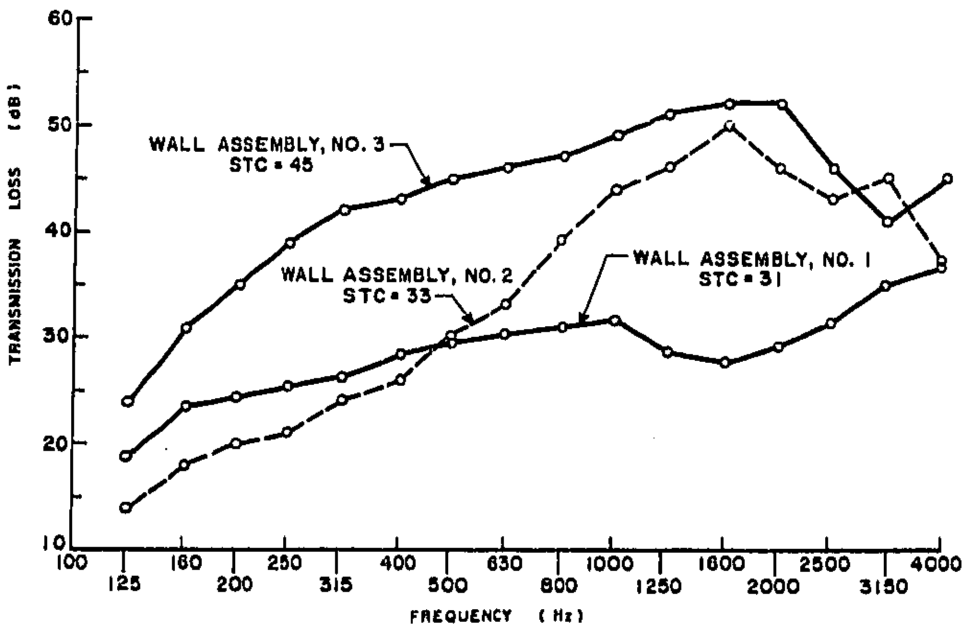



**FIGURE I-27.—Improvement in Wall Transmission Loss by Spacing Sides, and by Adding Absorbing Material in the Cavity. (Data Courtesy National Research Council of Canada.)**
**Wall Assembly No. 1: Two layers of ½-inch plasterboard with joint compound. Weight—4.6 lb/sq ft.**
**Wall Assembly No. 2: Two ½-inch plasterboard leaves with 3⅝-inch space, no studs. Weight—4.2 lb/sq ft.**
**Wall Assembly No. 3: Two ½-inch plasterboard leaves with 3⅝-inch space, 2-inch thick absorption. Weight—4.2 lb/sq ft.**

TABLE I-13—NOISE REDUCTION COEFFICIENTS FOR CONCRETE

(Courtesy Expanded Shale and Slate Institute)

| Material, medium texture, unpainted | Approximate NRC | Adjustment, percent Coarse texture | Fine texture |
|---|---|---|---|
| Expanded shale block .................. | 0.45 | Add 10 | Deduct 10 |
| Heavy aggregate block .................. | .27 | Add 5 | Deduct 5 |

Deductions from NRC for painted block, percent

| Paint type | Application | One Coat | Two Coats | Three Coats |
|---|---|---|---|---|
| Any .................. | Spray ....... | 10 | 20 | 70 |
| Oil base ............ | Brushed ... | 20 | 55 | 75 |
| Latex or resin base ..... | Brushed ... | 30 | 55 | 90 |
| Cement base ..... | Brushed ... | 60 | 90 | — |

In addition to plasterboard and masonry many other types of wall materials are used and the wall construction also ranges from a simple brick wall to walls with a complex stud system combined with acoustical and thermal batts. Plywood, hardboard, steel, etc. are other commonly used wall materials. In all cases it can be said that increased mass and decreased coupling between different components along the path of sound result in high transmission loss. Data Tables 27, 28, and 29 provide much useful information about the transmission losses of many different types of walls.

I-4.2.4—Glass

Glass windows are often the weak link in an otherwise good sound barrier. Acceptable sound transmission loss can be achieved in most cases by a proper selection of glass. Mounting of the glass in its frame should be done with care to eliminate noise leaks and to reduce the glass plate vibrations.

Acoustical performance of glass is often improved by a plastic inner layer or an air gap. Table I–14 shows the comparison of STC values for glass and laminated glass of various thicknesses. Table I–15 compares the monolithic glass plate with air-spaced glass of equal thicknesses.

TABLE I-14—SOUND TRANSMISSION CLASS OF MONOLITHIC AND LAMINATED GLASS

| Overall Thickness, inch | Monolithic Glass, STC | Two Equally Thick Layers Glass with 0.030-inch Plastic Inner Layer, STC |
|---|---|---|
| 0.125 | 23 | — |
| .25 | 28 | 34 |
| .5 | 31 | 37 |
| .75 | 36 | 41 |
| 1.00 | 37 | — |

TABLE I-15—SOUND TRANSMISSION CLASS OF AIRSPACED GLASS AND MONOLITHIC GLASS OF COMPARABLE THICKNESS

| Overall Thickness, inch | Air-spaced Glass Construction | STC | Comparably Thick Glass without Air Space, STC |
|---|---|---|---|
| 1.0 | Two 0.25-inch plates with 0.50-inch air space | 32 | 31 |
| 1.5 | Two 0.25-inch plates with 1-inch air space | 35 | 31 |
| 2.75 | 0.25- and 0.5-inch plates with 2-inch air space | 39 | 36 |
| 4.75 | 0.25- and 0.5-inch plates with 4-inch air space | 40 | 36 |
| 6.75 | 0.25- and 0.5-inch plates with 6-inch air space | 42 | 36 |

I-4.2.5—Doors

Sound transmission loss of a door depends upon its material and construction, and the sealing between the door and the frame. Most doors are of wood or steel construction with various stiffnesses and barrier batts added to the hollow cavity inside the door if one exists. It is usually difficult to specify the STC of a door because the sealing between the door and the frame is not a precisely controlled variable. The variations in STC's of two doors as the sealing was improved by increasing the deflection of gaskets, by adding extra gaskets, and by changing the gaskets materials, are shown in Figure I-28. In each case the improved sealing improves the performance such that the STC approaches its maximum possible value shown by the completely sealed case.

This figure points out improvements that can be made by attacking the weakest link. If better sealing does not offer sufficient improvement selecting a better door design becomes necessary. Generally the heavier doors provide increased attenuation. Wood and steel doors behave essentially in a similar manner as shown in Figure I-29 which shows a form of the mass law dependence of STC's on weights (in $lbs/ft^2$) for wood and steel doors. These data which are based on many tests conducted in an acoustical laboratory, indicate an increase of 8 to 9 dB in STC for a doubling of the weight. Note, however, that effects of better design, better sealing, etc., are also reflected in this figure. The approximate relationships are

For steel doors: $STC = 15 + 27 \log W$

For wood doors: $STC = 12 + 32 \log W$

where $W$ = weight of the door in $lb/ft^2$. It should be emphasized that these relationships are purely empirical and that a large deviation can be expected for any given door.

I-4.2.6—Enclosures

In many cases the purpose of an acoustic enclosure is to keep the noise from getting inside. Examples are sound proof booths for machine operators and audiometric test booths for testing the hearing of employees. It is relatively straightforward to calculate the noise reduction by employing the principles presented in Section I-4.2.3.2, since the enclosure may simply be regarded as a small room, and its walls as partitions. More often, however, an enclosure, or box, is placed around

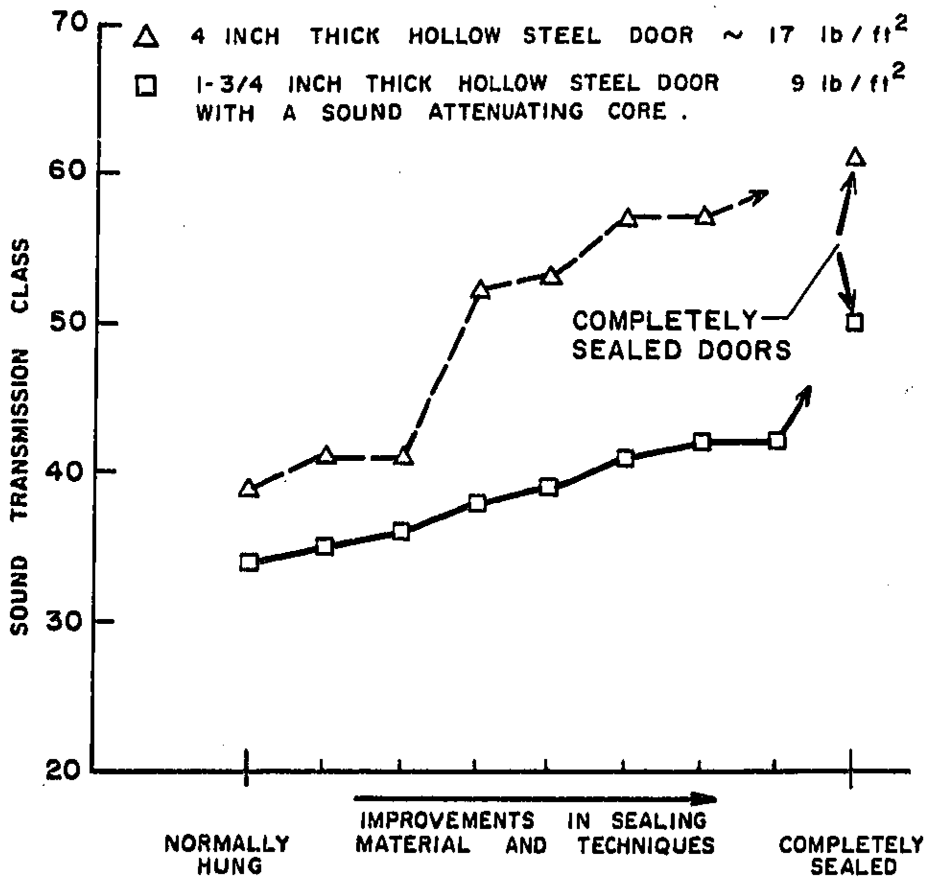



**FIGURE I-28.—Effects of Improved Sealing of Doors on Sound Transmission Class. (Based on a Series of Tests on Two Different Types of Door.)**

a noise source to keep the noise from getting outside. In predicting the noise reduction for this case there are some subtleties which warrant further discussion.

To predict the noise reduction of an enclosure the procedure is the same as with a barrier wall. One first determines the transmittance of the total surface area and then, including the absorption of the space outside the enclosure, determines the noise reduction of the box.

EXAMPLE: Suppose the noisy machine in the factory of the previous example is covered. If the enclosure is built with partitions whose transmission loss in the 500 Hz octave band is 50 dB and the size of the enclosure is 10 ft x 10 ft x 10 ft with a 7 ft x 3.5 ft door (no leak this time), and the sound pressure level inside the box is measured to be 99 dB in the 500 Hz octave band, what is the noise reduction of the enclosure?

SOLUTION: As before, first determine the total transmittance of the enclosure using equation (70) as

| Item | Area, $ft^2$ | $TL$, dB | $\tau$ | $S_\tau$ |
|---|---|---|---|---|
| Walls | 375.5 | 50 | 0.00001 | 0.0039 |
| Ceiling | 100.0 | 50 | .00001 | .0010 |
| Door | 24.5 | 25 | .00316 | .0775 |
| | | Total Transmittance | | $T=$ .0823 |

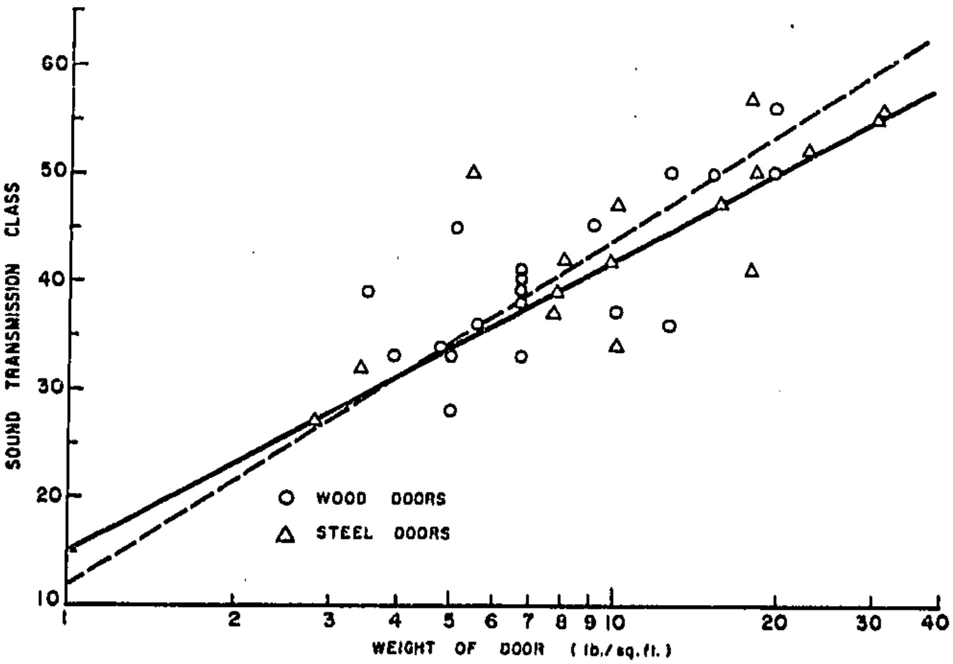



**FIGURE I-20.—Dependence of Sound Transmission Loss for Doors on Weight. Approximate STC for wood door, STC = 12 + 32 log *W*; Approximate STC for steel door, STC = 15 + 27 log *W*; where *W* = weight of the door in lb/sq ft.**

and then the noise reduction from equation (71)

$$NR = 10 \log \frac{A}{T} = 10 \log \frac{2865}{0.0823} = 45 \text{ dB}$$

where the total absorption in the room is taken from the previous example for the case where the room was treated with absorbent materials. In this case a noise reduction has been achieved that is greater than the 44 dB transmission loss that might be expected (and with a 25 dB door).

However, the noise reduction ($NR$) computed above is the difference between noise levels inside and outside the box, and represent what one would most likely be concerned with in practice. The real question concerns the reduction in noise level at a point outside the box, measured before and after the installation of the box. An interesting phenomenon occurs in a complete enclosure. If there is some source of sound power and a box is built around it, the sound energy density, or the intensity, will increase until the amount of power absorbed by the walls is equal to the power emitted by the source. This phenomenon is referred to as "sound build-up".

For example, the new machine to be installed in the room will be enclosed by a 10 ft x 10 ft x 10 ft box made of steel with an absorption coefficient in the 500 Hz octave band of 0.02. Assume the floor is smooth concrete with the same absorption coefficient. The room constant for this enclosure is determined using equation (56b)

$$R = S(e^{\bar{\alpha}} - 1) = 12 \text{ ft}^2.$$

The sound pressure level just inside the enclosure (assume 5 ft to wall) is now obtained from equation (61b)

$$L_p = L_w + 10 \log \left(\frac{1}{2\pi r^2} + \frac{4}{R}\right)$$

$$= 105 + 10 \log (0.0685 + 3.5880)$$

$$= 110.6 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2$$

Note: $r^2$ and $R$ must be in meters squared for this equation.

The sound pressure level that existed at the 5 ft position before this steel enclosure was built, was only

$$L_p = 105 + 10 \log (0.0685 + 0.0119)$$
$$= 105 - 10.9$$
$$= 94.1 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2$$

(using $R$ from the absorption example in the appendix with absorption in the room).

This value of 94.1 dB corresponds to the 5 ft position prior to the construction of the enclosure, whereas noise reduction corresponds to the value that exists within the enclosure. For example, since a noise reduction of 45 dB was determined for the enclosure $94.1 - 45 = 49.1$ dB is not used, but instead $110.6 - 45 = 65.6$ dB or an effective noise reduction of only $94.1 - 65.6 = 28.5$ dB.

This problem is not insurmountable. The solution is to add absorption to the lining of the walls of the enclosure. If the job is good enough, the level at the inside of the wall can be very nearly what it would be in a free field. In the above example, the external room constant was so large that the sound pressure at 5 ft from the source was essentially that of a free field. A quick check of the relative magnitudes of the two terms in the argument of the logarithm in equation (61) indicates this.

Another factor that must be considered is resonance. If the dimensions of the box result in resonance due to one of the modes of the sound, the box can be driven to high levels of vibration and become a new radiator of these components of the sound. When this occurs the sound pressure level outside the box can be higher than it was even before the box was installed. This effect is significantly reduced when the noise source occupies a sufficient fraction of the room volume, by the use of absorbent lining on the interior surfaces of the enclosure, damping treatment on the panels, and stiffening of the panels.

### I–4.2.7—Floors

The use of floors as barriers of sound in the path between two rooms is exactly as with walls plus a few additional considerations. First consider the STC of the floor. Generally, floors have good STC since their structural requirements are such that the floor has sufficient mass. However, this is not always true, especially in some of the modern apartment constructions.

One of the main problems with floors is that they are located in the direction of gravity for footsteps, falling objects, support of furniture and equipment of all sorts, etc. These falling objects produce impact noises both in the spaces above and below the floor. Because of these impacts, many floors are now tested for impact insulation.

As discussed in Section I–3.4, a standard tapping machine makes impacts on the floor and the sound pressure level is measured in the space below. These measurements are made in one-third octave bands and the spectrum of the sound is compared to a set of standard contours resulting in a one-number rating for the IIC of the floor. Also, the measured sound pressure level in each of the 16, one-third octave bands is normalized to a room with an absorption of 10 metric sabins or 108 sabins in square feet. To determine the sound pressure levels in the space below the floor, equation (46) is simply reversed

$$L_n = L_p - 10 \log A_0/A$$

or

$$L_p = L_n + 10 \log A_0/A$$

where $A_0$ is 108 sabins and $A$ is the absorption in the room below the floor.

For example, suppose the floor of interest is the ceiling of the large room used in the previous examples. If the floor had an IIC of 51, what sound pressure level would the tapping machine produce in the room below in the 500 Hz band? By definition, the IIC is the same as the sound pressure level in the 500 Hz band. Before adding the absorption treatment the total absorption in the room in the 500 Hz band was 278 sabins. Thus

$$L_p = 51 + 10 \log \frac{108}{278} = 47 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2$$

and with the measured background levels this would not contribute anything at all. What background level will be measured after absorption is added to the room? The total absorption is 2865 sabins in the 500 Hz band and

$$L_p = 51 + 10 \log \frac{108}{2865}$$
$$= 37 \text{ dB re } 2 \times 10^{-5} \text{ N/m}^2.$$

Again it is seen how absorption in the receiving space complements the sound barrier properties of some other item.

While these two calculations show the kind of games one can play with numbers and absorption treatments, it cannot be said that the real noises produced by objects hitting the floor above will resemble the noises of the tapping machine. There is no definite way one can predict the sound pressure levels in the room below any particular floor without first measuring the noise of the specific impact of interest. The only handle that is available is that the higher the IIC the lower the sound level in the space below for most, but not all, types of impact noises. Of course, just as with STC, the true shape of the sound spectrum must be considered in its entirety.

If it is desired to increase the IIC of a floor structure it can usually be accomplished with relative ease by the placing of a carpet and pad or other suitable soft material on the floor.

With regard to airborne sound transmission, it was shown earlier that the floor probably has a good STC. It should not be overlooked, however, that flanking paths such as into the walls of the upper room, down through the wall, and out into the space of the room below, can contribute a good portion of the noise in the space below. Also, any impact on the floor will send vibrations into the walls which can become airborne sound in the room below.

Laboratories that measure impact insulation provide a good test floor in terms of isolation. Any good installation of a floor that must have a high insulation against impact noises should be equal to the laboratory setup. There are numerous ways and materials that can be used to increase the isolation of the floor from the wall and even from the subfloor. The interested reader should consult a good book on architectural acoustics for the many designs presently used.

Of additional benefit to the sound barrier properties of a floor is the fact that if there is a space below there is probably some kind of ceiling also. Consequently, a floor should not be considered alone but as a floor-ceiling system. Well designed floor-ceiling systems can significantly improve the acoustic environment by reducing impact sound generation, increasing the sound absorption, and attenuating the airborne sound that passes through the floor.

Sound transmission of a floor can be decreased by increasing the weight of the floor or by designing a more complex floor system using acoustical batts, cavities, etc., as shown in the figures for Data Tables 30 and 31.

The IIC of a floor cannot be significantly increased by increasing its weight, but a carpet on the floor, or even better, a carpet placed on a pad, can greatly increase the IIC. The effects of various floor treatments on STC and IIC are shown in Table I-16.

Consideration must be given to what happens when a piece of vibrating machinery is mounted on the floor. At the moment no particular test procedure exists to predict what noise this type of installation will have. What can be said is that if the floor is driven to a sufficiently high level of vibration it will become an acoustic radiator of noise into the spaces both above and below. To prevent such problems one must mount machinery on proper vibration isolation mounts.

### I-4.2.8—Ducts and Piping

Previously the propagation of sound along the length of a duct and some of the benefits of linings, bends, plenum chambers, etc., were discussed. Now the concern is with sound that propagates through the duct wall, into and out of the duct. The primary concern in this case is keeping the sound from getting out of the duct, therefore, it should be remembered that ducts make good acoustical connections between rooms. One does not want to have sound enter the duct where it passes through a noisy room to be transmitted to another room, especially if a great deal of time, money, and effort have been expended to reduce the noise (e.g. from fans, blowers, etc.) by installing plenums or silencers. In either case, if barrier treatment is applied on the outside of the ductwork or the piping it should reduce the transmission of sound through the walls.

The covering of a pipe or duct with some sound barrier material is normally referred to

TABLE I-16.—TYPICAL IMPROVEMENTS WITH FLOOR AND CEILING TREATMENTS

| Type of Treatment | Change in Ratings | |
|---|---|---|
| | Airborne, STC | Impact, INR or IIC |
| 2-inch concrete topping, 24 psf | 3 | 0 |
| Standard 44 oz carpet and 40-oz pad | 0 | 48 |
| Other carpets and pads | 0 | 44 to 56 |
| Vinyl tile | 0 | 3 |
| 0.5-inch wood block adhered to concrete | 0 | 20 |
| 0.5-inch wood block and resilient fiber underlay adhered to concrete | 4 | 26 |
| Floating concrete floor on fiberboard | 7 | 15 |
| Wood floor, sleepers on concrete | 5 | 15 |
| Wood floor on fiberboard | 10 | 20 |
| Acoustical ceiling resiliently mounted | 5 | 27 |
| Acoustical ceiling added to floor with carpet | 5 | 10 |
| Plaster or gypsum board ceiling resiliently mounted | 10 | 8 |
| Plaster or gypsum board ceiling with insulation in space above ceiling | 13 | 13 |
| Plaster direct to concrete | 0 | 0 |

as "lagging". Lagging amounts to wrapping the pipe with a flexible sound barrier material in such a way that no seams exist to permit an acoustic leak. This is accomplished by overlapping the barrier material at the places where one piece ends and another begins, also overlapping the two ends of each piece at the point where they wrap back on each other. These seams should then be secured with duct tape so that the barrier remains properly in place.

To realize full benefit of the lagging, the barrier must not touch the pipe it is covering. Any direct connection between the lagging and the pipe will cause the lagging to vibrate as well, and reduce its effectiveness as a sound barrier. This incidently also holds for any enclosure around a noise source. The lagging can be effectively "floated" away from the pipe wall by first wrapping the pipe with a layer of foam, fiberglass, or other porous material that acts both as a vibration isolator, and sound absorber, and even increases the transmission loss in the higher frequencies. The outer layer of barrier material can be made of any limp impermeable membrane such as thin sheet metal, asphalted paper, rubber, lead loaded vinyl, lead sheet, etc. The heavier and limper the better, just as with any barrier application (see figures for Data Table 45 for application).

The means of determining how much reduction in sound level can be achieved by such treatment is a little more difficult to determine than for a wall or enclosure because of the different types of acoustical data that are encountered. Some items that are useful as lagging materials such as leaded vinyl may also be useful as a hanging curtain or as a plug to close some opening. Consequently, the manufacturer of these items has tested them for transmission loss in the usual way between two reverberation rooms. This provides a good measure of the sound barrier capability of the material, but requires that one knows the sound pressure level very close to the pipe along its length and the absorption in the surrounding space. Some manufacturers actually mount their material on a piece of test pipe and determine the noise reduction of the covering by measuring the sound pressure level inside the pipe and in the space outside the lagging. To use these data requires that the sound pressure level inside the pipe, the sound pressure level produced by the pipe vibrations, and the absorption in the surrounding space be known.

Some measurements are made with a test pipe in a reverberation room with a noise source of some kind inside the pipe. Measurements are made in the room with only the bare pipe and again after the pipe is lagged. This measurement is called "Insertion Loss", i.e., the loss of sound pressure level due to the insertion of the item under test. This is the same technique as used for mufflers and other such devices.

Since these insertion loss data are so much more meaningful and easier to use, there is presently under consideration by ASTM a standard test procedure for pipe lagging. Hopefully, in the near future the new data generated by this method will be available for use.

In pipes in which there is some fluid flowing, the sound source may be more than the noise of the fan, blower, or whatever. The turbulent fluid flow also creates noise which can travel far downstream from the source. The noise making item is usually connected to the following piping so that when the fluid-borne sound causes the pipe to vibrate, the vibration of the noise source is also transmitted along the pipe walls. Any or all of these vibrations can result in an increased sound power output of the piping system. It is therefore recommended that flexible pipe connections be inserted every so often in the pipe to prevent the passage of the pipe wall vibration to the next section of pipe. Prevention of such vibration paths, or short circuits, can be very helpful in reducing the amount of attenuation required in the succeeding section of piping.

## I-4.3—NOISE CONTROL BY COMBINATION OF ABSORPTION AND BARRIER

### I-4.3.1—Walls and Enclosures

Walls are usually thought of as sound barriers, but they are also a place to mount sound absorbent materials. It has been discussed how walls introduce a transmission loss into the paths of the sound from source to receiver, and how the barrier property is enhanced by proper use of absorption in the receiving space. Generally a wall behaves according to the mass law as a barrier but this predicted mass law can be exceeded if proper design techniques are incorporated, such as using double wall. Even this double wall construction can be enhanced as a sound barrier if the space between the two sides is filled with a sound absorbing material, or more limp mass can be added by simply hanging a piece of sheet lead or leaded vinyl in the space. All of these techniques have been in use for some time such that many constructions are available.

The capability of obtaining tremendous sound transmission loss through a wall still has a weakest link. All too often the effectiveness of a wall is reduced or even destroyed by careless inclusion of poor sound barrier windows and doors or even an open leak somewhere in an otherwise impermeable wall. (See example in Subsection I-4.2.3.2.)

Not only does the weakest link reduce our effectiveness but flanking is a reality that cannot be overlooked. If a sound barrier is to be installed then someone is concerned enough about it to spend the time and money. It only seems reasonable that the installation should produce its best results. No portion of the noise source should touch the barrier, and the barrier should be isolated from other surfaces that extend beyond it. For example, even when simply putting an enclosure over a noisy machine, the enclosure should not be mounted directly to the floor even if the machine is on vibration isolation mounts. There may still be some vibration in the floor and that, when coupled with the wall and the noise inside, can result in a loss of effectiveness.

Also, with enclosures one must be concerned with buildup of the sound pressure level within the enclosure and the room constant. For example, let an enclosure be placed at a position 10 ft from a noise source, and over the frequency range of interest let the transmission loss of the material be 30 dB. If the sound pressure level is measured at this position one might at first expect the level to be reduced by 30 dB. This is not the case, however. When the enclosure is built around the noise source it becomes a new room with its own room constant which will be different from that of the original space. If the original space is a very large room or outdoors such that the sound field is essentially that of a free field, the sound pressure level at the 10 ft position will be approximately 28 dB below the sound pressure level of the source (see Figure I–17). If the enclosure is now constructed out of a highly reflecting material such as steel, a reverberation field is set up inside the enclosure. If the room constant of the enclosure is now determined to be 500 the sound pressure level at the enclosure wall on the inside will be only 20 dB below the sound pressure level at the source, or 8 dB greater than the original measurement. Thus the transmission loss of the panel will be 30 dB below this new value and the overall reduction on the outside of the wall will only be 22 dB and not the 30 dB that was anticipated.

This sound pressure buildup inside the enclosure can cause an effective decrease in sound transmission loss of up to 10 dB. It is for this reason that enclosures are normally lined with a sound absorbent material in order to increase the room constant of the enclosure.

It should be noted, however, that not in any case can the use of acoustical treatment inside a room reduce the sound pressure level at a point below that of the direct path transmitted wave. This wave is the free field wave which represents the minimum achievable sound pressure level that can be obtained without using a sound barrier between the source and the receiver.

When using an enclosure to reduce the noise transmitted from a sound source, the importance of leaks cannot be overemphasized. A very small area of low transmission loss can greatly reduce the effectiveness of the surface. If, for example, a panel with a transmission loss of 50 dB, 4-ft wide by 8-ft long is installed with 0.1-inch crack around the edge, the effective transmission loss is reduced to approximately 22 dB.

The effects of a freestanding wall as a sound barrier depend on the frequency of the sound, the height, and the location of the wall. The frequency dependence is such that the dimensions of the wall or barrier must be very much larger than the wavelength of the lowest frequency of interest. Just as with absorption and transmission loss, the higher frequencies are more significantly affected. When the dimensions are small compared to a wavelength the sound wave merely diffracts over the top or around the edges and the attenuation is negligible.

For the maximum effect the wall should be as high and as near to the sound source or receiver as possible. When considering the use of a wall as a sound barrier the relative positions of the source and the observer must be taken into account. Also, it is possible that the side of the wall toward the noise source may need to be lined with an absorbent material so that reflected sound waves do not increase the sound pressure level on this side.

I–4.3.2—Ducts and Piping

When noise from an air duct must be reduced the usual procedures of absorption and transmission loss are used. A lining of an absorption type material not only reduces the sound pressure level observed outside the duct but also attenuates the sound waves that are propagating along the inside of the duct. For these sound waves the attenuation due to an absorbent type lining, per Equation (63),

$$\text{Attenuation} = 12.6 \frac{P}{A} \alpha^{1.4} \text{ dB/ft}$$

where $P$ is the perimeter in inches, $A$ is the cross-sectional area in square inches, and $\alpha$ is the absorption coefficient of the liner material. This empirical relationship has been found to predict the attenuation to within 10 percent over a limited range of duct size, absorption coefficient and frequency of the sound. For cases outside these ranges many techniques are available for reducing the sound pressure level. These techniques include the use of mufflers, tuned absorbers, bends, restrictions, special design of the duct liner plenums, etc.

To limit the noise transmitted through the pipe walls, a limp, massive, impermeable covering over some porous sound absorbing material can produce significant insertion loss. Vibration breaks in the length of the pipe or duct also serve to stop the flow of vibrational energy along the length of the piping.

Piping connected to vibrating machinery such as a compressor should be isolated by flexible couplings, or isolation hangers as shown in Figure I–30. The use of additional

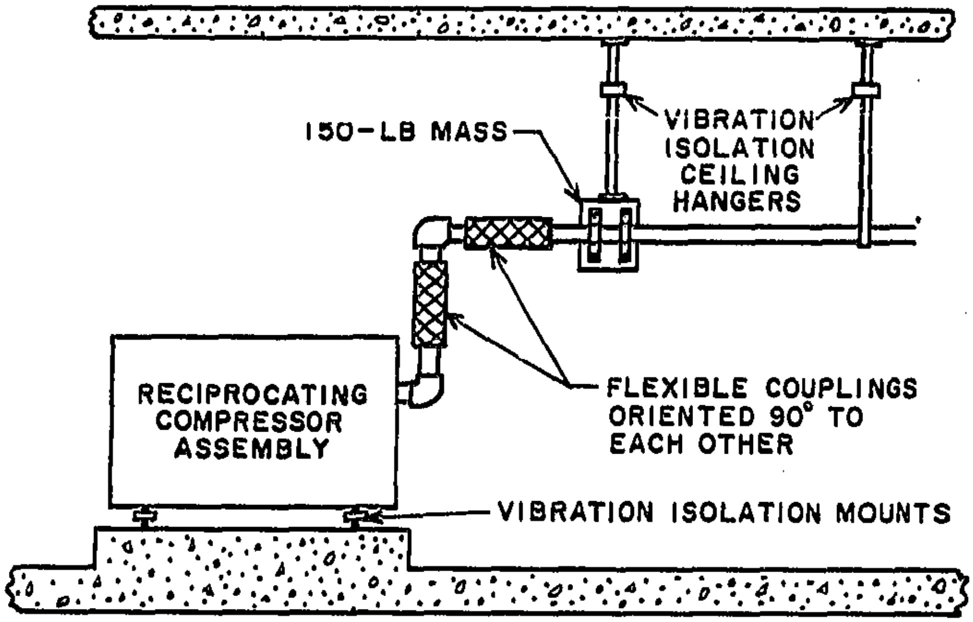



FIGURE I-30.—Vibration Isolation of Compressor Piping.

mass to further reduce vibrations is also shown. The compressor itself is mounted on vibration isolators. Where this is insufficient, the floor itself should be isolated from adjacent building structures as shown in Figure I-31. Such isolation may also be used for offices adjacent to production areas.

Noise generated by machinery can be reduced in adjacent work areas by the use of barriers (Figure I-32). Acoustic absorbent lining on such barriers on the side toward the source will increase this effectiveness. Reductions of 5 to 10 dB in the low frequency range and 20 dB in the high frequency range can be achieved. Much larger attenuation is obtained with a complete enclosure. These require well-designed access doors and observation windows. In any noise control application, while the required sound pressure level reduction will be the prime determiner of the acoustic treatment necessary, one should not overlook such items as the following:

space limitation,
weight limitation,
cost limitation,
exposure to damage by moving objects (e.g., lift trucks),
requirements for ventilation and maintenance,
weather exposure,
temperature environment, and
lifetime of the material under above situations.

## I-5—SELECTED PUBLICATIONS FOR FURTHER READING

### I-5.1—BOOKS ON ACOUSTICS AND NOISE CONTROL

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE); "Guide and Data Book, Systems", Chapter 33, Sound and Vibration (1970)

Beranek, L. L.; "Noise and Vibration Control", McGraw-Hill, New York (1971)

Beranek, L. L.; "Noise Reduction", McGraw-Hill, New York (1960)

Beranek, L. L., "Acoustics", McGraw-Hill, New York (1957)

Beranek, L. L.; "Acoustic Measurements", McGraw-Hill, New York (1949)

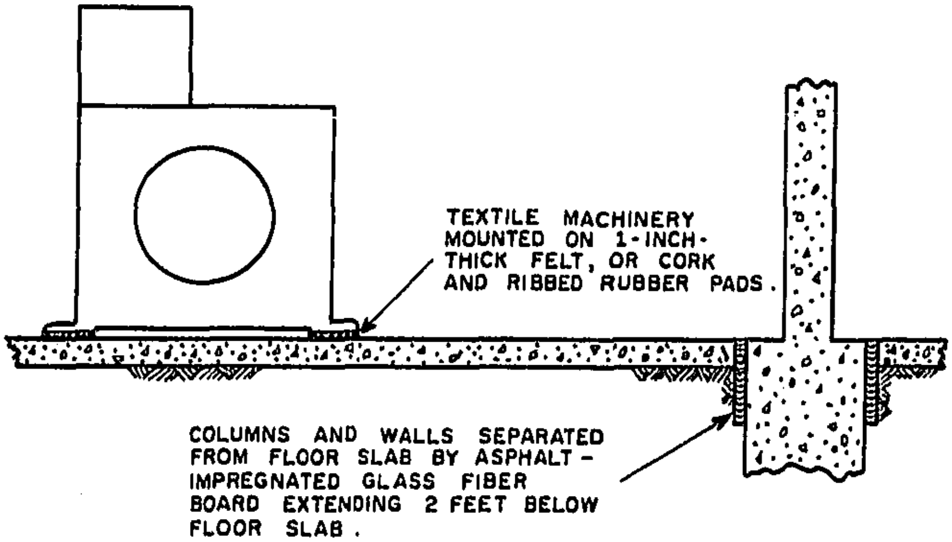



**FIGURE I-31.—Vibration Break in Building Structure to Reduce Transmission of Vibrations.**


Berendt, R. D.; Winzer, G. E.; Burroughs, C. B.; "A Guide to Airborne, Impact, and Structure-Borne Noise Control in Multifamily Housing", prepared by National Bureau of Standards for Federal Housing Administration, U. S. Govt. Printing Office, Washington, D. C. (1967)

Berendt, R. D.; Winzer, G. E.; "Sound Insulation of Wall, Floor, and Door Constructions", National Bureau of Standards Monograph 77 (Nov. 1964)

Bolt, R. H.; Lukasik, S. J.; Nolle, A. W.; Frost, A. D.; "Handbook of Acoustic Noise Control", WADC Technical Report 52-204, Vol. 1, USAF Wright Air Development Center, Ohio (Dec. 1952)

Bolt, R. H.; Lukasik, S. J.; Nolle, A. W.; Frost, A. D.; "Handbook of Acoustic Noise Control", WADC Technical Report 52-204, Vol. 1, Supplement 1, USAF Wright Air Development Center, Ohio (1955)

Broch, J. T.; "The Application of the Brüel and Kjaer Measuring Systems to Acoustic Noise Measurements", Brüel and Kjaer Instruments (Jan. 1971)

Bruel, P. V.; "Sound Insulation and Room Acoustics", Chapman and Hall Ltd., London (1951)

Close, P. D.; "Sound Control and Thermal Insulation of Buildings", Reinhold Publishing Corp., New York (1966)

Egan, "Concepts in Architectural Acoustics", McGraw-Hill, New York

Harris, C. M.; "Handbook on Noise Control", McGraw-Hill, New York (1957)

Hunter, "Acoustics", Prentice-Hall, Englewood Cliffs, N. J. (1962)

"Industrial Noise", Public Health Service Bulletin 1572, U. S. Govt. Printing Office (1967)

Ingerslev, "Acoustics in Modern Building Practice", Architectural Press, London (1952)

Kinsey, B. Y.; "Environmental Technologies in Architecture", Prentice-Hall (1965)

Kinsler, L. E.; Frey, A. R.; "Fundamentals of Acoustics", Wiley, 2nd ed. (1962)

Knudsen, V. O.; "Architectural Acoustics", Wiley, London (1947)

Kryter, K. D.; "Effects of Noise on Man", Academic Press, New York (1970)

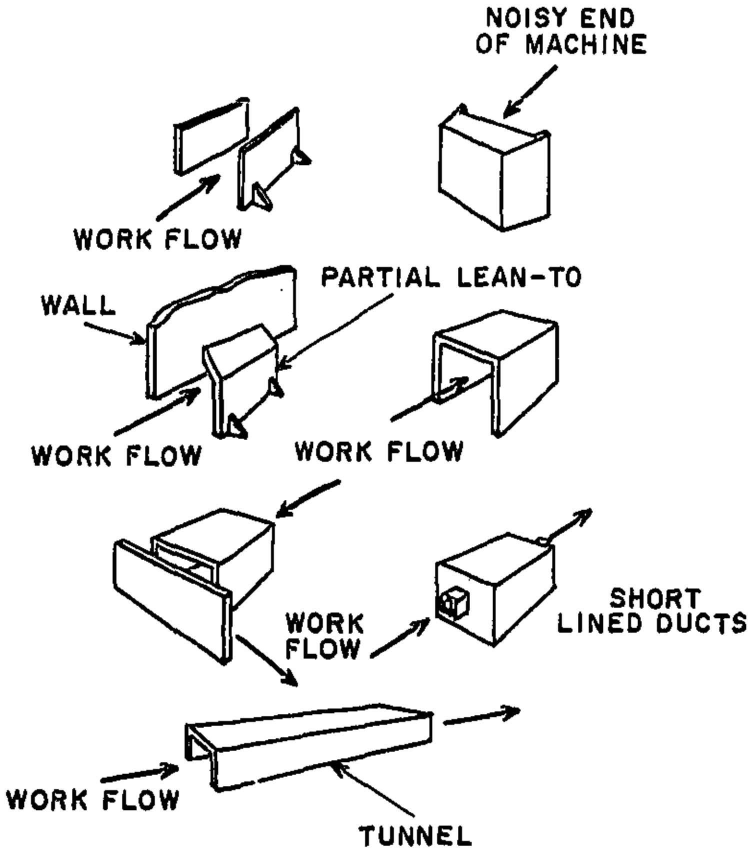



FIGURE I-32.—Typical Barriers for Partial Noise Control in Work Areas.

Meyer, H. B.; Goodfriend, L. S.; "Acoustics for the Architect", Reinhold, New York (1957)

NBS Sound Section Staff, "Sound Insulation of Wall and Floor Constructions", Building Materials and Structures Report 144, National Bureau of Standards (Feb. 1955)

Olsen, H. F.; "Acoustical Engineering", D. Van Nostrand, New Jersey (1957)

Parkin, P. H.; Humphreys, H. R.; "Acoustics, Noise and Buildings", F. A. Praeger Publishers, New York (1958)

Parkin, P. H.; Purkis, H. J.; Scholes, W. E.; "Field Measurements of Sound Insulation between Dwellings", Her Majesty's Stationery Office, London (1960)

Peterson, A.P.G.; Gross, E. E. Jr.; "Handbook of Noise Measurement", General Radio Company (1972)

Purkis, H. J.; "Building Physics: Acoustics", Pergammon Press (1966)

Rettinger, M.; "Acoustics, Room Design and Noise Control", Chemical Publishing Co., New York (1968)

Richardson, E. G., Ed.; "Technical Aspects of Sound", Vol. 1, Elsevier Publishing Co., New York (1953)

Sabine, H. J.; "Less Noise, Better Hearing", The Celotex Corporation

Smith, "Acoustics", Elsevier, Amsterdam, New York

Stevens and Bates, "Acoustics and Vibrational Physics", Edward Arnold Ltd., London (1966)

Thumann, A.; Miller, R. K.; "Secrets of Noise Control", Fairmont Press, Atlanta, Ga. (1974)

Yerges, L. F.; "Sound, Noise and Vibration Control", Van Nostrand Reinhold, New York (1969)

## I-5.2—PERIODICAL REFERENCES

This compilation comprises 239 papers on acoustic tests performed on building materials, and noise control. In the search following sources were examined:

1. Shock and Vibration Digest: Jan. 1969-Feb. 1973
2. J. Acoust. Soc. America
3. J. Sound and Vibration: July 1964-July 1972
4. S/V Sound and Vibration: Jan. 1966-June 1973
5. Acustica: Jan. 1966-June 1972
6. Nat'l Res. Council, Canada. List of publications (1947-71)

In addition, pertinent references listed in each article were included.

### I-5.2.1—Acoustic Materials

| | |
|---|---|
| Wood | Brick |
| Fabric Materials | Glass |
| Felt | Lead |
| Foams | Steel |
| Plastics | Metal Fibers |
| Porous Materials | Sandwich Construction |
| Concrete | General |

#### WOOD

Heebink, T. B.; Grantham, J. B.; "Field/Laboratory STC Ratings of Wood-Framed Partitions", S/V Sound and Vibration, *5*(10), pp 12-16 (Oct. 1971)

Godshall, W. D.; Davis, J. H.; "Acoustical Absorption Properties of Wood-Base Panel Materials", Forest Products Journal, *104*, p 8 (1969)

#### FABRIC MATERIALS

Kath, Von u.; "Der Einfluss Der Bekleidung Auf Die Schallabsorption Von Einzelpersonen", (The Influence of Clothes on the Sound Absorption of Individual Persons), Acustica, *17*(4), pp 234-237 (1966)

"Acoustical Drapery", J. Acoust. Soc. Amer., *47*(4), pp 971-972 (1970)

Lebedeva, I. A.; Nesterov, V. S.; "Acoustical Parameters of a Lightweight Perforated Membrane", Soviet Physics-Acoustics, *10*(3), pp 269-275 (1964)

Kingsbury, H. F.; Wallace, W. J.; "Acoustic Absorption Characteristics of People", S/V Sound and Vibration, *2*(12), pp 15-16 (Dec. 1968)

#### FELT

Tyzzer, F. G.; Hardy, H. C.; "The Properties of Felt in the Reduction of Noise and Vibration", J. Acoust. Soc. Amer., *19*(5), pp 872-877 (Sept. 1947)

Utley, W. A.; et al; "The Use of Absorbent Material in Double-Leaf Wall Constructions", J. Sound and Vib., *9*(1), pp 90-96 (Jan. 1969)

#### FOAMS

"Acoustical Foams for Sound Absorption Applications", S/V Sound and Vibration, *11*(7), pp 12-16 (July 1970)

Gardinier, R. E.; et al; "Acoustical Foams for Sound Absorption Applications", S/V Sound and Vibration, *4*(7), pp 12-16 (July 1970)

"S/V Observer; Noise Control in the F-111", S/V Sound and Vibration, *2*(8), p 4 (Aug. 1968)

#### PLASTICS

Betzhold, Von. C.; Kurz, K.; "Schalldammstoffe Aus Kunstoff", (Plastic for Sound Insulation), Acustica, *26*(3), pp 162-165 (March 1972)

## POROUS MATERIALS

Mechel, Von F.; Royar, J.; "Experimentelle Untersuchungen Zur Therie Des Perosen Absorbers", ((Experimental Investigation of the Theory of Porous Absorbers), Acustica, *26* (2), pp 81-96 (Feb. 1972)

"Der Einfluss Von Materialeigenschaften, Insbesondere Von Gefugedichte Und-Steifigkeit Auf Das Schallisolations-Ver-Halten Poroser Absorber", 7th Intl. Congr. on Acoustics, Budapest, p 129 (1971)

## CONCRETE

Kihlman, T.; "Sound Transmission in Building Structures of Concrete", J. Sound and Vib., *11*(4), pp 435-455 (April 1970)

Ward, F. L.; Randall, K. E.; "Investigation of Sound Isolation of Concrete Slab Floors", J. Sound and Vib., *3*(2), pp 205-215 (March 1966)

Noll, Von, G. G.; "Die Frequenzabhangigkeit Der Komplexen Elastizitatskonstanten Einiger Baustoffe Zwischen etwa 5 und 100 kHz", (Frequency Dependency of Complex Elastic Constants of Some Building Materials between Approximately 5 and 10 kHz), Acustica, *24*(2), pp 93-100 (Feb. 1971)

Kohasi, Y.; "Sound Absorption Characteristics of a Hollow Concrete Block with a Slotted Face", Report in the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III Paper E-3-5 (1968)

## BRICK

Noll, Von. G. G.; "Die Frequenzabhangigkeit Der Komplexen Elastizitatskonstanten Einiger Baustoffe Zwischen etwa 5 und 100 kHz", (Frequency Dependency of Complex Elastic Constants of Some Building Materials between Approximately 5 and 100 kHz), Acustica, *24*(2), pp 93-100 (Feb. 1971)

## GLASS

Bhandari, P. S.; Balachandran, C. G.; Krishnan, P. V.; "Functional Sound Absorbers and Noise Reduction in a Cafeteria", Indian J. Tech., *3*(11), pp 345-350 (Nov. 1965)

Noll, Von. G. G.; "Die Frequenzabhangigkeit Der Komplexen Elastizitatskonstanten Einiger Baustoffe Zwischen etwa 5 und 100 kHz", (Frequency Dependency of Complex Elastic Constants of Some Building Materials between Approximately 5 and 100 kHz), Acustica, *24*(2), pp 93-100 (Feb. 1971)

Eisenberg, A.; Quenett, R.; "Sound Reduction by Multilayered Glass Thermopanes", (Schalldammung von Doppelscheiben Aus Mehrschichtglasern), 7th Intl. Congr. on Acoustics, Budapest, p 81 (1971)

"Functional Acoustic Absorbers", S/V Sound and Vibration, *3*(7), p 4 (July 1969)

## LEAD

Eisenberg, A.; Quenett, R.; "Schalldammung von Doppelscheiben Aus Mehrschichtglasern", (Sound Reduction by Multilayered Glass Thermopanes), 7th Intl. Congr. on Acoustics, Budapest, p 81 (1971)

Ostergaard, P. B.; Cardinell, R. L.; Goodfriend, L. S.; "Transmission Loss of Leaded Building Materials", J. Acoust. Soc. Amer., *35*(6), pp 837-843 (June 1963)

Meier, A. V.; "Application of Lead for Sound Insulating Partitions", S/V Sound and Vibration, *1*(5), pp 14-19 (May 1967)

Meteer, C. L.; "Application of Lead-Vinyl Noise Barriers in Transportation Equipment", SAE Paper No. 720222, pp 1-7

## STEEL

Noll, Von., G. G.; "Die Frequenzabhangigkeit der Komplexen Elastigitatskonstanten Einiger Baustoffe Zwischen etwa 5 und 100 kHz", (Frequency Dependency of Complex Elastic Constants of Some Building Materials between Approximately 5 and 100 kHz), Acustica, *24*(2), pp 93-100 (Feb. 1971)

## METAL FIBERS

Karplus, H. B.; et al; "Noise and Vibration Control with Fiber Metallurgy", J. Soc. Japan, *10*(5), pp 209-217 (Nov. 1964)

## SANDWICH CONSTRUCTION


Choudhury, N. K. D.; Bhandari, P. S.; "Impact Noise Rating of Resilient Floors", Acustica, *26*(3), pp 135-140 (March 1972)

Chen, Y. N.; "Influence of the Space in the Acoustic Sandwich Sheet 'Rockwool, Foil, Perforated Plate' on the Sound Absorption Capacity", 7th Intl. Congr. on Acoustics, Budapest, p 241 (1971)

Burns, J. J.; "The Use of Asphalt-Mastics for Acoustical Damping", S/V Sound and Vibration, *6*(10), pp 4, 6, 8 (Oct. 1972)

Toyoda, H.; Hayek, S.; "Attenuation of Acoustic Waves by Composite Plates", J. Sound and Vib., pp 103-113 (Jan. 1971)

Higgs, R. W.; Eriksson, L. J.; "Acoustic Attenuation in Composite Materials", J. Acoust. Soc. Amer., *50*(1), pp 306-309 (July 1971)

Heebink, T. B.; Grantham, J. B.; "Field-Laboratory STC Ratings of Wood-Framed Partitions", S/V Sound and Vibration, *5*(10), pp 12-16 (Oct. 1971)

Utley, W. A.; Cummings, A.; Parbrook, H. D.; "The Use of Absorbent Material in Double-Leaf Wall Constructions", J. Sound and Vib., *9*(1), pp 90-96 (Jan. 1969)

Braunisch, Von H.; "Vibration Damping by Three-Layered Sandwich Systems", Acustica, *22*(5), pp 136-144 (1969)


## GENERAL


Szudrowicz, B.; Zuchowicz, I.; "Uber Bezeichnung der Akustischen Eigenschaften von Werkstoffen und Konstruktionen auf Grund von Messungen an Kleinen Proben", (Specification of Acoustical Properties of Structural Materials and Construction on the Basis of Small Test Models), 7th Intl. Congr. on Acoustics, Budapest (1971)

Callaway, D. B.; Ramer, L. G.; "The Use of Perforated Facings in Designing Low Frequency Resonant Absorbers", J. Acoust. Soc. Amer., *24*(3), pp 309-312 (May 1952)

"Acoustical Ceilings", Contr. Spec. Inst., Monograph 09M531 (June 1970)

Scott, H. L.; "The Performance of Sound Absorbers in a Radial Diffuser Configuration", J. Sound and Vib., *19*(4), pp 445-451 (Dec. 1971)

"How to Select Acoustical Materials," Acoustical Materials Assn., 7, pp 187-188 (July 1965)

Waller, R. A.; "The Performance and Economics of Noise and Vibration Reducing Materials in the Construction Industry", J. Sound and Vib., *8*(2), pp 177-185 (Sept. 1968)

Lindblad, S.; "Impact Sound Characteristics of Resilient Floor Coverings with Linear and Nonlinear Dissipative Compliance", 7th Intl. Congr. on Acoustics, Budapest (1971)

Svensson, J.; "Impact Noise Reduction Predicted from Samples on Flooring Materials", 7th Intl. Congr. on Acoustics, Budapest, p 60 (1971)

Borisov, L. A.; "Experimental Investigation of the Effectiveness of Sound-Absorbent Coatings", Soviet Phys. Acoust., *11*(4), pp 366-372 (1966)

Mallik, A. K.; et al; "Improvement of Damping Characteristics of Structural Members with High Damping Elastic Inserts", J. Sound and Vib., *27*(1), pp 25-36 (Mar. 1973)

Yerges, L. F.; "The Use of Acoustical Absorbents in Industrial Noise Control", S/V Sound and Vibration, *6*(9), pp 31-32 (Sept. 1972)

Emme, J. H.; "Composite Materials for Noise and Vibration Control", S/V Sound and Vibration, *4*(7), pp 17-21 (July 1970)

"Lead-Vinyl Fabric Shuts out Noise", Materials in Design Engineering, *64*(4), pp 27-29 (Oct. 1966)

"Functional Panels Control Noise", S/V Sound and Vibration, *3*(7), pp 4, 6 (July 1969)

"Grass Makes a Good Sound Absorber", S/V Sound and Vibration, *3*(5), p 10 (May 1969)

Brilloin, J.; "Sound Absorption by Structures with Perforated Panels", S/V Sound and Vibration, *2*(7), pp 6-22 (July 1968)

Pancholy, M.; Bindal, V. N.; "Transmission Loss Studies in Granular Materials", Acustica, *17*(1), pp 51-55 (1966)

Duggar, B. C.; "Special Sound Absorptive Materials in Noise Control", Amer. Industrial Hygiene Assn. J., *20*, pp 447-452 (Dec. 1959)

## I-5.2.2—BUILDINGS AND BUILDING COMPONENTS

- Houses and Buildings
- Rooms
- Walls and Partitions
- Panels
- Floors
- Ceilings
- Doors and Windows
- Fences and Other Noise Barriers
- Effects of Structural Elements
- Architectural Acoustics
- Standards

### HOUSES AND BUILDINGS

Young, J. R.; "Attenuation of Aircraft Noise by Wood-Sided and Brick-Veneered Frame Houses", Stanford Research Inst., NASA CR-1637

Pretlove, A. J.; "The Transmission of Outdoor Noises into Buildings", Environmental Engineers, *43*, pp 7-10 (March 1970)

Hardy, A. D.; Lewis, P. T.; "Sound Insulation Standards for Buildings Adjacent to Urban Motorways", J. Sound and Vib., *15*(1), pp 53-59 (Mar. 1971)

"Engineering Outline 113; Sound Insulation in Buildings", Anon. Engineering, *205*(5314), pp 307-310 (1968)

Siekman, W., Jr.; "Architectural Acoustics (A Problem of Measurement)", Frontier, *3*, pp 16-21 (Autumn 1966)

Sato, H.; "On the Outdoor Noise Insulation of Dwellings Particularly on the Results of Field Measurements", Reports of the 6th Intl. Congr. on Acoustics, Vol. IV, Paper F-5-16, Tokyo (1968)

Ingemansson, S.P.N.; "The Calculation of Sound Insulation in a Building", Reports of the 6th Intl. Congr. on Acoustics, Vol. III, Paper E-4-7, Tokyo (1968)

Ellwood, E.; "The Anatomy of a Wall", S/V Sound and Vibration, *6*(6), pp 14-18 (June 1972)

Kihlman, T.; "Transmission of Structure-Borne Sound in Buildings", Natl. Swedish Inst. of Building Research, Box 27163, Stockholm 27, Report 9-1967

### ROOMS

Harris, C. M.; "Acoustical Design of the John F. Kennedy Center for the Performing Arts", J. Acoust. Soc. Amer., *51*(4), pp 1113-1126 (April 1972)

"Acoustical Drapery", J. Acoust. Soc. Amer., *47*(4), pp 971-972 (1970)

Sarkov, N.; Petrov, K.; "Ober Absorptionsgradmessungen in Hallraum", (Measurement of Degree of Absorption in Halls), 7th Intl. Congr. of Acoustics, Budapest, p. 189 (1971)

Lazar, D.; "Schallschluckendre Modulelemente", Intl. Congr. on Acoustics, Budapest, p 249 (1971)

Kihlman, T.; "Sound Radiation into a Rectangular Room. Applications to Air-Borne Sound Transmission in Buildings", Acustica, *18*(1), pp 11-20 (1967)

Eijk, J. van Den; "The New Dutch Code on Noise Control and Sound Insulation in Dwellings and its Background", J. Sound and Vib., *3*(1), pp 7-19 (Jan. 1966)

Bhandari, P. S.; Balachandran, C. G.; Krishnan, P. V.; "Functional Sound Absorbers and Noise Reduction in a Cafeteria", Indian J. Technol., *3*(11), pp 345-350 (1965)

Barron, M.; "Growth and Decay of Sound Intensity in Room According to Some Formulae of Geometric Acoustics Theory", J. Sound and Vib., *27*(2), pp 183-196 (March 1973)

### WALLS AND PARTITIONS

Utley, W. A.; Cummings, A.; Parbrook, H. D.; "The Use of Absorbent Material in Double-Leaf Wall Constructions", J. Sound and Vib., *9*(1), pp 90-96 (Jan. 1969)

Heebink, T. B.; Grantham, J. B.; "Field/Laboratory STC Ratings of Wood-Framed Partitions", S/V Sound and Vibration, *5*(10), pp 12-16 (Oct. 1971)

Meier, A. V.; "Application of Lead for Sound Insulating Partitions", S/V Sound and Vibration, *1*(5), pp 14-19 (May 1967)

Rettinger, M.; "Acoustic, Room Design and Noise Control", N. Y., p 386 (1968)

Harris, C. H.; "Reduction of Noise by Walls or Fences", Handbook of Noise Control, p 7, New York (1975)

Siekman, W.; "STC's and Room Dividers", Construction Specifier, pp 51-54 (Dec. 1971)

"Eine Dunne, Leichte Trennwand mit Hoher Schalldammung", (A Thin Lightweight Partition Wall High Sound Reduction), 7th Intl. Congr. on Acoustics, Proceedings 4, p 77, Budapest (1971)

Szudrowicz, B.; Zuchowicz, I.; "Uber Bezeichnung der Akustichen Eigenschaften von Werkstoffen und Konstruktionen Auf Grund Von Messungen an Kleinen Proben", (The Designation of Acoustic Properties of Materials and Constructions Based on Small Sample Measurements), 7th Intl. Congr. on Acoustics Proceedings 4, Budapest, p 141 (1971)

Ingemanson, S.; "Sound Insulation of Light Walls", 5th Intl. Congr. on Acoustics Proceedings, Liege (Sept. 1965)

Lindahl, R.; "The Use of Insulation Board in Walls of Gypsum and Wood Studs to Improve Airborne Sound Insulation", 5th Intl. Congr. on Acoustics Proceedings, Liege (Sept. 1965)

Zaborov, V. I.; "Normalization of the Acoustic Reduction in Buildings", Soviet Physics-Acoustics, *16*(1), pp 43-45 (July/Sept. 1970)

Donato, R. J.; "Sound Transmission through a Double-Leaf Wall", J. Acous. Soc. Amer., *51*(3), pp 807-815 (March 1972)

Kost, Von A.; "Modelluntersuchungen zur Theorie der Einfachwand", (Model Investigations on the Theory of Partition Walls), Acustica, *18*(6), pp 342-350 (1967)

"Zur Luftschalldammung von Einschaligen Wanden und Decken", (Airborne Sound Insulation of Single Partitions and Ceilings), *20*(6), pp 334-342 (1968)

Nilsson, A. C.; "Reduction Index and Boundary Conditions for a Wall between Two Rectangular Rooms. Part II: Experimental Results", Acustica, *26*(1), pp 19-23 (Jan. 1972)

Nilsson, A. C.; "Reduction Index and Boundary Conditions for Wall between Two Rectangular Rooms. Part I: Theoretical Results", Acustica, *26*(1), pp 1-8 (Jan. 1972)

Kihlman, T.; "Sound Transmission in Building Structures of Concrete", J. Sound and Vib., *11*(4), pp 435-445 (April 1970)

Velizhanina, K. A.; et al; "Impedance Investigation of Sound Absorbing Systems in Oblique Sound Incidence", Soviet Physics-Acoustics, *17*(2), pp 193-197 (Oct./Dec. 1971)

Lord, P.; "Improved Sound Insulation of Double Leaf Partitions Using Absorbent Cavity Linings", Insulation, *10*(3), pp 122-123 (1966)

Von Meier, A.; "Sound Insulation of Stiff Lightweight Partitions", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-4-4 (1968)

Banuls-Terol, V.; "Composed Airborne Sound Isolation of Partitions under Suspended Ceilings", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-4-5 (1968)

Fader, B.; "Mass-Air Mass Resonance Monograph", S/V Sound and Vibration, *4*(8), p 25 (Aug. 1970)

Tseo, G. G.; "Estimating the Noise Reduction of Wall Structures of Enclosures", J. Acoust. Soc. Amer., *52*(6), Part 1, pp 1573-1578 (Dec. 1972)

## PANELS

Awaya, K.; Miyazaki, Y.; "A New Theory on the Edge Effect of Sound Absorbing Panels", 7th Intl. Congr. on Acoustics Proceedings 4, Budapest, p 245 (1971)

Ford, R. D.; Lord, P.; Walker, A. W.; "Sound Transmission through Sandwich Constructions", J. Sound and Vib., *5*(1), pp 9-21 (Jan. 1967)

Fang, G. T.; "Influence of Internal and Boundary Damping on Response of Panels to Random Excitations", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. IV, Paper F-4-9 (1968)

Kuga, S.; "On the Sound Transmission Loss of Sandwich Panels", Reports of the 6th Intl.

Congr. on Acoustics, Tokyo, Vol. III, Paper E-4-6 (1968)

## FLOORS

Ward, F. L.; Ranadall, K. E.; "Investigation of the Sound Isolation of Concrete Slab Floors", J. Sound and Vib., *3*(2), pp 205-215 (March 1966)

Choudhury, N. K. D.; Bhandari, P. S.; "Impact Noise Rating of Resilient Floors", Acustica, *26*(3), pp 135-140 (March 1972)

Ver, I. L., "Impact Noise Isolation of Composite Floors", J. Acoust. Soc. Amer., *50*(4), pp. 1043-1050 (Oct. 1971)

Ver, I. L.; "Relation between the Normalized Impact Sound Level and Sound Transmission Loss", J. Acoust. Soc. Amer., *50*(6), pp 1414-1417 (Dec. 1971)

Zaborov, V. I.; et al; "Reduction of Impact Noise by Flooring Materials", Soviet Physics-Acoustics, *12*(3), pp 263-265 (1967)

Choudhury, N. K. D.; "Impact Noise Transmission Through Floors", Indian J. Technol., *6*(7), pp 213-216 (1968)

Zaborov, V. I., "On the Transmission of Impact Noise through Single-Layer Floors", Akust. ZH., *14*(1), pp 127-128 (1968)

Larsen, J.; "Transmission Loss of Double Door Constructions", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper P-0-14 (1968)

Matsui, M.; et al; "Sound Absorption Characteristics on an Acoustic Ceramic Tile", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-3-7 (1968)

Northwood, T. D.; Clark, D. M.; "Frequency Considerations in the Subjective Assessment of Sound Insulation", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-3-8 (1968)

Ellwood, E.; "The Anatomy of a Wall", S/V Sound and Vibration, *6*(6), pp 14-18 (June 1972)

DeBiase, J. L.; "Criteria and Design Specifications for Plant Noise Control", S/V Sound and Vibration, *6*(9), pp 26-30 (Sept. 1972)

Barton, C. K.; "A Single Number Rating for Effective Noise Reduction", S/V Sound and Vibration, *7*(2), pp 23-25 (Feb. 1973)

Heebink, T. B.; Grantham, J. B.; "Field/Laboratory STC Ratings of Wood-Framed Partitions", S/V Sound and Vibration, *5*(10), pp 12-16 (Oct. 1971)

Siekman, W.; et al; "A Simplified Field Sound Transmission Test", S/V Sound and Vibration, *5*(10), pp 17-21 (Oct. 1971)

"Standards and Codes", S/V Sound and Vibration, *5*(2), pp 4-5 (Feb. 1971)

"Airport Operators Quit Noise Abatement Council", S/V Sound and Vibration, *2*(3), p 4 (March 1968)

## CEILINGS

Gosele, Von K.; "Zur Luftschalldammung Von Einschaligen Wanden und Decken", (Airborne Sound Insulation of Single Partitions and Ceilings), Acustica, *20*(6), pp 334-342 (1968)

Donato, R. J.; "Insulating Houses against Aircraft Noise", J. Acoust. Soc. Amer., *53*(4), pp 1025-1027 (April 1973)

## DOORS AND WINDOWS

"Zur Bewertung der Schalldemmung Von Fenstern", (The Evaluation of Sound Damping by Windows), 5th Intl. Congr. on Acoustics Proceedings, Liege (Sept. 1965)

"Schalldammung Von Doppelscheiben Aus Mehrschichtglasern", (Sound Reduction by Double Pane Windows of Multilayered Glass), 7th Intl. Congr. on Acoustics Proceedings 4, Budapest (1971)

Kiss, L. G.; "Ober Einige Akustischen Probleme Von Schalldammenden Turen und Fenstern in Studios", (Several Acoustic Problems on Sound Reducing Doors and Windows in Studios), 7th Intl. Congr. on Acoustics, Budapest (1971)

## FENCES AND OTHER NOISE BARRIERS

Rettinger, M., "Fences and Other Noise Barriers", New York (1968)

Harris, C. H.; "Reduction of Noise by Walls or Fences", Handbook of Noise Control, New York (1957)

Scholes, W. E.; Salvidge, A. C.; Sargent, J. W.; "Field Performance of a Noise Barrier", J. Sound and Vib., *16*(4), pp 627-642 (June 1971)

**EFFECTS OF STRUCTURAL ELEMENTS**

Bhandari, P. S.; Balachandran, C. G.; Krishnan, P. V.; "Functional Sound Absorbers and Noise Reduction in a Cafeteria", Indian J. Technol., *3*(11), pp 345-350 (1965)

Focsa, V.; Biborosch, L. D.; "Untersuchung der Schalldammung in Bauteilen Mit Hilfe Einer Impulsmethode", (Investigation of Sound Reduction of Structural Elements with the Help of an Impulse Method), 7th Intl. Congr. on Acoustics, Budapest (1971)

Lazar, D.; "Schallschluckendre Modulelelemente", (Sound Absorbing Modular Elements), 7th Intl. Congr. on Acoustics, Budapest (1971)

**ARCHITECTURAL ACOUSTICS**

Eijk, J. V. D.; "The New Dutch Code on Noise Control and Sound Insulation in Dwellings and Its Background", J. Sound and Vib., *3*(1), pp 7-19 (Jan. 1966)

Harris, C. M.; "Acoustical Design of the John F. Kennedy Center for the Performing Arts, J. Acoust. Soc. Amer., *51*(4), pp 1113-1126 (April 1972)

"Ober Einige Akustischen Probleme Von Schalldammenden Turen und Fenstern in Studios", (Several Acoustic Problems on Sound Reducing Doors and Windows in Studios), 7th Intl. Congr. on Acoustics, Budapest (1971)

Ishill, K.; "Architectural Acoustics of Steel Pavillion at Expo '70 in Alaska", 7th Intl. Congr. on Acoustics, Budapest (1971)

**STANDARDS**

Siekman, W.; "STC's and Room Dividers", Construction Specifier, pp 51-54, (Dec. 1971)

Kryter, K. D.; "Acoustical Society of America Policy on Noise Standards", J. Acoust. Soc. Amer., *51*(3), pp 803-806 (March 1972)

Meyer, A. F.; "The Need for Standards on Noise", J. Acoust. Soc. Amer., *51*(3), pp 800-802 (March 1972)

Heebink, T. B.; Granthan, J. B.; "Field/Laboratory STC Ratings of Wood-Framed Partitions", S/V Sound and Vibration, *5*(10), pp 12-16 (Oct. 1971)

Guinter, J. M.; "Action Plan for Product Noise Reduction", S/V Sound and Vibration, *6*(12), pp 18-22 (Dec. 1972)

"AGMA Standard Specification for Measurement of Lateral Vibration on High Speed Helical and Herringbone Gear Units", S/V Sound and Vibration, *7*(6), p 20 (June 1973)

Thoma, F. A.; "Vibration Limits for High-Speed Gear Units", S/V Sound and Vibration, *7*(6), p 20 (June 1973)

## I-5.2.3—INDUSTRIAL AND MACHINERY NOISE

Machinery and Equipment
Ducts
Appliances
Traffic Noise
General

**MACHINERY AND EQUIPMENT**

Hardy, H. C.; Bishop, D. E.; "Evaluation of Equipment Noise", ASHRAE Journal Section Heating, Piping & Air Conditioning, pp 137-141 (Sept. 1955)

Callaway, D. B.; "Reducing Noise in Machines", Machine Design, pp 1-8 (Dec. 1951)

Potter, S. M.; Hardy, H. C.; "General Principles of Reducing Noise in Machinery", Noise Control, *1*(5), pp 43-48 (Sept. 1955)

Sanders, G. J.; "Noise Reduction in Machinery", Noise Control, *3*(6), pp 29-37 (Nov. 1957)

Sperry, W. C.; Sanders, G. J.; "Quiet Blades for 18-Inch Rotary Type Power Lawn Mowers", Noise Control, *5*(3), pp 26-31 (May 1959)

Badgley, R. H.; "Mechanical Aspects of Gear-Induced Noise in Complete Power Train Systems", ASME Paper 70-WA/DGP-1

Diboll; "The Measurement and Prediction of Exhaust Frequencies in Large Internal Combustion Engines", ASME Paper 72-DGP-2

## DUCTS

Scott, H. L.; "The Performance of Sound Absorbers in a Radial Diffuser Configuration", J. Sound and Vib., *19*(4), pp 445-451 (Dec. 1971)

Hall, H. H.; "Laboratory Evaluation of Field Measurements of the Truck Exhaust Noise", J. Acoust. Soc. Amer., *26*(2), pp 216-220 (March 1954)

Sparks, C. R.; Lindgren, D. E.; "Design and Performance of High-Pressure Blowoff Silencers", ASME Paper 70-WA/PET-1

Davies, H. G.; Williams, J. E. F.; "Aerodynamic Sound Generation in a Pipe", J. Fluid Mech., *32*(4), pp 765-778 (1968)

"Coping with Control-Valve Noise", Chemical Engineering, pp 149-153 (Oct. 1970)

Callaway, D. B.; Tyzzer, F. G.; Hardy, H. C.; "Techniques for Evaluation of Noise-Reducing Piping Components", J. Acoust. Soc. Amer., *24*(6), pp 725-730 (Nov. 1952)

Callaway, D. B.; Tyzzer, F. G.; Hardy, H. C.; "Resonant Vibrations in a Water-Filled Piping System", J. Acoust. Soc. Amer., *23*(5), pp 550-553 (Sept. 1951)

Mariano, S. J.; "Sound Absorption in Lined Rectangular Ducts with Wall Shear Layers-Convergence of the Numerical Procedure to the Analytical Solution", J. Sound and Vib., *27*(1), pp 123-127 (March 1973)

Bokor, J.; "A Comparison of Some Acoustic Duct Lining Materials According to Scott's Theory", J. Sound and Vib., *14*(3), pp 367-373 (Feb. 1973)

Lansing, D. L.; et al; "Effects of Wall Admittance Changes on Duct Transmission and Radiation Sound", J. Sound and Vib., *27*(1), pp 85-100 (March 1973)

Candel, S. M.; "Acoustic Radiation from the End of a Two-Dimensional Duct, Effects of Uniform Flow and Duct Lining", J. Sound and Vib., *28*(1), pp 1-13 (May 1973)

Hirata, Y.; et al; "Influence of Airflow on the Attenuation Characteristics of Resonator Type Mufflers", Acustica, 28(2), pp 115-120 (Feb. 1973)

Audette, R. R.; McCormick, R. J.; "Silencers for Corrosive Applications", S/V Sound and Vibration, *5*(2), pp 10-11 (Feb. 1971)

Strumpft, F. M.; "Water Piping Systems and Noise Control", S/V Sound and Vibration, *3*(5), pp 23-25 (May 1969)

Sanders, G. J.; "Silencers: Their Design and Application", S/V Sound and Vibration, *2* (2), pp 6-13 (Feb. 1968)

Doak, P. E.; "Fundamentals of Aerodynamic Sound Theory and Flow Duct Acoustics", J. Sound and Vib., *28*(3), pp 527-562 (June 1973)

## APPLIANCES

Tree, D. R.; Uffman, W. P.; "Noise Reduction of a Household Vacuum Cleaner", S/V Sound and Vibration, *7*(3), pp 27-30 (March 1973)

Tsao, M. C. C.; Musa, R. S.; "Noise Control in Home Appliances", S/V Sound and Vibration, *7*(3), pp 31-33 (March 1973)

Bender, E. K.; "Noise Source Impact in Construction/Buildings/Homes", S/V Sound and Vibration, *7*(5), pp 33-41 (May 1973)

## TRAFFIC NOISE

"Noise in Mass Transit Systems", SRI Journal, *16*(1), pp 2-7 (Sept. 1967)

Meteer, C. L.; "Application of Lead-Vinyl Noise Barriers in Transportation Equipment", Soc. Automotive Engineering, Preprint 720222, p 7, 4 refs.

Harris, C. M.; Aitken, B. H.; "Noise in Subway Cars", S/V Sound and Vibration, *5*(2), pp 12-14 (Feb. 1971)

Campbell, R. A.; "A Survey of Passby Noise for Boats", S/V Sound and Vibration, *3*(9), pp 24-26 (Sept. 1969)

Callaway, V. E.; "Noise Control of Auxiliary Power Units for Aircraft", S/V Sound and Vibration, *1*(9), pp 10-16 (Sept. 1967)

Brasch, J. K.; "Vehicular Traffic Noise Near High Speed Highways", S/V Sound and Vibration, *1*(12), pp 10-27 (Dec. 1967)

"Objective and Subjective Measurement of Truck Noise", S/V Sound and Vibration, *1*(4), pp 8-13 (April 1967)

### GENERAL

Sanders, G. J.; Lawrie, W. E.; "Low Frequency Combustion Noise in Oilburning Equipment", ASHRAE Journal, Section Heating, Piping and Air Conditioning, (Oct. 1958)

"A Pitch for the Noiseless Home", Business Week, pp 87-88 (May 1971)

Bonvallet, G. L.; "The Measurement of Industrial Noise", Amer. Indus. Hygiene Assoc. Quart., Technical Guide No. 5 (Sept. 1952)

Karplus, H. B.; Bonvallet, G. L.; "A Noise Survey of Manufacturing Industries", Amer. Indus. Hygiene Assoc. Quart., *14*(4), pp 235-263 (Dec. 1953)

"Typical Factory and Office Noise Problems in an Aircraft Plant", Noise Control, 2(2), pp 22-25, 90 (March 1956)

Heitner, I.; "How to Estimate Plant Noises", Hydrocarbon Processing, *47*(12), pp 67-74 (Dec. 1968)

Seebold, J. G.; "Process Plant Noise Control at the Design Engineering Stage", ASME J. Engr. Industry, pp 779-784 (Nov. 1970)

Jacks, R. L.; "Sound Suppression", Chemical Process Industries, pp 127-134 (Feb. 1961)

Tyzzer, F. G.; "Reducing Industrial Noise, General Principles", Amer. Indus. Hygiene Assoc. Quart., *14*(4), pp 1-22 (Dec. 1953)

Bonvallet, G. L.; "Noise Sources in Modern Industry", Noise Control, *1*(3), pp 30-33 (May 1955)

Eijk, J. V. D.; Bitter, C.; "Neighbour's Footsteps", 7th Intl. Congr. on Acoustics, Budapest (1971)

Hosey, A. D.; et al; "Industrial Noise: A Guide to its Evaluation and Control", U. S. Dept. of Health, Education and Welfare, Publication 1572

DeBiase, J. L.; "Criteria and Design Specifications for Plant Noise Control", S/V Sound and Vibration, *6*(9), pp 26-30 (Sept. 1972)

Mulholland, K. A.; "The Transmission of Sound through Structures", J. Inst. Heat. Vent. Engr., *38*, pp 58-60 (June 1970)

DiRita, R. A.; George, D. L.; "How to Estimate Sound Levels in Industrial Environments", S/V Sound and Vibration, *6*(9), pp 33-36 (Sept. 1972)

"Acceptable Noise Exposures", S/V Sound and Vibration, *1*(11), pp 4, 6 (Nov. 1967)

"Noise Control of Metal Stamping Operations", S/V Sound and Vibration, *5*(11), pp 41-45 (Nov. 1971)

"Standards and Codes", S/V Sound and Vibration, *5*(2), pp 4-5 (Feb. 1971)

"The First Quiet Portable Compressor", S/V Sound and Vibration, *3*(5), pp 6-8 (May 1969)

Torpey, P. J.; "Noise Reduction of a 115 KW Generator Set", S/V Sound and Vibration, *1*(11), pp 16-22 (Nov. 1967)

"Circular Saw Noise Control", S/V Sound and Vibration, *3*(7), p 6 (July 1969)

### I-5.2.4—COMMUNITY NOISE AND NOISE EFFECTS ON HUMANS

Hardy, H. C.; "Tentative Estimate of a Hearing Damage Risk Criterion for Steady-State Noise", J. Acoust. Soc. Amer., *24*(6), pp 756-761 (Nov. 1952)

Cohen, A.; Anticaglia, J. R.; Carpenter, P. L.; "Temporary Threshold Shift in Hearing from Exposure to Different Noise Spectra at Equal dBA Levels", *51*(2), pp 503-507 (Feb. 1972)

Jones, H. H.; Cohen, A.; "Noise as a Health Hazard at Work, in the Community, and in the Home", 95th Annual Meeting of the American Public Health Assoc., *83*(7), pp 533-536 (July 1968)

Karplus, H. B.; "Mechanism of a Correlation Theory of Hearing", from Bionics Symp., 1962, J. Acoust. Soc. Amer., *35*, p 809 (1963)

Attenborough, K.; et al; "Large Scale Noise Surveys: An Educational Experiment", Acustica, *28*(5), pp 290-295 (March 1973)

Rice, C. G.; Marton, A. M.; "Impulse Noise Damage Risk Criteria", J. Sound and Vibration, *28*(3), pp 359-368 (June 1973)

Northwood, T. D.; Clark, D. M.; "Frequency Considerations in the Subjective Assessment on Sound Insulation", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-3-8 (1968)

Schultz, T. J.; "Comments of the Paper 'Errors Due to Sampling in Community Noise Level Distributions' ", J. Sound and Vib., *27*(2), p 261 (March 1973)

Schultz, T. J.; "Some Sources of Error in Community Noise Measurement", S/V Sound and Vibration, *6*(2), pp 18-27 (Feb. 1972)

Safeer, H. B.; "Community Noise Levels—A Statistical Phenomenon", J. Sound and Vib., *26*(4), pp 489-502 (Feb. 1973)

Bragdon, C. R.; "Urban Planning and Noise Control", S/V Sound and Vibration, *7*(5), pp 26-32 (May 1973)

Thiessen, G. J.; Olson, N.; "Community Noise-Surface Transportation", S/V Sound and Vibration, *2*(4), pp 10-16 (April 1968)

Donley, R.; "Community Noise Regulation", S/V Sound and Vibration, *3*(2), pp 12-21 (Feb. 1969)

Bragdon, C. R.; "City Noise Ordinances—A Status Report", S/V Sound and Vibration, *7*(5), pp 45-48 (May 1973)

Guinter, J. M.; "Action Plan for Product Noise Reduction", S/V Sound and Vibration, *6*(12), pp 18-22 (Dec. 1972)

Adams, J. V.; et al; "S/V Status Report: 3 Community-Noise Programs", S/V Sound and Vibration, *7*(5), pp 42-44 (May 1973)

"New Housing and Airport Noise (A Supplement to the Site Planning Handbook)" Central Mortgage and Housing Corporation, Ottawa, K1A, OP7, Canada

## I-5.2.5—MEASUREMENT AND TESTING

Test Facilities
Testing Techniques
Test Results

### TEST FACILITIES

Schultz, T. J.; "New Acoustical Test Facilities of the National Gypsum Company", J. Acoust. Soc. Amer., *45*(1), pp 20-36 (Jan. 1969)

Ingerslev, F.; Pedersen, O. J.; Moller, P. K.; Kristensen, J.; "New Rooms for Acoustic Measurements at the Danish Technical University", Acustica, *19*(4), pp 185-199 (1968)

Koltzsch, P.; Carraro, U.; "Ein Akustisch Reflexionsarmer Raum Mit Schallhartem Boden fur Industrielle Messzwecke", (A Room for Industrial Measurements with Low Acoustic Reduction Properties and Acoustically Nonabsorbing Floors), 7th Intl. Congr. on Acoustics, Budapest (1971)

Lavender, D. C.; "Interpretation of Noise Measurements", J. Sound and Vib., *15*(1), pp 1-9 (March 1971)

Siekman, W.; "STC's and Room Dividers", Construction Specifier, pp 51-54 (Dec. 1971)

Kost, V. A.; "Modelluntersuchungen Zur Theorie Der Einfachwand", (Model Investigations on the Theory of Partition Walls), Acustica, *18*(6), pp 342-350 (1967)

Zaveri, K.; "Estimation of Sound Pressure Levels at a Distance from a Noise Source", Testing Technique, pp 24-29

Hirschorn, M.; Singer, E.; "The Effect of Ambient Noise on Audiometric Room Selection", S/V Sound and Vibration, *7*(2), pp 18-22 (Feb. 1973)

"Test Room for Vocoder Research", S/V Sound and Vibration, *2*(7), p 4 (July 1968)

"Laboratory Measurements of Sound Transmission through Suspended Ceiling Systems", J. Acoust. Soc. Amer., *33*(11), pp 1523-1530 (Nov. 1961)

Sepmeyer, L. W.; "Effect of Filter Bandwidth and Attenuation Characteristics on Sound-Transmission Loss Measurements", J. Acoust. Soc. Amer., *39*(2), pp 399-401 (Feb. 1966)

Parking, P. H.; Stacy, E. F.; "The Anechoic and Reverberant Rooms at the Building Research Station", J. Sound and Vib., *19*(3), pp 277-286 (Dec. 1971)

Siekman, W., Jr.; "Architectural Acoustics (A Problem of Measurement", Frontier, pp. 16-21 (Autumn 1966)

Kolmer, F.; Wagner, G.; "Several Physical Conditions at Measurements in Reverberation Rooms", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Papers E-5-6 (1968)

### TESTING TECHNIQUES

Siekman, W.; Yerges, J. F.; Yerges, L. F.; "A Simplified Field Sound Transmission Test", S/V Sound and Vibration, *5*(10), pp 17-21 (Oct. 1971)

Utley, W. A.; Cummings, A.; Parbrook, H. D.; "The Accuracy of Laboratory Measurements of Transmission Loss", J. Sound and Vib., *16*(4), pp 643-644 (June 1971)

Jorgen, G. O.; "Technical Problems in Impact Noise Testing", 5th Int. Congr. on Acoustics, Liege (Sept. 1965)

Svensson, J.; "Impact Noise Reduction Predicted from Samples of Flooring", 7th Int. Congr. on Acoustics, Budapest (1971)

Walker, B.; Delsasso, L. P.; "Integrated Pulse Technique for the Measurement of Acoustical Absorption Techniques", 7th Int. Congr. on Acoustics, Budapest (1971)

Szudrowicz, B.; Zuchowicz, I.; "Uber Bezeichnung der Akustichen Eigenschaften Von Werkstoffen und Konstruktionen Auf Grund Von Messungen an Kleinen Proben", (The Designation of Acoustic Properties of Materials and Constructions Based on Small Sample Measurements), 7th Int. Congr. on Acoustics, Budapest (1971)

Focsa, V.; Biborosch, L. D.; "Untersuchung der Schalldammung in Bauteilen mit Hilfe Einer Impulsmethode", (Investigation of Sound Reduction of Structural Elements with the Help of an Impulse Method), 7th Int. Congr. on Acoustics, Budapest (1971)

Tyzzer, F. G.; Hall, H. H.; "An Evaluation Technique for Impact-Type Noises", Noise Control, *2*(2), pp 38-41, *98* (March 1956)

Higginson, R. F.; "A Study of Measuring Techniques for Airborne Sound Insulation in Buildings", J. Sound and Vib., *21*(4), pp 405-429 (April 1972)

Burd, A. N.; "The Measurement of Sound Insulation in the Presence of Flanking Paths", J. Sound and Vib., *7*(1), pp 13-26 (Jan. 1968)

"8th Acoustics Conference on Room and Building Acoustics in Czechoslovakia", J. Acoust. Soc. Amer., *47*(5), pp 1160-1161 (1970)

Huntley, R.; "The Effect of Room Characteristics on Sound Power Measurements", Noise Control, *5*(1), pp 59-63, 77 (Jan. 1959)

Heebink, T. B.; "The Field Measurement of Sound Insulation", S/V Sound and Vibration, *3*(5), pp 18-22 (May 1969)

Zwieback, E. L.; "Recording Aircraft Flyover Noise", S/V Sound and Vibration, *1*(9), pp 17-24 (Sept. 1967)

"Research Project on Impact Noise", S/V Sound and Vibration, *2*(3), p 4 (March 1968)

Safeer, H. B.; "Community Noise Levels—A Statistical Phenomenon", J. Sound and Vib., *26*(4), pp 489-502 (Feb. 1973)

Schultz, T. J.; "Some Sources of Error in Community Noise Measurement", S/V Sound and Vibration, *6*(2), pp 18-27 (Feb. 1972)

Fearn, R. W.; "Some Reverberation Time Measurements in English and Spanish Churches", J. Sound and Vib., *27*(1), pp 134-135 (March 1973)

Schultz, T. J.; "Comments of the Paper 'Errors Due to Sampling in Community Noise Level Distributions' ", J. Sound and Vib., *27*(2), p 261 (March 1973)

Kartr, T. S.; King, D. B.; "Noise Control Design Using Scale Model Tests", S/V Sound and Vibration, *7*(1), pp 14-21 (Jan. 1973)

Steele, J. M.; "Time/Accuracy Tradeoffs in the Analysis of Random Signals", S/V Sound and Vibration, *6*(12), pp 23-27 (Dec. 1972)

Tatge, R. B.; "Noise Control of Gas Turbine Power Plants", S/V Sound and Vibration, *7*(6), pp 23-27 (June 1973)

"AGMA Standard Specification for Measurement of Lateral Vibration on High Speed Helical and Herringbone Gear Units", S/V Sound and Vibration, *7*(6), pp 20-22 (June 1973)

Maling, G. C.; "Guidelines for Determination of the Average Sound Power Radiated by Discrete-Frequency Sources in a Reverberation Room", J. Acoust. Soc. Amer., *53*(4), pp 1064-1069 (April 1973)

## TEST RESULTS

Lindahl, R.; "The Use of Insulation Board in the Walls of Gypsum and Wood Studs to Improve Airborne Sound Insulation", 5th Intl. Congr. on Acoustics Proceedings, Liege (Sept. 1965)

Hudson, R. R.; Mulholland, K. A.; "The Measurement of High Transmission Loss (The Brick Wall Experiment)", Acustica, *24*(5), pp 251-261 (May 1971)

Nilsson, A. C.; "Reduction Index and Boundary Conditions for a Wall Between Two Rectangular Rooms. Part II: Experimental Results", Acustica, *26*(1), pp 19-23 (Jan. 1972)

Ward, F. L.; Randall, K. E.; "Investigation of the Sound Isolation of Concrete Slab Floors", J. Sound and Vib., *3*(2), pp 205-215 (March 1966)

Choudhury, N. K. D.; Bhandari, P. S.; "Impact Noise Rating of Resilient Floors", Acustica, *26*(3), pp 135-140 (March 1972)

Scholes, W. E.; Salvidge, A. C.; Sargent, J. W.; "Field Performance of a Noise Barrier, J. Sound and Vib., *16*(4), pp 627-642 (June 1971)

Scholes, W. E.; "A Note on the Repeatability of Field Measurements of Airborne Sound Insulation", J. Sound and Vib., *10*(1), pp 1-6 (July 1969)

Kodaras, M. J.; Hansen, R. A.; "Measurement Sound-Transmission Loss in the Field", J. Acoust. Soc. Amer., *36*(3), pp 565-569 (March 1964)

Ostergaard, P. B.; Cardinell, R. L.; Goodfriend, L. S.; "Transmission Loss of Leaded Building Materials", J. Acoust. Soc. Amer., *35*(6), pp 837-843 (June 1963)

Eisenberg, A.; Quenett, R.; "Schalldammung von Doppelscheiben Aus Mehrschichtglasern", (Sound Reduction by Double Pane Windows of Multilayered Glass), 7th Intl. Congr. on Acoustics, Budapest (1971)

Fasold, W.; "Zur Bewertung Der Schalldammung von Fenstern", (The Evaluation of Sound Damping by Windows), 5th Int. Congr. on Acoustics, Liege (Sept. 1965)

Kasteleijn, M. L.; "The Statistical Spread of Measured Airborne and Impact Sound Insulation in the Field", J. Sound and Vib., *3*(1), pp 36-45 (Jan. 1966)

Sarkov, N.; Petrov; "Uber Absorptionsgradmessunger in Hallraum", (Measurement of the Degree of Absorption in Halls), 7th Intl. Congr. on Acoustics, Budapest (1971)

Bishop, D. E.; "Reduction of Aircraft Noise Measured in Several Schools, Motel, and Residential Rooms", J. Acoust. Soc. Amer., *39*(5), pp 907-913 (1966)

Bhandari, P. S.; Balachandran, C. G.; Krishnan, P. V.; "Functional Sound Absorbers and Noise Reduction in a Cafeteria", Indian J. Technol., *3*(11), pp 345-350 (1965)

Mintz, F.; Tyzzer, F. G.; "A Loudness Chart for Octave-Band on Complex Sounds", J. Acoust. Soc. Amer., *24*(1), pp 80-82 (Jan. 1952)

Utley, W. A.; Cummings, A.; Parbrook, H. D.; "The Use of Absorbent Material in Double-Leaf Wall Constructions", J. Sound and Vib., *9*(1), pp 90-96 (Jan. 1969)

McFadden, D.; Russell, W. E.; Pulliam, K. A.; "Monaural and Binaural Masking Patterns for a Low-Frequency Tone", J. Acoust. Soc. Amer., *51*(2), pp 534-543 (1972)

Tyzzer, F. G.; Hardy, H. C.; "The Properties of Felt in the Reduction of Noise and Vibration, J. Acoust. Soc. Amer., *19*(5), pp 872-878 (Sept. 1947)

Callaway, D. B.; Ramer, L. G.; "The Use of Perforated Facings in Designing Low Frequency Resonant Absorbers", J. Acoust. Soc. Amer., *24*(3), pp 309-312 (May 1952)

Noll, V. G. G.; "Die Frequenzabhangigkeit der Komplexen Elastizitatskonstanten, Einiger Baustoffe Zwischen etwa 5 und 100 kHz", (Frequency Dependency of Complex Elastic Constants of Some Building Materials between Approximately 5 and 100 kHz), Acustica, *24*(2), pp 93-100 (Feb. 1971)

Attenborough, K.; "Large Scale Noise Surveys: An Educational Experiment", Acustica, *28*(5), pp 290-295 (March 1973)

Koyasu, M.; "Investigations into the Precision of Measurement of Sound Absorption Coefficients in a Reverberation Room", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-5-8 (1968)

Kolmer, F.; Wagner, G.; "Several Physical Conditions at Measurements in Reverberation Rooms", Reports of the 6th Intl. Congr. on Acoustics, Tokyo, Vol. III, Paper E-5-6 (1968)

Karplus, H. B.; "Environment for Measuring Noise", Noise Control, *3*(2), pp 19-22 (March 1957)

McAuliffe, D. R.; "Design and Performance of a New Reverberation Room at Armor Research Foundation", J. Acoust. Soc. Amer., *29*(12), pp 1270-1273 (Dec. 1957)

Duggar, B. C.; "Special Sound Absorptive Materials in Noise Control", Amer. Indus. Hygiene Assn. J., *20*, pp 447-452 (Dec. 1959)

## I-5.2.6—THEORETICAL ANALYSIS

Waya, K.; Miyazaki, Y.; "A New Theory on the Edge Effect of Sound Absorbing Panels", 7th Intl. Congr. on Acoustics, Budapest (1971)

Mechel, V. F.; Royar, J.; "Experimentelle Untersuchungen Zur Theorie Des Porosen Absorbers", (Experimental Investigation of the Theory of Porous Absorbers), Acustica, *26* (2), pp 81-96 (Feb. 1972)

Ingemanson, S.; "Sound Insulation of Light Walls", 5th Intl. Congr. on Acoustics Proceedings, Liege (Sept. 1965)

Nilsson, A. C.; "Reduction Index and Boundary Conditions for a Wall between Two Rectangular Rooms. Part I: Theoretical Results", Acustica, *26*(1), pp 1-18 (Jan. 1972)

Kihlman, T.; "Sound Transmission in Building Structures of Concrete", J. Sound and Vib., *11*(4), pp 435-445 (April 1970)

Waller, R. A.; "The Performance and Economics of Noise and Vibration Reducing Materials in the Construction Industry", J. Sound and Vib., *8*(2), pp 177-185 (Sept. 1968)

Ver, I. L.; "Calculation of the Resonant Sound Transmission Loss of a Finite Double Partition with Elastic Bridges using Statistical Energy Analysis", 7th Intl. Congr. on Acoustics, Budapest (1971)

Zaborov, V. I.; "Normalization of the Acoustic Waves by Composite Platse", Soviet Physics-Acoustics, *16*(1), pp 43-45 (July-Sept. 1970)

Toyoda, H.; Hayek, S.; "Attenuation of Acoustic Waves by Composite Plates", J. Sound. Vib., *14*(1), pp 103-113 (Jan. 1971)

Thurston, E. G.; "On the Lowest Flexural Resonant Frequency of a Circular Disk of Linearly Varying Thickness Driven at Its Center", J. Acoust. Soc. Amer., *27*(5), pp 926-929 (Sept. 1955)

Donato, R. J.; "Sound Transmission through a Double-Leaf Wall", J. Acoust. Soc. Amer., *51*(3), pp 807-815 (March 1972)

Kihlman, T.; "Sound Radiation into a Rectangular Room, Applications to Airborne Sound Transmission in Buildings", Acustica, *18*(1), pp 11-20 (1967)

Ford, R. D.; Walker, A. W.; "Sound Transmission through Sandwich Constructions", J. Sound and Vib., *5*(1), pp 9-21 (Jan. 1967)

Karplus, H. B.; Raelson, V. J.; Schwartzbart, H.; "Noise and Vibration Control with Fiber Metallurgy", The Shock & Vibration Bulletin, *35*(7), pp 261-265 (April 1966)

Gilford; Gibbs, B. M.; "Internal Losses of Sound Propagation in Structures", 7th Intl. Congr. on Acoustics, Budapest (1971)

Kraak, W.; Stobe, H. D.; "Der Einfluss Von Materialegenschaften, Insebesondere von Gefugenschaften, Insbesondere von Gefugedichte und Steifigkeit auf Das Schallisolations Verhalten Poroser Absorber", (The Effect of Material Properties Especially of Grain Density and Grain Stiffness on the Sound Reducing Properties of Porous Absorbers), 7th Intl. Congr. on Acoustics, Budapest (1971)

Betzhold, V. C.; Kurz, K.; "Schalldammstoffe Aus Kunststoff", (Plastic for Sound Insulation), Acustica, *6*(3), pp 162-165 (March 1972)

Sperry, W. C.; "Analysis of Dynamic Systems Using the Mechanical Impedance Concept", Noise Control, *7*(2), pp 13-21 (March-April 1961)

Sanders, G. J.; "Identification and Diagnosis of Noise Problems with References to Product Noise Quieting", Noise Control, *4*(2), pp 15-21, 72-73 (March 1958)

Al-Temimi, C. A.; "Interaction between Two Sound Fields Propagating in Different Directions", J. Sound and Vib. *8*(1), pp 44-63 (July 1968)

Pretlove, A. J.; "The Transmission of Outdoor Noises into Buildings", Environmental Engineers, *43*, pp 7-10 (March 1970)

Young, J. R.; "Attenuation of Aircraft Noise by Wood-Sided and Brick-Veneered Frame Houses" NASA CR-1637 (Aug. 1970)

Tyzzer, F. G.; Hardy, H. C.; "Accelerometer Calibration Technique", J. Acoust. Soc. Amer., *22*(4), pp 454, 457 (July 1950)

Benson, R. W.; "Efficiency and Power Rating of Loudspeakers", Proc. of the Natl. Electronics Conference (Oct. 1955)

Hardy, H. C.; Hall, H. H.; Ramer, L. G.; Proc. of the Natl. Electronics Conference, *8* (Jan. 1953)

Benson, R. W.; "Evaluation of High-Powered Outdoor Sound Systems", Proc. of the Natl. Electronics Conference (Oct. 1956)

Yousri, S. N.; et al; "Sound Radiation from Transversely Vibrating Unbaffled Beams", J. Sound and Vib., *26*(3), pp 437-439 (Feb. 1973)

Koss, L. L.; et al; "Transient Sound Radiated by Spheres Undergoing an Elastic Collision", J. Sound and Vib., *27*(1), pp 59-75 (March 1973)

Mazzola, C. G.; "A Note on Stimulated Emission Acoustic Power", J. Sound and Vib., *26*(3), pp 307-310 (Feb. 1973)

Guy, R. W.; et al; "The Transmission of Sound through a Cavity-Backed Finite Plate", J. Sound and Vib., *27*(2), pp 207-223 (March 1973)

Romilly, N.; "Sound Transmission through a Thin Plate under Tension", Acustica, *22*(3), pp 183-186 (1970)

Meier, A. V.; "Transmission Loss of Homogeneous and Sandwich Plates in the Coincidence Range", Acustica, *22*(3), pp 125-136 (1970)

Tseo, G. G.; "Estimating the Noise Reduction of Wall Structures of Enclosures", J. Acoust. Soc. Amer., *52*(6), Part 1, pp 1573-1578 (Dec. 1972)

Donato, R. J.; "Insulating Houses against Aircraft Noise", J. Acoust. Soc. Amer., *53*(4), pp 1025-1027 (April 1973)

Braunisch, Von. H.; "Vibrating Damping by Three-Layered Sandwich Systems", Acustica, *22*(3), pp 136-144 (1969)

## II—COMPANY CODE NUMBERS AND ADDRESSES

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 1. | Abco Inc. | 4901 North Cooper<br>Oklahoma City, Okla. 73118 | 33 |
| 2. | Accessible Products Co. | 1350 East 8th St.<br>Tempe, Ariz. 85281 | 43 |
| ✓3. | Acousticorp Inc. | North Morehall Rd.<br>Malvern, Pa. 19355 | 12, 23 |
| ✓4. | Acoustics Development Corp. | 1810 Holste Rd.<br>Northbrook, Ill. 60062 | 26 |
| 5. | Acoustics Mfg. Corp. | 17210 Gable Ave.<br>Detroit, Mich. 48212 | 34 |
| 6. | Acoustiflex Corp. | P.O. Box 434<br>327 North Water St.<br>Batavia, Ill. 60510 | 1, 10-11, 20, 34, 36 |
| 7. | Adcomold International | 1558 California St.<br>Denver, Colo. 80202 | 44 |
| 8. | Adhaco Hardware Corp. | 5436 West 111th St.<br>Oak Lawn, Ill. 60453 | 46 |
| 9. | Aeroacoustic Corp. | P.O. Box 65<br>Amityville, N. Y. 11701 | 20, 40 |
| 10. | Aeronca Inc.<br>Environmental Control Gp. | P.O. Box 688<br>Pineville, N. C. 28134 | 20, 39 |
| 11. | Air-O-Plastik Corp. | Asia Place<br>Carlstadt, N. J. 07072 | 7 |
| 12. | Airtex Industries Inc.<br>(612) 588-0715 | 3558 Second St. North<br>Minneapolis, Minn. 55412 | 1, 6-9, 12, 18, 24,<br>36, 41-42, 44-45 ✓ |
| 13. | Airtherm Mfg. Co. | 700 South Spring Ave.<br>St. Louis, Mo. 63110 | 25 |
| 14. | Alpana Aluminum Products Inc. | 14105 State Hwy. 55<br>Minneapolis, Minn. 55427 | 33 |
| ✓15. | Alpro Acoustics Div.<br>Structural Systems Corp. | P.O. Box 30460<br>New Orleans, La. 70190 | 21, 39, 40 |
| 16. | Amax Aluminum Co., Inc.<br>Foil Products Div. | 6106 South Broadway<br>St. Louis, Mo. 63111 | 13 |
| 17. | Amelco Window Corp. | P.O. Box 333<br>Hasbrouck Heights, N. J. 07604 | 33 |
| ✓18. | American Acoustical Products<br>Div. of Ward Process Inc. | 9 Cochituate St.<br>Natick, Mass. 01760 | 8-10, 12, 19 ✓ |
| 19. | American Desk Mfg. Co. | Temple, Tex. 76501 | 46 |

## II—COMPANY CODE NUMBERS AND ADDRESSES—Continued

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 20. | American Seating Co. | 901 Broadway Ave. N.W.<br>Grand Rapids, Mich. 49504 | 46 |
| 21. | American Smelting & Refining Co. | 150 St. Charles St.<br>Newark, N. J. 07101 | 13 |
| 22. | American Vermiculite Corp. | 52 Executive Pk. South<br>Atlanta, Ga. 30329 | 44 |
| 23. | Amweld Building Products | 100 Plant St.<br>Niles, Ohio 44446 | 32 |
| 24. | Antiphon Inc. | 10 Westport Ave.<br>Norwalk, Conn. 06851 | 17 |
| 25. | Arketex Ceramic Corp. | Brazil, Ind. 47834 | 11, 29 |
| 26. | Arlon Products Inc. | 23924 South Vermont Ave.<br>Harbor City, Calif. 90710 | 45 |
| 27. | Art Drapery Studios Inc. | 2766 North Lincoln Ave.<br>Chicago, Ill. 60614 | 36 |
| 28. | Bar-Ray Products Inc. | 209 25th St.<br>Brooklyn, N. Y. 11232 | 13 |
| 29. | BASF Mexicana, S. A. | Apartado Postal: 18-953<br>Mexico 18, D. F. | 21 |
| 30. | Berven Rug Mills Inc. | P.O. Box 1792<br>2600 Ventura Ave.<br>Fresno,Calif. 93717 | 24 |
| 31. | Breeko Industries | P.O. Box 1247<br>Nashville, Tenn. 37202 | 29 |
| 32. | Brunswick Corp. | One Brunswick Plaza<br>Skokie, Ill. 60076 | 44 |
| 33. | Builders Brass Works Corp. | 3447 Union Pacific Ave.<br>Los Angeles, Calif. 90023 | 45 |
| 34. | Burkart | 36th & Commercial Sts.<br>Cairo, Ill. 62914 | 1, 4, 24 |
| 35. | Butler Mfg. Co. | BMA Tower, Penn Valley Pk.<br>Kansas City, Mo. 64141 | 30 |
| 36. | Canada Metal Co. Ltd. | 721 Eastern Ave.<br>Toronto 8, Canada | 8, 10, 12-13, 43 |
| 37. | Carey Electronic Engr. Co. | 1882 Clifton Ave.<br>Springfield, Ohio 45505 | 44 |
| 38. | Carney & Assoc. Inc. | P.O. Box 1237<br>Mankato, Minn. 56001 | 4, 18 |

## II—COMPANY CODE NUMBERS AND ADDRESSES—Continued

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 39. | Casings Inc. | West Middlesex, Pa. 16159 | 46 |
| 40. | C. E. Glass Co. | 825 Hylton Rd.<br>Pennsauken, N. J. 08110 | 16 |
| 41. | Chemprene Inc. | 579 South Ave.<br>Beacon, N. Y. 12508 | 18 |
| 42. | Commercial Plastics & Supply Corp. (COMCO) | 98-34 Jamaica Ave.<br>Richmond Hill, N. Y. 11418 | 33 |
| 43. | Concrete Products Inc. | P.O. Box 130<br>Brunswick, Ga. 31520 | 25 |
| 44. | Congoleum Industries Inc. | 195 Belgrove Dr.<br>Kearny, N. J. 07032 | 41 |
| 45. | Consolidated Kinetics Corp. | 249 Farnof Lane<br>Columbus, Ohio 43207 | 1, 9, 18, 36, 39, 43-45 |
| 46. | Corlett-Turner Co. | 9145 King St.<br>Franklin Park, Ill 60130 | 46 |
| 47. | Dearborn Glass Co. | 6600 South Harlem Ave.<br>Bedford Park, Ill.<br>P.O. Argo, Ill. 60501 | 16 |
| 48. | Designed Enclosures Inc. | 316 East Beach Ave.<br>Inglewood, Calif. 90302 | 40 |
| 49. | DeVac Inc. | 10130 State Hwy. 55<br>Minneapolis, Minn. 55441 | 33 |
| 50. | Diamond Perforated Metals Div. of Whittaker Corp. | 1791 South Figueroa<br>Gardena, Calif. 90248 | 44 |
| 51. | Dixie Mfg. Co. | 110 Colley Ave.<br>Norfolk, Va. 23501 | 4 |
| 52. | Dodge Cork Co. Inc. | Lancaster, Pa. 17604 | 18, 41, 44 |
| 53. | Donn Products Inc. | 1000 Crocker Rd.<br>Westlake, Ohio 44145 | 21-22, 38 |
| 54. | Duracote Corp. | 350 North Diamond St.<br>Ravenna, Ohio 44266 | 18 |
| 55. | Duraflake Co. | P.O. Box 428<br>Albany, Oreg. 97321 | 16, 32, 41, 44, 46 |
| 56. | Duwe Precast Concrete Products Co. | P.O. Box 412<br>Oshkosh, Wis. 54901 | 25 |
| 57. | Eagle-Picher Industries Inc. Chemicals and Fibers Div. | P.O. Box 1328<br>Joplin, Mo. 64801 | 20, 43 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 58. | Eastern Products Corp. | 9325 Snowden River Pkwy. Columbia, Md. 21046 | 27 |
| 59. | Eckel Industries Inc. | 155 Fawcett St. Cambridge, Mass. 02138 | 6, 9, 19-20, 26, 32, 36, 39-40 |
| 60. | Eggers Hardwood Products Corp. | P.O. Box 250 Neenah, Wis. 54956 | 32 |
| 61. | E. I. DuPont de Nemours & Co. | Wilmington, Del. 19898 | 16 |
| 62. | Elwin G. Smith Div. | 100 Walls St. Pittsburgh, Pa. 15202 | 22, 28 |
| 63. | Emerson Engr. Co. | 2719 North Emerson Ave. Indianapolis, Ind. 46218 | 32 |
| 64. | Environeering Inc. | 9933 North Lawler Skokie, Ill. 60076 | 40 |
| 65. | ESP Inc. Environmental Services & Products | P.O. Box 1281 Dayton, Ohio 45401 | 9, 12, 18 |
| 66. | Enviropane Inc. | 348 North Marshall St. Lancaster, Pa. 17602 | 33 |
| 67. | Erdle Perforating Co. Inc. | P.O. Box 1568 100 Pixley Industrial Pkwy. Rochester, N.Y. 14603 | 9, 44 |
| 68. | Feeder Corp. of America | 4429 James Place Melrose Park, Ill. 60507 | 40 |
| 69. | Felters Co. | 22 West St. Millbury, Mass. 01527 | 4 |
| 70. | Fenestra Door Products | 4040 West 20th St. P.O. Box 8189 Erie, Pa. 16505 | 32 |
| 71. | Fentron Industries Inc. | 2801 NW Market St. Seattle, Wash. 98107 | 33 |
| 72. | Ferro Corp. | 34 Smith St. Norwalk, Conn. 06852 | 1, 9, 18, 36, 43-45 |
| 73. | Fire Protection Products Co. | 1101 16th St. San Francisco, Calif. 94107 | 20, 39 |
| 74. | Flexicore Co. Inc. | P.O. Box 825 Dayton, Ohio 45401 | 30 |
| 75. | Florida Concrete & Products Assoc. Inc. | P.O. Box 160 Winter Park, Fla. 32789 | 5 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 76. | Florida Tile | 608 Prospect St.<br>Lakeland, Fla. 33802 | 44 |
| 77. | Foamade Industries | 1220 Morse St.<br>Royal Oak, Mich. 48068 | 1, 6 |
| 78. | Formigli Corp. | P.O. Box F<br>Berlin, N. J. 08009 | 30 |
| 79. | Forty-Eight Insulations Inc. | Aurora, Ill. 60504 | 10, 18, 43 |
| 80. | Friedrich & Dimmock Inc. | Millville, N. J. 08332 | 44 |
| 81. | GAF Corp.<br>Industrial Products Div. | 140 West 51 St.<br>New York, N. Y. 10020 | 14-15, 18 |
| 82. | General Acoustics Corp. | 12248 Santa Monica Blvd.<br>Los Angeles, Calif. 90025 | 1, 20, 26, 39-40 |
| 83. | General Noisecontrol Corp. | 101 East Main St.<br>Little Falls, N. J. 07424 | 26 |
| 84. | Glen O'Brien<br>Movable Partition Co. Inc. | 5301 East 59th St.<br>Kansas City, Mo. 64130 | 38 |
| 85. | Globe-Amerada Glass Co. | 2001 Greenleaf Ave.<br>Elk Grove Village, Ill. 60007 | 16 |
| 86. | Globe Industries Inc. | 2638 East 126th St.<br>Chicago, Ill. 60633 | 10-11, 14-15 |
| 87. | Goodyear Tire & Rubber Co. | Akron, Ohio 44316 | 39, 44 |
| 88. | Gordon J. Pollock & Assoc. Inc. | P.O. Box 4243<br>Euclid, Ohio 44132 | 40 |
| 89. | Harbison-Walker Refractories | 2 Gateway Center<br>Pittsburgh, Pa. 15222 | 29 |
| 90. | Harrington & King<br>Perforating Co. Inc. | 5655 Fillmore St.<br>Chicago, Ill. 60644 | 44 |
| 91. | Hecht Rubber Corp. | 484 Riverside Ave.<br>Jacksonville, Fla. 32202 | 44 |
| 92. | H. E. Douglas Engr. Sales Co. | 2700 West Burbank Blvd.<br>Burbank, Calif. 91505 | 26 |
| 93. | H. J. Otten Co. Inc. | 77 Cornwall Ave.<br>Buffalo, N. Y. 14215 | 39 |
| 94. | H. K. Porter Co. Inc. | P.O. Box 10516<br>Charlotte, N. C. 28201 | 18, 44 |
| 95. | Holcomb & Hoke Mfg. Co. Inc. | 1545 Calhoun St.<br>Indianapolis, Ind. 46207 | 23, 37 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 96. | **Hol-O-Met Corp.** | P.O. Box 1190<br>441 South Robson St.<br>Mesa, Ariz. 85201 | 32 |
| 97. | **Homasote Co.** | Box 240<br>West Trenton, N. J. 08628 | 27, 41-42 |
| 98. | **Hough Mfg. Corp.** | Janesville, Wis. 53545 | 37 |
| 99. | **Huebert Fiberboard Inc.** | P.O. Box 167<br>East Morgan St.<br>Boonville, Mo. 65233 | 27 |
| 100. | **Hunter Douglas Canada Ltd.** | 2501 Trans Canada Hwy.<br>Pointe-Claire, Quebec, Canada | 21 |
| 101. | **Hupp Corp.<br>Richard-Wilcox Mfg. Co.** | 174 Third St.<br>Aurora, Ill. 60507 | 32, 37-38 |
| 102. | **Illinois Brick Co.** | 228 North LaSalle St.<br>Chicago, Ill. 60601 | 29 |
| 103. | **Incel Corp.** | P.O. Box 395<br>Bluffton, Ind. 46714 | 44 |
| 104. | **Industrial Acoustics Co. Inc.** | 380 Southern Blvd.<br>Bronx, N. Y. 10454 | 26, 32, 38-39 |
| 105. | **Inescon, Inc.** | P.O. Box 1386<br>Hudson, Ohio 44236 | 20 |
| 106. | **Inland-Ryerson<br>Construction Products Co.** | Box 393<br>Milwaukee, Wis. 53201 | 20, 25, 35, 39, 46 |
| 107. | **Insul-Coustic Birma Corp.** | Jernee Mill Rd.<br>Sayreville, N. J. 08872 | 10-11, 18-19 |
| 108. | **Jamison Door Co.** | P.O. Box 70<br>Hagerstown, Md. 21740 | 32 |
| 109. | **Johns-Manville Sales Corp.** | Greenwood Plaza<br>Denver, Colo. 80217 | 2, 4, 21, 34, 39, 46 |
| 110. | **Kawneer Co. Inc.** | 1105 North Front St.<br>Niles, Mich. 49120 | 33 |
| 111. | **Korfund Dynamics Corp.** | P.O. Box 235<br>Contiague Rd.<br>Westbury, Long Island, N. Y. 11590 | 6, 12, 18, 20, 26, 29, 36, 39 |
| 112. | **Krieger Steel Products Co.** | 14200 South San Pedro St.<br>Los Angeles, Calif. 90061 | 32 |
| 113. | **Lahabra Products Inc.** | 1631 West Lincoln Ave.<br>Anaheim, Calif. 92800 | 44 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 114. | **Lake Shore Industries Inc.** | 2806 North Reynolds Rd. Toledo, Ohio 43615 | 32 |
| 115. | **Laminated Glass Corp.** | 355 West Lancaster Ave. Haverford, Pa. 19041 | 16 |
| 116. | **L. E. Carpenter and Co.** | 964 Third Ave. New York, N. Y. 10022 | 20, 22, 39 |
| 117. | **Bob Lench Co.** | 16808 Armstrong Ave. Santa Ana, Calif. 92705 | 32 |
| 118. | **Logan Long Co.** | Franklin, Ohio 45005 | 11, 14-15 |
| 119. | **Lord Corp.** | 2000 West Grandview Blvd. Erie, Pa. 16512 | 1, 9, 11, 17, 19, 26, 39 |
| 120. | **Martin Fireproofing Georgia Inc.** | Elberton, Ga. 30635 | 25 |
| 121. | **Mason Industries Inc.** | 92-10 182nd Place Hollis, N. Y. 11423 | 30 |
| 122. | **Masonite Corp.** | 29 North Wacker Dr. Chicago, Ill. 60606 | 27 |
| 123. | **Midwest Woodworking Co. Inc.** | 4019-21 Montgomery Rd. Cincinnati, Ohio 45212 | 32 |
| 124. | **Miller Building Supply Co. Inc.** | 1721 Standard Ave. Glendale, Calif. 91201 | 32, 33 |
| 125. | **MIP Sciences Inc.** | 223 Maple Ave. Waukesha, Wis. 53181 | 1 |
| 126. | **Munchhausen Soundproofing Co. Inc.** | 290 Riverside Dr. New York, N. Y. 10025 | 32 |
| 127. | **National Cellulose Corp.** | 12315 Robin Blvd. Houston, Tex. 77045 | 3, 11, 17, 19, 43 |
| 128. | **National Gypsum Co. Gold Bond Building Products** | 1650 Military Rd. Buffalo, N. Y. 14217 | 19-21, 27, 34 |
| 129. | **National Research Corp.** | Concord Rd. Billerica, Mass. 01821 | 13, 19-20, 36, 39 |
| 130. | **Norton Co./Sealants** | 12 Bennett Dr. Granville, N. Y. 12832 | 45 |
| 131. | **Overly Mfg. Co.** | Greensburg, Pa. 15602 | 32 |
| 132. | **Owens/Corning Fiberglas Corp. Technical Center** | Granville, Ohio 43023 | 2, 18-21, 27, 30-31 |
| 133. | **Owens-Illinois Inc.** | 1020 North Westwood Ave. Toledo, Ohio 43607 | 44 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 134. | Panelfold Doors Inc. | 10700 Northwest 36th Ave.<br>Miami, Fla. 33167 | 37, 44 |
| 135. | Paramount Industries Inc. | P.O. Box 4<br>1711 South Second St.<br>Piscataway, N. J. 08854 | 6 |
| 136. | Peelle Co. Ltd. | P.O. Box 10<br>Torbram Rd.<br>Malton, Ontario, Canada | 32 |
| 137. | Pittsburgh Corning Corp. | Three Gateway Center<br>Pittsburgh, Pa. 15222 | 19 |
| 138. | PPG Industries Inc. | P.O. Box 11472<br>Guys Run Rd.<br>Pittsburgh, Pa. 15238 | 16 |
| 139. | Precision Acoustics Corp. | 55 West 42nd St.<br>New York, N. Y. 10036 | 26 |
| 140. | Presray Corp. | 159 Maple Blvd.<br>Pawling, N. Y. 12564 | 45 |
| 141. | The Proudfoot Co. Inc. | P.O. Box 9<br>Greenwich, Conn. 06830 | 5, 29 |
| 142. | Ray Proof Corp. | 50 Keeler Ave.<br>Norwalk, Conn. 06856 | 26, 39 |
| 143. | RCA Rubber Co. | 1833 East Market St.<br>Akron, Ohio 44305 | 8, 41 |
| 144. | Reeves-Bowman Div.<br>Cyclops Corp. | Box 2129<br>Pittsburgh, Pa. 15230 | 25 |
| 145. | Republic Steel Corp. | 1315 Albert St.<br>Youngstown, Ohio 44505 | 32 |
| 146. | Reynolds Aluminum | 5th & Cary Sts.<br>Richmond, Va. 23218 | 21 |
| 147. | Rink Corp. | Hazleton, Pa. 18201 | 20, 39 |
| 148. | Rohm and Haas Co.<br>Plastics Engr. Lab. | Box 219<br>Bristol, Pa. 19007 | 16 |
| 149. | John Schneller & Assoc. | Kent, Ohio 44240 | 6, 8, 12, 18 |
| 150. | Scott Paper Co.<br>Foam Div. | 1500 East Second St.<br>Chester, Pa. 19013 | 1, 6, 7, 44 |
| 151. | Semco Mfg. Co. | P.O. Box 189<br>Salisbury, Mo. 65281 | 20, 30 |

## II—COMPANY CODE NUMBERS AND ADDRESSES—Continued

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 152. | **Shatterproof Glass Corp.** | 4815 Cabot Ave.<br>Detroit, Mich. 48210 | 16 |
| 153. | **Shielding Research Co.** | 3295 South Hwy. 97<br>Redmond, Oreg. 97756 | 8 |
| 154. | **Simpson Timber Co.** | 2000 Washington Building<br>Seattle, Wash. 98101 | 27 |
| 155. | **Singer Partitions Inc.** | 444 North Lake Shore Dr.<br>Chicago, Ill. 60611 | 18, 23, 36, 40 |
| 156. | **Sound Fighter Systems Inc.** | 1200 Mid-South Towers<br>Shreveport, La. 71101 | 1, 12, 32, 39, 43 |
| 157. | **Sound Solutions Corp.** | 601 Washington St.<br>Lynn, Mass. 01901 | 1, 4, 6, 9, 12, 26,<br>32, 39, 43, 45-46 |
| 158. | **Southér Inc.** | 1952 Kienlen Ave.<br>St. Louis, Mo. 63133 | 46 |
| 159. | **Span-Deck Inc.** | Box 99<br>Franklin, Tenn. 37064 | 30 |
| 160. | **Specialty Composites Corp.** | Delaware Industrial Pk.<br>Newark, Del. 19711 | 7, 9, 11-12 |
| 161. | **Standard Felt Co.** | P.O. Box 871<br>115 South Palm Ave.<br>Alhambra, Calif. 91802 | 4, 18 |
| 162. | **Stark Ceramics Inc.** | P.O. Box 8880<br>Canton, Ohio 44711 | 11, 29 |
| 163. | **Starline Inc.** | P.O. Drawer G<br>Carencro, La. 70520 | 33 |
| 164. | **Starrco Co. Inc.** | 1515 Fairview Ave.<br>St. Louis, Mo. 63132 | 26 |
| 165. | **St. Joe Minerals Corp.** | Monaca, Pa. 15061 | 13 |
| 166. | **Superwood Corp.** | 14th Ave. West & RR<br>Duluth, Minn. 55802 | 13, 18 |
| 167. | **Tenneco Chemicals** | 1430 East Davis St.<br>Arlington Heights, Ill. 60005 | 37 |
| 168. | **Tracor Inc.** | 6500 Tracor Lane<br>Austin, Tex. 78721 | 26 |
| 169. | **Transco Inc.** | 80 East Jackson Blvd.<br>Chicago, Ill. 60600 | 39 |
| 170. | **Tremco Mfg. Co.** | 10701 Shaker Blvd.<br>Cleveland, Ohio 44104 | 45 |

## II—COMPANY CODE NUMBERS AND ADDRESSES—Continued

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 171. | **Trus Joist Corp.** | 9777 West Chinden Blvd.<br>Boise, Idaho 83702 | 31 |
| 172. | **United McGill Corp.**<br>**United Sheet Metal Div.** | 883 North Cassady Ave.<br>Columbus, Ohio 43219 | 20, 39 |
| 173. | **U. S. Air Duct Corp.** | P.O. Box 187 Mattydale<br>Syracuse, N. Y. 13211 | 39 |
| 174. | **U. S. Industrial Chemicals Co.** | P.O. Box 218<br>Tuscola, Ill. 61953 | 44 |
| 175. | **U. S. Mineral Products Co.** | Stanhope, N. J. 07874 | 3, 17 |
| 176. | **U. S. Plywood** | 777 Third Ave.<br>New York, N. Y. 10017 | 32 |
| 177. | **U. S. Rubber Reclaiming Co. Inc.** | P.O. Box 54<br>Vicksburg, Miss. 39180 | 44 |
| 178. | **United Sheet Metal Div.**<br>**United McGill Corp.** | 200 East Broadway<br>Westerville, Ohio 43081 | 20 |
| 179. | **Vecta Educational Co.** | 2605 East Kilgore Rd.<br>Kalamazoo, Mich. 49003 | 37 |
| 180. | **Veneered Metals Inc.** | P.O. Box 327<br>Woodbridge Ave. at Main St.<br>Edison, N. J. 08817 | 13, 44 |
| 181. | **Vibrasonics Inc.** | P.O. Box 2543<br>Garland, Tex. 75040 | 20, 39 |
| 182. | **Virginia Metal Products Div.** | Orange, Va. 22960 | 28 |
| 183. | **Vogel-Peterson Co.** | P.O. Box 90<br>Elmhurst, Ill. 60126 | 19 |
| 184. | **Ward Process Inc.** | P.O. Box 85<br>Cochituate, Mass. 01778 | 8, 10, 12 |
| 185. | **Wausau Metals Corp.** | 1415 West St.<br>P.O. Box 1182<br>Wausau, Wis. 54401 | 33 |
| 186. | **Weblite Corp.** | P.O. Box 780<br>Roanoke, Va. 24004 | 20 |
| 187. | **Wenger Corp.** | Owatonna, Minn. 55060 | 26 |
| 188. | **Western Acadia Inc.** | 4115 Ogden Ave.<br>Chicago, Ill. 60623 | 23, 44 |

| Code Number | Company | Address | Pertinent Data Table Number |
|---|---|---|---|
| 189. | **Weyerhaeuser Co.** | Box B<br>Tacoma, Wash. 98401 | 27, 31-32 |
| 190. | **Wheeling Corrugating Co.** | 1134 Market St.<br>Wheeling, W. Va. 26003 | 25 |
| 191. | **William T. Burnett & Co. Inc.** | 1500 Bush St.<br>Baltimore, Md. 21230 | 1 |
| 192. | **Workwall Movable Partitions** | P.O. Box 130<br>Bronson, Mich. 49028 | 23 |
| 193. | **Zero Weatherstripping Co. Inc.** | 415 Concord Ave.<br>Bronx, N. Y. 10455 | 46 |

## OTHER ORGANIZATIONS CONTRIBUTING DATA

**Acoustical and Insulating Materials Assoc.**
205 West Touhy Ave.
Park Ridge, Ill. 60068

**American Hardboard Assoc.**
20 North Wacker Dr.
Chicago, Ill. 60606

**American Plywood Assoc.**
1119 A St.
Tacoma, Wash. 98401

**Brick Inst. of America**
1750 Old Meadow Rd.
McLean, Va. 22101

**Carpet & Rug Inst. Inc.**
909 Third Ave.
New York, N. Y. 10022

**Cast Iron Soil Pipe Inst.**
2029 K St. NW
Washington, D. C. 20006

**Expanded Shale Clay, & Slate Inst.**
National Press Bldg.
Washington, D. C. 20004

**Gypsum Assoc.**
201 N. Wells St.
Chicago, Ill. 60606

**Lead Industries Assoc. Inc.**
292 Madison Ave.
New York, N. Y. 10017

**NAHB Research Foundation Inc.**
627 Southlawn Lane
Rockville, Md. 20850

**National Concrete Masonry Assoc.**
P.O. Box 9185, Rosslyn Station
1800 North Kent St.
Arlington, Va. 22209

**National Research Council of Canada**
Div. of Building Research
Ottawa, Canada

**Perlite Inst. Inc.**
45 West 45th St.
New York, N. Y. 10036

**Prestressed Concrete Inst.**
20 North Wacker Dr.
Chicago, Ill. 60606

**Spancrete Manufacturer's Assoc.**
660 East Mason St.
Milwaukee, Wis. 53202

**U. S. Dept. of Agriculture**
**Wood Construction Research**
4507 University Way NE
Seattle, Wash. 98105

## III—LIST OF DATA TABLES AND COMPANIES REPRESENTED

| No. | Title | Company Code Numbers[1] |
|---|---|---|
| | **GROUP A: SOUND ABSORPTION MATERIALS** | |
| 1 | Foams | 6, 12, 34, 45, 65, 72, 77, 82, 119, 125, 150, 156-157, 191 |
| 2 | Glass Fiber Materials | 6, 109, 132 |
| 3 | Spray-on Absorption Materials | 127, 175 |
| 4 | Felt and Other Fibers | 34, 38, 51, 69, 109, 157, 161 |
| 5 | Concrete Blocks | 75, 141 |
| | **GROUP B: COMPOSITE MATERIALS** | |
| 6 | Composites Vinyl/Foam | 12, 59, 77, 111, 135, 149-150, 157 |
| 7 | Film/Foam | 11-12, 150, 160 |
| 8 | Lead/Foam | 12, 18, 36, 143, 149, 153, 184 |
| 9 | Other Barrier Materials and Foam | 12, 18, 45, 59, 65, 67, 72, 119, 157, 160 |
| 10 | Barrier Material/Fiberglass | 6, 18, 36, 79, 86, 107, 184 |
| 11 | Other Composite Materials | 3, 6, 25, 86, 107, 118-119, 127, 160, 162 |
| 12 | Foam/Barrier/Foam | 12, 18, 36, 65, 111, 149, 156-157, 160, 184 |
| | **GROUP C: SOUND BARRIER MATERIALS** | |
| 13 | Lead | 16, 21, 28, 36, 129, 165-166, 180 |
| 14 | Mastic | 81, 86, 118 |
| 15 | Mastic with Cotton | 81, 86, 118 |
| 16 | Glass and Plastic | 40, 47, 55, 61, 85, 115, 138, 148, 152 |
| 17 | Spray-on Materials | 24, 119, 127, 175 |
| 18 | Other Barrier and Damping Materials | 12, 38, 41, 45, 52, 54, 65, 72, 79, 81, 94, 107, 111, 132, 149, 155, 161, 166 |
| | **GROUP D: SOUND ABSORPTION SYSTEMS** | |
| 19 | Unit Absorbers | 18, 59, 107, 116, 119, 127-129, 132, 137, 183 |
| 20 | Wall Treatments and Facings | 6, 10, 57, 59, 73, 82, 104-106, 111, 116, 128-129, 132, 147, 151, 172, 178, 181 |
| 21 | Ceilings | 15, 29, 53, 100, 109, 128, 132, 146 |
| 22 | Partitions (Absorption) | 53, 62, 116 |
| 23 | Curtains (Absorption) | 3, 95, 155, 188, 192 |
| 24 | Floor Coverings (Absorption) | 12, 30, 34 |
| 25 | Roof Decks (Absorption) | 13, 43, 56, 106, 120, 144, 190 |

[1] Company code numbers are listed in section II.

| No. | Title | Company Code Numbers[1] |
|---|---|---|
| | **GROUP E: COMPOSITE SYSTEM** | |
| 26 | Prefabricated Quiet Rooms | 4, 9, 59, 82, 92, 104, 111, 119, 139, 142, 157, 164, 168, 187 |
| | **GROUP F: SOUND BARRIER SYSTEMS** | |
| 27 | Gypsum Board Walls | 58, 97, 99, 122, 128, 132, 154, 189 |
| 28 | Steel Walls | 62, 182 |
| 29 | Masonry Walls | 25, 31, 89, 102, 141, 162, 186 |
| 30 | Concrete Floors | 74, 78, 121, 132, 159 |
| 31 | Wood Floors | 132, 171, 189 |
| 32 | Doors | 23, 55, 59, 63, 70, 96, 101, 104, 108, 112, 114, 117, 123-124, 126, 131, 136, 145, 156-157, 176, 189 |
| 33 | Windows | 1, 14, 17, 42, 49, 66, 71, 110, 124, 163, 185 |
| 34 | Suspended Ceilings — Sound Attenuation Factor | 5, 6, 109, 128 |
| 35 | Roof Decks (Barrier) | 106, 120 |
| 36 | Curtains (Barrier) | 6, 12, 27, 45, 59, 72, 155 |
| 37 | Operable Partitions | 95, 98, 101, 134, 167, 179 |
| 38 | Semipermanent Partition Assemblies | 53, 84, 101, 104 |
| 39 | Prefabricated Sound Barrier Panels | 10, 15, 35, 45, 55, 59, 73, 82, 87, 93, 104, 106, 109, 111, 116, 119, 129, 142, 147, 151, 156-157, 169, 172-173, 181 |
| 40 | Enclosures | 9, 48, 59, 68, 82, 88, 155 |
| 41 | Floor Coverings — Tapping Machine Data | 12, 44, 52, 55, 97, 143 |
| 42 | Floor Coverings — Transmission Loss Data | 12, 97 |
| 43 | Pipe Laggings | 2, 36, 45, 57, 72, 79, 127, 156, 157 |
| | **GROUP G: SPECIALIZED ITEMS** | |
| 44 | Other Materials | 7, 12, 22, 32, 37, 45, 50, 52, 55, 67, 72, 76, 80, 87, 90-91, 94, 103, 113, 133-134, 150, 174, 177, 180, 188 |
| 45 | Gaskets, Sealants, and Sealing Tapes | 12, 26, 33, 45, 72, 130, 140, 157, 170 |
| 46 | Special Application Products | 8, 15, 19-20, 39, 46, 55, 64, 106, 109, 157-158, 193 |
| 47 | General Building Materials and Furnishings | |

## IV—TESTING LABORATORIES WITH ACRONYMS AND ADDRESSES

**Cedar Knolls Acoustical Laboratory** ........ CKAL
9 Saddle Road
Cedar Knolls, N. J. 07927

**Cominco Ltd. of Canada** ........ CLC
1090 Speers Road
Oakville, Ontario, Canada

**Geiger & Hamme** ........ G&H
Box 1345
Ann Arbor, Mich. 48106

**International Acoustical Testing Laboratory (INTEST)** ........ IATL
2200 Highcrest Drive
St. Paul, Minn. 55119

**Kodaras Acoustical Laboratory** ........ KAL
75-02 51st Avenue
Elmhurst, N. Y. 11373

**Riverbank Acoustical Laboratory** ........ RAL
1512 Batavia Avenue
Geneva, Ill. 60134

**National Bureau of Standards** ........ NBS
Sound Section
Room B106, Building 233
Washington, D. C. 20234

**Owens Corning Reverberation Laboratory** ........ OCRL
Product Testing Laboratory
Technical Center
Owens Corning Fiberglas Corp.
P.O. Box 415
Granville, Ohio 43023

**Scott Foam Division Acoustical Laboratory** ........ SFDAL
Scott Paper Co.
1500 East Second Street
Chester, Pa. 19013

**Product tested by the manufacturer** ........ CT
For address of the manufacturer
see Section II

These are the principal laboratories performing acoustical tests on products listed in this document. The first six are independent testing laboratories whose facilities meet the requirements for performing tests according to the standards discussed in Section V. Note, however, that the National Bureau of Standards does not perform tests of this sort on a routine basis as in the past. To maintain uniformity among testing laboratories, the American Society for Testing and Materials (ASTM) Committee E-33 on Environmental Acoustics periodically conducts a round robin test series, in which a single specimen is tested in each of the laboratories. The results of these tests are compared at the committee meetings, and laboratories are able to maintain their test results to within a few decibels of each other.

Not only do the independent testing laboratories participate in these round robin tests, but many manufacturers with their own test facilities also join the testing to check on and to maintain their calibration.

The next three laboratories are owned and operated by the manufacturer for the purpose of testing their own products. However, they sometimes perform tests for other companies and are thus identified here.

The last listing includes any testing facility operated by a company for the express purpose of testing their own products. These facilities do not necessarily meet the requirements imposed by any testing standard. However when they do meet the requirements the test data will include a statement that the test was performed in accordance with the required standard.

For the purpose of uniformity, testing laboratories identified as CLC, OCRL, and SFDAL are listed as company tested (CT) when the data are for their own products.

# V—DESCRIPTION OF PERTINENT STANDARDS

The published standards that pertain to the many types of noise measurements are too numerous to be included here. While ASTM is by no means the only organization publishing standards, it is these standards which cover almost all of the tests reported in the data tables in Section VI. It is therefore pointed out that since through the years standards have been changed, data obtained using older standards are somewhat different than they are today.

A user knows the year of the standard because the ASTM designation shows the year as the last digits of the code number. For example, for the present absorption test the code designation is C423-66 indicating standard number C423 first appeared as a standard in 1966. This does not necessarily mean that 1966 is the first year ASTM had a standard for absorption testing but that this form of the standard was published in 1966.

It should also be noted here that there are standards covering the measurement of these values under field rather than laboratory conditions. The procedures are basically the same in principle, but generally, tests performed in the field will yield poorer results than tests performed under controlled laboratory conditions. However if careful attention is given to detail during construction and good measurement practice is maintained, the field test can give values approaching the laboratory values.

## V-1.—ABSORPTION

The absorption standards are

**ASTM C423-66** American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms

**ASTM C423-65T** American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms

**ASTM C423-60T** American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms

**ASTM C423-58** American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms

**ASTM C384-58** American Society for Testing and Materials Standard Method of Test for Impedance and Absorption of Acoustical Materials by the Tube Method

*Brief descriptions of standards listed above:*

ASTM C423-66—Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

The measurement method for determining the sound absorption properties of materials in a diffuse sound field is specified. Included in the specification are the test methods, room and specimen requirements, and sound source.

When the specimen is in the form of an extended flat surface, the results are reported as random incidence absorption coefficients (i.e., absorption per unit area). If the specimen is in some specific size or shape such as a chair, or unit absorber, or landscape screen, etc., the results shall be reported as the total absorption in sabins for that unit (i.e., sabins/unit). When this is the case the size, shape, number, and spacing of the units during the test must be stated exactly. When the specimen is in the form of an extended flat surface an additional piece of information reported is a one-number rating called Noise Reduction Coefficient (NRC). This NRC is an average of the values of the absorption coefficients at 250, 500, 1,000, and 2,000 Hz.

Sometimes absorption coefficients measured by this method are greater than unity. This standard recommends that no adjustment be made to these values. However, if some adjustment is made the laboratory report must state exactly how the adjustment was performed. It is common for laboratories to report absorption coefficients greater than 1 but to round the NRC to 0.95 if it is greater than 1. The method for absorption testing in a reverberation room is described in Subsection I-3.1.1.

ASTM C423-65T — Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This test method and ASTM C423-66 are exactly alike. The number is different because the method was accepted tentatively in 1965, and then adopted officially in 1966.

ASTM 423-60T—Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This standard covers the same tests as ASTM C423-66 but allows a choice of three different sound sources. The other portions of the test procedure are essentially the same and results obtained in accordance with either form are equivalent.

The current standard states that the test signals shall be one-third octave bands of random noise with a continuous frequency spectrum and with either equal energy per constant bandwidth, called white noise, or equal energy per constant proportional bandwidth, called pink noise.

This earlier version of the standard permitted swept frequency tones or "warble" tones. The tone was warbled at a rate of 5 to 10 times per second through a range of +11 percent to −11 percent of the center frequency giving a bandwidth of approximately one-third octave. In lieu of warbling the tone signal this standard also permitted the use of suitable multitones centered on the standard test frequencies with a bandwidth of one-third octave. Finally, it also permitted the use of white noise of one-third octave bands centered on the standard test frequencies.

One of the main reasons for rewriting the absorption standard was to eliminate the differences in test signals between testing laboratories. The newer standard specifies only the one type of test signal that may be used. While the test signals are quite different in these two test procedures, no problems are encountered when using the earlier data since the values obtained according to each standard compare well with each other.

ASTM C423-58—Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This standard preceded and is similar to C423-60T. It was one of the first modern standards dealing with the properties of absorption as measured in the reverberation room.

ASTM C384-58 (Reapproved 1972)—Standard Method of Test for Impedance and Absorption of Acoustical Materials by the Tube Method.

The methodology for computing normal incidence absorption coefficients is specified. The method uses a closed tube with the specimen mounted in one end. A pure tone of sound is generated within the tube and the maxima and minima of the sound pressure inside the tube are measured.

Normal incidence absorption coefficients, which this method determines are always lower than random incidence coefficients determined in a reverberation room. There is no simple way of relating these two values, especially since the relationship depends on the material itself.

This standard is discussed in more detail in Subsection I-3.2.

## V-2.—PROPERTIES OF THERMAL INSULATION

The standards for the properties of thermal insulation are

| | |
|---|---|
| **ASTM C262-64** | American Society for Testing and Materials Standard Specification for Mineral Fiber Batt Insulation (Industrial Type) |
| **ASTM C553-70** | American Society for Testing and Materials Standard Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type) |

ASTM C612-70 — American Society for Testing and Materials Standard Specification for Mineral Fiber Block and Board Thermal Insulation

*Brief descriptions of standards listed above:*

ASTM C262 — Standard Specification for Mineral Fiber Batt Insulation (Industrial Type).

The composition, dimensions, and physical properties are specified for mineral fiber industrial batt type thermal insulation, for use on surfaces operating continuously at temperatures up to 1,200° F.

ASTM C553 — Standard Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type).

The composition, dimensions, and physical properties are specified for mineral fiber blanket and felt thermal insulation for use either on heated surfaces up to 400° F or on refrigerated surfaces of equipment, ducts, and space at temperatures below ambient.

ASTM C612 — Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

The composition, physical properties, and dimensions are specified for mineral fiber (rock, slag or glass) block and board intended for use as thermal insulation on surfaces at temperatures below ambient and above ambient up to 1,800° F.

## V-3.—TRANSMISSION LOSS, SOUND TRANSMISSION CLASS, AND IMPACT ISOLATION

The standards of transmission loss, determination of sound transmission class, and impact isolation are

ASTM E90-70 — American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E90-66T — American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E90-61T — American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E90-55 — American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

ASTM E336-71 — American Society for Testing and Materials Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings

ASTM E336-67T — American Society for Testing and Materials Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings

AMA-I-II-1967 — Acoustical Materials Association Ceiling Sound Transmission Test by the Two-Room Method for Measurement of Normalized Attenuation Factors

ASTM E413-70T — American Society for Testing and Materials Tentative Classification for Determination of Sound Transmission Class

| | |
|---|---|
| **ASTM E492-73T (RM14-4)** | American Society for Testing and Materials Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine |
| **FHA 750** | Federal Housing Administration Guide to Impact Noise Control in Multifamily Dwellings |

*Brief descriptions of standards listed above:*

ASTM E90-70 — Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

Testing of the sound barrier properties of walls, partitions, doors, windows, floors, floor-ceiling assemblies, or any other material or system which may be utilized to provide sound isolation between two spaces is covered. The procedure calls for mounting the specimen between two reverberation rooms and measuring the sound pressure level in each. A description of the test procedure can be found in Subsection I-3.3.

This standard was adopted in 1970 essentially unchanged from its predecessor which appeared in 1966.

ASTM E90-66T—Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This standard which covers testing of tiem sound barrier properties is the same as E90-70. It was in this standard that the test frequencies were fixed at one-third octave of either pink or white noise. Prior to this the transmission loss standard permitted the testing laboratory a choice of one of three different sound source signals.

ASTM E90-61T—Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

The same testing as in E90-66T and E90-70 is covered by this standard. However, the sound source is not as completely specified in this standard. Because of the different sound sources used, the data obtained under this standard sometimes showed values a few decibels higher in the lower frequencies. Also, this standard had provision for determining two different one-number ratings of the specimen.

One of these ratings is called the "Nine-Frequency Average". This number is simply the average decibel value of the transmission losses at the nine test frequencies of 125, 175, 250, 350, 500, 700, 1,000, 2,000, and 4,000 Hz. It should be noted that the test frequencies, while they are approximately one-third octave wide, they are centered on the one-half octaves and are not the series used in today's test standards.

The other one-number rating was called the Sound Transmission Class (STC). STC's obtained by this method are equivalent to STC's computed by E413-70T to within the accuracy of the measurements, however the methods of computation are different.

The change made in 1966 for transmission loss testing was the same as the change made in the absorption standard. The choice of one-third octave wide warble tone bands, or multitone bands, as in absorption testing, were replaced with a continuous spectrum source, either white or pink noise in shape, and filtered with a one-third octave band filter. Whereas this change produced little effect in absorption coefficients, the values of transmission loss tested with the newer sound source showed values 2 to 3 dB lower in the first few bands leaving the higher frequency bands relatively unchanged. Normally, a 2 to 3 dB change would not be a matter of major concern, although this 2 or 3 dB could result in a lower value of STC for a particular product.

ASTM E90-55 — Standard Recommended Practice for the Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This standard preceded and is similar to E90-61T. It was one of the first modern standards dealing with the properties of transmission loss of industrial materials.

ASTM E336-71—Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings.

This standard establishes uniform procedures for the determination of field transmission loss, i.e., the airborne sound insulation provided by a partition already installed in a building. It also establishes a standard method for the measurement of the noise reduction between two rooms in a building. If the test structure is a complete enclosure out-of-doors, neither the field transmission loss nor the noise reduction is appropriate; instead, a method for determining the insertion loss is established.

Results from this method may then be reported in three ways: Field Sound Transmission Class (FSTC), which provides an evaluation of the performance of a partition in certain common sound insulation problems; Noise Isolation Class (NIC), which provides an evaluation of the sound isolation between two enclosed spaces which are acoustically connected by one or more paths; or Field Insertion Loss (FIL), which is a measure of the sound isolation between two locations, one of which is not enclosed.

ASTM E336-67T — Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings.

This test method and ASTM E336-71 are exactly alike. The numbers are different because it was accepted as a tentative method in 1967 before the official adoption in 1966.

AMA-I-II-1967—Ceiling Sound Transmission Test by the Two-Room Method for Measurement of Normalized Attenuation Factors.

The method of test is intended for the direct measurement of sound transmission through a suspended ceiling. This is a performance test for a configurational property of ceiling construction, without explicit reference to the sound absorption coefficients or sound transmission loss (*TL*) of ceiling materials. Performance is rendered independent of the total *in situ* absorption contribution of the receiving-room ceiling under test conditions by normalizing results with respect to separate measurements and thereby focusing attention upon the relative energy transmission of the ceiling configuration. The method of test is designed to reflect field conditions of ceiling erection under laboratory conditions of measurement control.

ASTM E413-70T—Tentative Classification for Determination of Sound Transmission Class.

The purpose of this classification is to provide a standard method for determining the one-number rating of sound barrier items. The original intention of STC was to correlate measured sound reduction properties with subjective impressions of the specimen performance when used as a barrier against such sounds as speech, music, radio, television, etc., because these are the types of sounds that exist in most homes, apartments, offices, and schools. Consequently, the sounds of a factory, or of jet aircraft, or other transportation systems, whose noise spectrum is quite different from music or speech are not well treated by the STC value. It is therefore necessary to use the complete set of *TL* values to determine the performance of a partition against such noises.

Prior to the publication of E413 in 1970 the procedure for determining STC was published by ASTM as a recommended method (RM14-2) in 1966. This procedure is the same as E413 and first appeared in 1966 when E90 was revised. The procedure for determining STC before 1966 was a part of E90-61T and was different from the present method (see discussion of E90-61T).

This standard specifies the technique for comparing the *TL* values at each of the 16 one-third octave bands to the STC contours and the determination of the STC. The highest contour to which the specimen *TL* curve meets the requirements (see Subsection I-3.3.2) is the STC curve. The value of this curve at 500 Hz is the STC rating of the specimen. The numerical values for this set of standard contours are shown in Table I-5.

Further discussion of STC can be found in Subsection I-3.3.

ASTM E492-73T (RM14-4) — Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine.

This procedure was originally published in 1971 as a recommended method only (RM14-4). The method uses a standard tapping machine to produce impacts on a floor-ceiling assembly and the sound pressure levels produced by these impacts are measured in the room below the assembly. There is still much debate over the use of the tapping machine as to impact source because many feel that these impacts are not representative of noises produced by such occurrences as dropping objects on the floor, sliding objects across the floor, and in particular, the noises due to footfalls. Prior to the publication in 1971 of RM14–4 there was no American standard to cover impact testing. There is, however, an international standard which is very much the same which is published by the International Standards Organization (ISO) as R140. This standard does not provide for an IIC value but did specify normalization to 10 metric sabins (meter$^2$) absorption.

This standard is discussed in more detail in Subsection I–3.4.

FHA 750—Guide to Impact Noise Control in Multifamily Dwellings.

This authority establishes a method of testing which makes it possible to evaluate different floors, as to their ability to impede the transmission of impact noise to the space below.

A tapping machine, which generates the impact noise, is set into operation on the floor. Sound pressure levels are then taken in the space below. These levels are normalized to a receiving room with a reverberation time of 0.5 second. The normalized levels are then compared to the standard FHA impact noise curve, allowing a single number, the Impact Noise Rating (INR), to be determined. INR numbers which are zero or greater meet the recommended FHA specifications; those less than zero do not. The higher the INR the better the impact isolation.

## V–4.—AMERICAN NATIONAL STANDARDS INSTITUTE

For the many other types of acoustic test data there is probably some type of standard which governs the procedure. While the above test standards and the many other standards that relate to specific types of items provide for the measurement of particular items, there is another series of standards that specifies general acoustic measurement methods, values for references, etc. These are the standards published by the American National Standards Institute (ANSI).

This institute was originally known as the American Standards Association and the published standards have the prefix ASA. In 1966 the name was changed to United States of America Standards Institute (USASI) and standards published by this group are prefixed with USAS. Again in 1969 the name of this organization was changed. Since American National Standards Institute is the current name, the following standards are shown with the prefix ANSI regardless of the year of publication. While some copies of earlier standards may bear the title of ASA standard or USAS standard, all of these have been adopted as ANSI standards. These standards specify how to make acoustic measurements, the characteristics of laboratory microphones, how calibrations shall be performed on these, test room characteristics, etc. This organization does not concern itself with the special procedures which must be followed when making these measurements on any special class of items.

These standards are listed below and described in the subsequent paragraphs.

| | |
|---|---|
| **ASA Z24.19–1957** | Laboratory Measurement of Airborne Sound Transmission Loss of Building Floors and Walls |
| **ANSI S1.1–1960** | American National Standard Acoustical Terminology. |
| **ANSI S1.2–1962** | American National Standard Method for the Physical Measurement of Sound |
| **ANSI S1.4–1971** | American National Standard Specification for Sound Level Meters |
| **ANSI S1.6–1967** | American National Standard Preferred Frequencies for Acoustical Measurements |

| | |
|---|---|
| ANSI S1.8-1969 | American National Standard Preferred Reference Quantities for Acoustical Levels |
| ANSI S1.10-1966 | American National Standard Method for the Calibration of Microphones |
| ANSI S1.11-1966 | American National Standard Specification for Octave, Half-Octave, and One-Third Octave Band Filter Sets |
| ANSI S1.12-1967 | American National Standard Specification for Laboratory Standard Microphones |
| ANSI S1.13-1971 | American National Standard Method for the Measurement of Sound Pressure Levels |
| ANSI S1.21-1972 | American National Standard Method for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms |

*Brief descriptions of standards listed above:*

ASA Z24.19-1957 — Laboratory Measurement of Airborne Sound Transmission Loss of Building Floors and Walls.

This recommended practice is intended to cover the random incidence or reverberant sound method for the laboratory measurement of airborne sound transmission loss of floors, walls, windows, doors, etc. It gives specifications for the test facility and testing equipment including the signal requirements of random noise or warble tone, sound sources, position of microphones, and format for the report. It also gives minimum conditions of the sample.

ANSI S1.1-1960—American National Standard Acoustical Terminology (Including Mechanical Shock and Vibration).

The purpose of this standard is to establish and define standard acoustical terminology.

ANSI S1.2-1962—American National Standard Method for the Physical Measurement of Sound.

Methods for measuring and reporting the sound pressure levels and sound power generated by a source of sound are established. This standard applies primarily to airborne sound produced by apparatus which normally operates in air. These sounds must not be impulsive and must be of sufficient duration to be within the dynamic measuring capabilities of the instruments used.

ANSI S1.4-1971—American National Standard Specification for Sound Level Meters.

The purpose of this standard is to maintain maximum possible accuracy of sound level measuring instruments and to maintain uniformity between instrument measured quantities.

Characteristics of sound level meters starting with the amplitude, frequency response, and directional properties of the microphone are specified. The frequency weighting filters are standardized both to shape of the weighting function and tolerances on these shapes. The tolerances are divided into three groups with Type I (Precision) the most stringent, then Type II (General Purpose) and Type III (Survey) the least stringent. Meter response time and output requirements are also covered.

ANSI S1.6-1967—American National Standard Preferred Frequencies for Acoustical Measurements.

To maintain uniformity and comparability among measurements this standard specifies which series of frequencies shall be used as the preferred octave, one-half octave, and one-third octave bandwidths. It is in this standard that the one-third octave series is modified so that they are actually one-tenth decade. This modification changes the bandwidths less than 0.1 percent and provides a series of frequencies where 10 successive one-third octave bands are in the ratio of 10:1 in center frequency (see Subsection I-2.2.4).

ANSI S1.8-1969—American National Standard Preferred Reference Quantities for Acoustical Levels.

Values to be used as reference when acoustic quantities such as power, pressure, intensity, etc., are stated in the form of levels are specified. This standard does not specify that level shall be used but provides the reference to a convenient magnitude for any physical quantity that may be used in acoustics.

ANSI S1.10-1966 — American National Standard Method for the Calibration of Microphones.

Techniques and principles involved for performing absolute calibration of microphones are described. Experimental procedures for determining pressure, free field, and diffuse field calibrations are standardized. These procedures provide for either absolute calibration based on the reciprocity principle or calibration by comparison with another microphone.

ANSI S1.11-1966 — American National Standard Specification for Octave, Half-Octave, and One-Third Octave Band Filter Sets.

Just as ANSI S1.4 specifies the characteristics and tolerances on sound level meters, this standard specifies the characteristics of band pass filters for acoustical measurements. Some of the items specified are the features of the pass band and the slope and width of the skirts of the band. This standard assures the user of acoustic band pass filter sets that measurements made with one filter set will agree with those made with any other filter set providing each set conforms to the standard.

ANSI S1.12-1967 — American National Standard Specification for Laboratory Standard Microphones.

The physical, electrical, and acoustical properties of microphones that are suitable for calibration by an absolute method, such as the reciprocity technique described in ANSI S1.10, are described. These microphones are intended to be used for acoustical standards or as comparison microphones for calibrating other microphones by the comparison technique.

ANSI S1.13-1971 — American National Standard Method for the Measurement of Sound Pressure Levels.

This standard is a partial revision of ANSI S1.2-1962 and contains recommendations pertaining to the techniques of the physical measurement of sound. These techniques are applicable to a variety of environment conditions but are not intended to include measurements made for the purpose of determining the sound power level radiated from a source. This standard is applicable to the many different types of sound pressure level measurements that may be encountered in practice and is intended to provide assistance to those persons responsible for the preparation of test codes, ordinances, acoustical criteria, and effects of noise on people, etc.

ANSI S1.21-1972 — American National Standard Method for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms.

While the main purpose of this standard is to describe in detail the procedures for the measurement of sound power levels, its pertinence here is due to the lengthy and complete discussion of the quality and characteristics of the reverberation room for making the measurements. This standard describes both a direct method for determining sound power level and a comparison method which uses a calibrated reference sound source.

# DATA TABLES

## SECTION VI
## DATA TABLES

GUIDES TO TABLES

Materials for noise control come in a variety of forms. Actually any material can be used to reduce noise since each form has a certain capacity to absorb, reflect or attenuate sound. The products listed in the data tables have been proven to be efficient and/or economical means to reduce noise. Usually the basic materials are either good sound barriers or absorbers. To improve the acoustic performance of a product, two or more such materials are often combined to form a composite material or a total sound control system. There are materials and systems which control noise directly by sound absorption or sound transmission reduction, and indirectly by limiting the sound power output of machines by reducing the vibration levels of panels, floors, etc. This diversity of products requires different testing procedures and parameters. For this reason products are grouped in these tables so that a meaningful study of the products and their properties may be made.

Group A: Sound Absorption Materials (Tables 1 through 5)

Foams, glass fiber products, spray-on materials, felts, and concrete blocks with cavities.

Group B: Composite Materials for Sound Absorption and Sound Transmission Reduction (Tables 6 through 12)

Foams laminated to lead or leaded vinyl, foam with protective films, glass fibers applied to barrier materials, and other such products.

Group C: Sound Barrier Materials (Tables 13 through 18)

Lead, mastic, mastic with cotton, glass, plastic, and others.

Group D: Sound Absorption Systems (Tables 19 through 25)

Functional absorbers, wall treatments, ceilings, partitions, curtains, floor coverings, and roof decks.

Group E: Composite System for Sound Absorption and Transmission Reduction (Table 26)

Quiet rooms and booths constructed from sound barrier panels on the outside and lined with absorptive materials on the inside.

Group F: Sound Barrier Systems (Tables 27 through 43)

Walls, floors, ceilings, roof decks, curtains, partitions, panels, machinery enclosures, floor coverings, and pipe laggings. Certain floors and floor coverings which reduce impact noise generation and transmission are also listed in this group of tables.

Group G: Specialized Items (Tables 44 through 47)

Special materials like rubber, cloth, etc., which may be used with advantage in specific applications. Also included in this group are gaskets, sealants, special application products, general building materials, and furnishings.

The data tables along with appropriate footnotes are for the most part self-explanatory. The following comments are made to clarify or to emphasize certain points:

- The tables are presented in three distinct formats: (1) Transmission loss and noise reduction data are provided for each one-third octave band with center frequencies of 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, and 4000 Hz. (2) In a slightly different format, sound absorption coefficient data are shown for one-third octave bands with center frequencies of 125, 250, 500, 1000, 2000, and 4000 Hz. (3) Products for which the transmission loss or sound absorption type information was not available are listed as to product name, description, application, and manufacturers.

- The products are arranged in the order of increasing thicknesses. Sound absorption of the products depends upon how they were mounted in the test laboratory and accordingly, sound absorption materials are initially arranged according to the mounting number. For each mounting method the products are arranged according to their thicknesses.

- Testing procedures are not always identical for the products listed in the same table. For this reason the footnotes and the test procedure codes should be studied carefully before making a comparison between two products in the same table.

- The weight or density of the product may be given in $lb/ft^2$, $lb/ft^3$, or in lb/unit. The column headings show the units used in each table.

- The identification numbers of the manufacturers appearing in the data tables are listed in Section II.

- The Lab. column identifies the laboratory where the acoustic test was performed and the test report number. Acronyms of the laboratories are used and they are spelled out in Section IV.

- A dash indicates that the information for the column was not available.

- Product name is listed in the Product column. Some items are identified by a short product description as no trade name was given.

- Some products are in more than one table, their properties being applicable to a variety of situations.

- Glossary includes generic trade terms, but does not include more specific, product orientated terms which are described in the footnotes.

- Footnotes include specific product information, test specifications or test method, and other useful data.
- Abbreviations and rating codes that are used in the tables and footnotes to provide additional acoustic or nonacoustic information about a product or test procedure are explained below.

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| UL | Underwriters Laboratories |
| UL 94 | UL Specification 94 -- ASTM Designation D1692. Small-scale laboratory procedure to compare flammability. Correlation with flammability under actual use condition is not implied. |
| Temperature Range | Range of temperature in which the product behaves according to specification |
| Humidity Range | Range of relative humidity in which the product behaves according to specification |
| AIMA | Acoustical and Insulating Materials Assn. |
| AMA | American Materials Assn. (Now AIMA) |
| ANSI | American National Standards Institute |
| FHA | Federal Housing Administration |
| ASA | American Standards Assn. (Now ANSI) |
| ISO | International Standards Organization |
| NEMA | National Electrical Manufacturers Assn. |
| NFPA | National Fire Protection Assn. |
| UL Fire Hazard Classification a/b/c | The UL-developed tunnel test method, UL723, for testing the fire characteristics of building materials is also known as standard ASTM E-84 and NFPA Number 255.<br>a: Flame Spread<br>Material to be tested is placed on the underside of a removable top panel of a tunnel and a flame is introduced at one end. The distance at which the flame spreads, in a given period of time, is called the flame spread and is rated on a scale where cement asbestos board is zero and red oak is 100. Most building codes have sections in which the most stringent requirements permit a flame spread rating from zero to 25.<br>b: Fuel Contributed<br>The temperature rate of increase is measured at the end of the tube opposite the flame, and again compared to cement asbestos board and red oak.<br>c: Smoke Developed<br>The smoke density is measured with a photoelectric cell. |

Figures used in table guides are included courtesy of the following manufacturers:

| Figure | Company |
|---|---|
| 1 | Sound Solutions Corp. |
| 5 | The Proudfoot Co. Inc. |
| 6 | Sound Solutions Corp. |
| 7 | Specialty Composites Corp. |
| 10A | Canada Metal Co. Ltd. |
| 10B | Globe Industries, Inc. |
| 11A | Stark Ceramics Inc. |
| 11B | Specialty Converters, Inc. |
| 12A | Canada Metal Co. Ltd. |
| 12B | Korfund Dynamics |
| 19A | Pittsburgh Corning Corp. |
| 19B | Insul-Coustic Birma Corp. |
| 19C | Owens/Corning Fiberglas Corp. |
| 20A | L. E. Carpenter and Co. |
| 20B | Owens/Corning Fiberglas Corp. |
| 21 | Owens/Corning Fiberglas Corp. and Johns-Manville Sales Corp. |
| 22 | L. E. Carpenter and Co. |
| 25A | Concrete Products, Inc. |
| 25B | Inland Ryerson |
| 26A | Industrial Acoustics Co. Inc. |
| 26B | Korfund Dynamics |
| 27A | Owens/Corning Fiberglas Corp. |
| 27B | National Gypsum Co. |
| 28 | Virginia Metal Products |
| 29 | Florida Concrete |
| 30 | Owens/Corning Fiberglas Corp. |
| 31 | Owens/Corning Fiberglas Corp. |
| 32 | Overly Manufacturing Co. |
| 33 | Amelco Window Corp. |
| 34 | Acoustical and Insulating Materials Assn. |
| 36 | National Research Corp. |
| 37 | Hough Manufacturing Corp. |
| 40 | General Noise Control Corp. |
| 43 | Ferro Corp. |

## TABLE 1
## FOAMS

The sound absorption properties of various types of foams are listed. Foam has excellent absorption, provides a fair amount of vibration isolation and damping, but is a poor sound barrier material. Ester types of polyurethane foams are most commonly used for noise reduction. These flexible foams are available in reticulated open-pore construction or non-reticulated with a microporous integral skin left intact.

Foams with convoluted surfaces and compressed felt-like foams are also manufactured to maximize absorption in specific frequency regions. The 2 $lb/ft^3$ density foam is normally used for sound absorption. Flame retardatory additives and protective films for dirty or oily environments are the commonly available options.

The table is arranged in the order of increasing thicknesses ranging from 1/4 inch to 6 inches. Figure 1 shows foams of different thicknesses. The companies (by number shown in Section II) with products listed in Table 1 are: 6, 12, 34, 45, 65, 72, 77, 82, 119, 125, 150, 156, 157, 191.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. ABSORPTION COEFFICIENTS ARE SHOWN EITHER AS PERCENTAGES (NORMAL INCIDENCE DATA) OR AS DECIMAL FRACTIONS (RANDOM INCIDENCE DATA). THE DIFFERENCES BETWEEN THESE TWO DATA ARE DISCUSSED IN SECTION I-3.2.

GLOSSARY

Reticulated: Thread-like network.

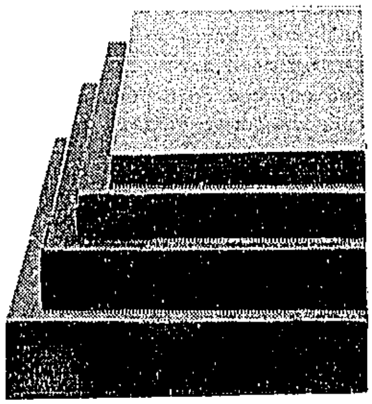


Figure 1  Sample Illustration
of Acoustical Foam

TABLE 1 FOAMS

| Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/4 | .25 | 2.2% | 2.6% | 3.6% | 7.0% | 36% | 62% | 2 | IATL S-250 | 12 | Industrial Foam 4100 | 1,3, 24 |
| 1/4 | .30 | 2.4% | 2.9% | 3.4% | 5.9% | 17% | 66% | 2 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 1/4 | .33 | .08 | .10 | .20 | .30 | .70 | 1.00 | 2 | - | 45 72 | Coustifoam | 5,15,27 |
| 1/4 | .38 | 2.2% | 3.3% | 8.4% | 17.8% | 45% | 63% | 2 | IATL | 12 | Industrial Foam 2950 | 1,3, 24 |
| 1/4 | - | 12% | 14% | 27% | 45% | 60% | 69% | 2 | - | 157 | UL-94 Foam | 6,9 |
| 1/4 | - | .04 | .10 | .13 | .24 | .61 | 1.00 | - | CT | 150 | Scott Fine Pore Acoustical Foam | 9,17,25 |
| 1/4 | - | .10 | .10 | .13 | .18 | .48 | .75 | 2 | IATL | 65 | Acoustical Foam F-2007 | 7,9 |
| 1/4 | - | | .17 | .13 | .23 | .82 | 1.00 | 2 | RAL T72-1 | 191 | Unifoam | 23,24 |
| 3/8 | .35 | .15 | .20 | .26 | .21 | .73 | .59 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 1/2 | .31 | .15 | .21 | .26 | .17 | .63 | .65 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 1/2 | .32 | 3% | 4% | 5.2% | 9% | 23% | 79% | 2 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 1/2 | .45 | .09 | .11 | .22 | .60 | .88 | .95 | 2 | IATL | 45 72 | Coustifoam | 5,15,27 |
| 1/2 | .51 | 6% | 11% | 20% | 32% | 70% | 85% | - | SFDAL | 12 | Acoustic Foam 4780 | 3,4, 24 |
| 1/2 | .60 | 4.3% | 10.2% | 24% | 35% | 68% | 62% | 2 | IATL | 12 | Industrial Foam 2950 | 1,3, 24 |
| 1/2 | .65 | 3% | 4.8% | 11.5% | 46% | 86% | 56% | - | IATL | 12 | Foamkote-749 on Foam #2950 | 10,24, 26 |
| 1/2 | .66 | 5.4% | 7.2% | 15.5% | 57% | 71% | 66% | 2 | IATL 5-250 | 12 | Industrial Foam 4100 | 1,24 |
| 1/2 | .67 | 3.6% | 9.2% | 25% | 75% | 47% | 32% | - | IATL | 12 | Foamkote-749 on Foam #4100 | 1,10, 24,26 |
| 1/2 | - | 16% | 25% | 44% | 82% | 93% | 94% | 2 | - | 157 | UL-94 Foam | 6,9 |
| 1/2 | - | .10 | .10 | .22 | .40 | .75 | .82 | 2 | - | 65 | Acoustical Foam F-2007 | 7,9 |
| 1/2 | - | .075 | .12 | .26 | .51 | .84 | .90 | 2-4 | CT | 150 | Pyrell | 13,14, 25 |
| 1/2 | .51 | .12 | .21 | .36 | .54 | .92 | 1.00 | 2.5 | CT | 150 | Coustex | 12,23, 25,28 |
| 1/2 | - | - | .10 | .27 | .50 | .86 | 1.00 | 4 | CT | 150 | Scottfelt 4-900 | 11,25, 28 |
| 1/2 | - | .07 | .10 | .21 | .45 | .80 | 1.00 | 4-40 | CT | 150 | Scottfelt 3-900 | 11,25, 28 |

TABLE 1 FOAMS (Contd)

| Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | - | .06 | .13 | .30 | .63 | .97 | .92 | - | CT | 150 | Scott Fine Pore Acoustical Foam | 9,17, 25 |
| 5/8 | .38 | .14 | .18 | .28 | .21 | .86 | .97 | 2.1 | RAL T7201 | 6 | Acousti-foam | 8,23,24 |
| 3/4 | .39 | 3.9% | 5.5% | 8.1% | 17.5% | 51% | 91% | 2.1 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 3/4 | .60 | 7% | 13% | 25% | 45% | 81% | 85% | - | SFDAL | 12 | Acoustic Foam 4780 | 3,4, 24 |
| 3/4 | .61 | 7.3% | 16.5% | 29% | 44% | 58% | 56% | 2 | IATL | 12 | Industrial Foam 2950 | 1,3, 24 |
| 3/4 | .67 | 4.2% | 7.0% | 11.5% | 38% | 98.5% | 66% | 2 | IATL | 12 | Industrial Foam 4100 | 1,3, 6,24 |
| 3/4 | - | 22% | 34% | 61% | 87% | 96% | 95% | 2 | CT | 157 | UL-94 Foam | 6,9 |
| 3/4 | .60 | .14 | .25 | .44 | .70 | .98 | 1.00 | 2.4 | CT | 150 | Coustex | 12,23, 25,28 |
| 13/16 | .59 | .16 | .25 | .40 | .73 | .98 | .78 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 1 | .58 | 4.5% | 7.3% | 11.4% | 29.5% | 79% | 82.5% | 2 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 1 | .63 | .16 | .25 | .45 | .84 | .97 | .87 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 1 | .63 | 10.5% | 20.5% | 29% | 56% | 51% | 63% | 2 | IATL | 12 | Industrial Foam 2950 | 1,3, 24 |
| 1 | .64 | 8% | 15% | 30% | 53% | 85% | 86% | - | SFDAL | 12 | Acoustic Foam 4780 | 3,4, 24 |
| 1 | .65 | .08 | .20 | .47 | .90 | 1.00 | 1.00 | - | CT | 150 | Scottfelt 3-900 | 11,23, 25,28 |
| 1 | .65 | .16 | .30 | .53 | .80 | 1.00 | 1.00 | 2.4 | CT | 150 | Coustex | 12,23, 25,28 |
| 1 | .65 | .13 | .27 | .46 | .91 | .95 | .89 | - | CT | 150 | Pyrell | 13,14, 25 |
| 1 | .70 | - | .37 | .68 | .93 | .89 | .84 | 2 | CT | 150 | Afonic | 14,25 |
| 1 | .70 | .08 | .24 | .66 | 1.02 | .93 | .81 | 2 | G&H | 77 | Foamade Product 22313 | 16,23, 26 |
| 1 | .72 | 7.2% | 11.5% | 23% | 67% | 83% | 82% | 2 | IATL | 12 | Industrial Foam 4100 | 1,3, 24 |
| 1 | .72 | 8% | 19% | 43% | 74% | 47% | 38% | - | IATL | 12 | Foamkote-749 on Foam #4100 | 1,10, 24,26 |
| 1 | .73 | .5% | 9% | 30% | 98.5% | 52% | 71% | - | IATL | 12 | Foamkote-749 on Foam #2950 | 1,10, 24,26 |
| 1 | .73 | 8.2% | 38% | 51% | 54% | 48% | 64% | 6 | IATL | 12 | Industrial Foam 4600 | 1,3, 24 |
| 1 | .76 | .23 | .54 | .60 | .98 | .93 | .99 | 2 | - | 45 72 | Coustifoam | 5,15,27 |
| 1 | .77 | 8.3% | 16.4% | 49% | 89% | 61% | 79% | 4 | IATL | 12 | Industrial Foam 4400 | 1,3, 24 |

TABLE 1 FOAMS (Contd)

| Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .85 | .11 | .48 | 1.04 | .90 | .89 | .97 | 1.8 | RAL A69-60 | 191 | 90 PPI Custom Foam | 16,26 |
| 1 | - | .16 | .26 | .47 | .72 | .93 | .92 | 2 | - | 65 | Acoustical Foam F-2007 | 7,9 |
| 1 | - | 31% | 61% | 86% | 96% | 99% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 1 | - | 27% | 44% | 70% | 93% | 97% | 96% | 2 | - | 157 | UL-94 Flat Surface Foam | 6,9 |
| 1 | - | .10 | .28 | .49 | .96 | 1.00 | .95 | 2 | CT | 150 | Scott Fine Pore Acoustical Foam | 9,17, 25 |
| 1 | - | .10 | .23 | .39 | .72 | 1.00 | 1.00 | 4-40 | CT | 150 | Scottfelt 2-900 | 11,25, 28 |
| 1 | - | .20 | .40 | .73 | .86 | .86 | .94 | 4-40 | CT | 150 | Scottfelt 7-900 | 11,25, 28 |
| 1-7/16 | .69 | .17 | .30 | .53 | .97 | .96 | .96 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 1-1/2 | .66 | 21.2% | 24% | 36% | 62% | 48% | 65% | 2 | IATL | 12 | Industrial Foam 2950 | 1,3, 24 |
| 1-1/2 | .75 | 11.5% | 18.1% | 33% | 86% | 87% | 98% | 2 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 1-1/2 | .85 | 10% | 21% | 53% | 97.5% | 75% | 84% | 2 | IATL | 12 | Industrial Foam 4100 | 1,3, 24 |
| 1-1/2 | - | 31% | 72% | 91% | 97% | 99% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 2 | .64 | 21.8% | 24% | 36% | 50.5% | 52% | 61% | - | - | 12 | Industrial Foam 2950 | 1,3, 24 |
| 2 | .80 | .19 | .43 | .77 | 1.00 | 1.00 | 1.00 | 2-4 | CT | 150 | Scott Industrial Foam | 22,23, 25,28 |
| 2 | .80 | .24 | .49 | .81 | .91 | .98 | .97 | 2.1 | - | 6 | Acousti-foam | 8,23,24 |
| 2 | .82 | .17 | .38 | .94 | .96 | .99 | .91 | 2 | - | 45 72 | Coustifoam | 5,15, 27 |
| 2 | .87 | 14.5% | 32% | 70% | 95.2% | 67% | 77.5% | 2 | IATL | 12 | Safety Foam 4750 | 2,3, 24 |
| 2 | .90 | 18.2% | 46% | 62% | 81% | 84% | 80.5% | 2 | IATL | 12 | Industrial Foam 4100 | 1,3, 24 |
| 2 | - | .33 | .50 | .72 | .85 | .96 | .91 | 2 | - | 65 | Acoustical Foam F-2007 | 7,9 |
| 2 | - | 33% | 91% | 97% | 100% | 99% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 2 | - | .60 | .91 | 1.00 | 1.00 | 1.00 | 1.00 | 4 | CT | 150 | Scottfelt 2-1/2 -900 | 11,25, 28 |
| 2 | - | .27 | .61 | .90 | .98 | 1.00 | 1.00 | 4-40 | CT | 150 | Scottfelt 3-900 | 11,25, 28 |
| 2-1/2 | - | 39% | 94% | 99% | 100% | 99% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 3 | .82 | .36 | .54 | .91 | .86 | .97 | .99 | 2 | - | 45 72 | Coustifoam | 5,15, 27 |

TABLE 1 FOAMS (Concl)

| Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | - | 81% | 85% | 98% | 100% | 97% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 4 | .58 | .04 | .22 | .46 | .80 | .84 | .88 | 2 | - | 119 | Open Cell Polyurethane Foam | 18,23 |
| 4 | .86 | .56 | .69 | .85 | .90 | .98 | .95 | 2.1 | RAL T72-1 | 6 | Acousti-foam | 8,23,24 |
| 4 | .89 | .67 | .80 | .90 | .92 | .94 | .97 | 2 | - | 45 72 | Coustifoam | 5,15,27 |
| 4 | - | .41 | .83 | 1.00 | 1.00 | 1.00 | 1.00 | 2-4 | CT | 150 | Scott Industrial Foam | 22,25, 28 |
| 5 | .90 | .72 | .83 | .88 | .93 | .95 | .98 | 2 | - | 45 72 | Coustifoam | 5,15,27 |
| 5 | - | 86% | 96% | 99% | 100% | 99% | 96% | 2 | - | 157 | UL-94 Convoluted Foam | 6,9 |
| 6 | .91 | .72 | .83 | .88 | .94 | .97 | 1.00 | 2 | - | 45 72 | Coustifoam | 5,15,27 |
| 6 | - | .80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2-4 | CT | 150 | Scott Industrial Foam | 22,25, 28 |
| - | - | | | See Footnote | | | | - | - | 156 | Foam Sheet (SFF-I, SFF-II) | 19 |
| - | - | | | See Footnote | | | | - | - | 34 | Fire Retardant Urethane Foam | 20 |
| - | - | | | See Footnote | | | | - | - | 125 | Synthocell | 21 |
| 24 | 1 | .99+ | | | | | | - | - | 82 | Polyurethane Wedges | 29 |

FOOTNOTES FOR TABLE 1

FOAMS

1. Polyester urethane foam, chemical resistant, self-extinguishing.

2. Open cell, flexible polyester urethane foam combined with a permanent fire retardant. UL approved. Passed UL test 94.

3. Supplied in sheet, roll, slab, or block form. Custom fabrication available. Sound barrier laminates and protective sheets or films can be ordered with the foam.

4. Polyester urethane foam with a microporous integral skin and reticulated cellular structure of good repeatability. UL approval pending.

5. Self-extinguishing, resilient with less than 10% compressive set, temperature range -45° to 275°F, also good thermal insulation, resistant to oils, greases, alkalis and mild acids.

6. Certified by UL to meet or exceed their number 94 specifications. Polyester foam with charcoal color is available in thicknesses ranging from 1/4 inch to 5 inches. Standard sheet size is 36" x 56". Custom sizes and thicknesses on request. The product is available with 1/2 mil flexible vinyl film or 1/2 mil DuPont Mylar coating. Foam with convoluted surface is also available in similar sizes and it is claimed that greater low frequency attenuation is achieved by this surface as compared to flat surface foam.

7. Polyurethane polyether foam. Self-extinguishing per ASTM D1692-67T. Sizes: 2'x 4' sheets. Density 2 ± 0.1 lb/cu ft. Maximum temperature 250°F. Thicknesses: 1/4", 1/2", 1", 2". Recommended adhesive 3M34 industrial adhesive.

8. Fire retardant, flexible polyurethane foam. Can be glued, taped, heat sealed, nailed or bonded. Supplied in rolls 36" wide x 20 yards long, and in 1/4", 1/2", 3/4", and 1" thicknesses. Also available laminated to mass filled vinyl or reinforced foil. Color: gray. Maximum compressive set 10%. Tested according to ASTM C384-58.

9. Data extracted from a graph.

10. Melts at 275°F, nonburning, polyethylene sheeting is chemically inert and impervious to all normal contaminants.

11. Flexible, compressed urethane foam. Permanent set as high as 20 (compressed to 1/20 of original thickness) available. Can be cut, glued, or shaped. Available in various sizes. Thickness range: 1/16" to 2".

12. Reticulated polyurethane foam with microporous surface. Passes ASTM 1692-68 test for flame retardance. Temperature range: -40° to 250°F. Chemical resistant.

13. Polyester polyurethane foam. Temperature range: -40° to 250°F. Available in various sizes with or without barrier laminates. Protective coverings. Passes vertical and horizontal tests for fire retardant effectiveness. Flame spread UL-94.

14. Flame spread - UL-94. Temperature range: -40° to 250°F. Excellent resistance to chemicals.

15. Polyester flexible foam. Supplied in sheet of roll form to suit customer requirements.

16. Hung on wall with approximately 2" space between wall and the test specimen.

17. Is not an open-pore foam. Available in various sizes and shapes. Resilient.

18. Temperature range: 0° to 150°F. Relative humidity range: 0 to 95%. Self-extinguishing, ASTM D16[illegible]

19. Foam with Pyrell. Available with Tedlar finish. Fire retardant. Size: 48" x 24". Thickness 1/2", 1", and custom.

20. Fire retardant foam. Temperature range: -50° to 175°F. Humidity range: 0 to 95%. Flame spread less than 4" per minute. Sizes as required. Density range: 1.5 to 4 lb/cu ft.

21. Resilient molded foam made in any desired shape. Density range: 2.5 to 4.5 lb/cu ft.

22. Reticulated, open-pore, ester type of polyurethane foam. Temperature range: -40° to 250°F. Is not affected by oils or greases at normal temperatures. Ninety pores per linear inch. Available as buns, rolls, or fabricated parts. Various sizes. Colors: gray, beige, or green.

23. Tested in number 4 mounting position.

24. Tested and evaluated according to ASTM C384-58 impedance tube test method.

25. Normal incidence data obtained with impedance tube corrected to random absorption coefficients.

26. Tested and evaluated according to ASTM C423-66 reverberation room test method.

27. Reverberation room test method used.

28. Temperature range: -40° to 225°F. Flame retardant. Conforms to ASTM 1692-59T, excellent chemical resistance.

29. 24" x 24" x 25" long wedge. Module comprised of three 8" x 24" x 25" long polyurethane wedges. For use in anechoic chambers.

## TABLE 2
## GLASS FIBER MATERIALS

The sound absorption properties of various glass fiber products are listed. Long glass fibers when bonded with resins or other bonding materials, convert acoustic energy into heat through air friction within the porous body of the material. However, glass fiber products are poor sound barrier materials.

Table 2 is subdivided into five parts (2A, 2B, 2C, 2D, and 2E) for convenience. The scheme of the subdivision is:

2A Glass fiber products tested with mounting No. 4

2B Glass fiber products tested with mounting No. 6 and thicknesses up to 1/2 inch

2C Glass fiber products tested with mounting No. 6 and thicknesses 3/4 inch and 1 inch

2D Glass fiber products tested with mounting No. 6 and thicknesses greater than 1 inch

2E Glass fiber products tested with mounting No. 7

Within each table the products are arranged in the order of increasing thickness. The companies (by numbers shown in Section II) with products listed in Table 2 are: 6, 109, 132

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. AND ILLUSTRATED IN FIGURE I-11.

### GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

TABLE 2A GLASS FIBER TESTED WITH MOUNTING NO. 4

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density $lb/ft^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1/2 | .40 | .04 | .13 | .32 | .46 | .61 | .73 | .85 | CKAL 671-8 | 109 | Spin-glas | 11,18 |
| 4 | 1/2 | .45 | .08 | .14 | .32 | .60 | .73 | .73 | .75 | - | 109 | Microlite | 12 |
| 4 | 1/2 | .50 | .08 | .16 | .37 | .68 | .77 | .78 | .75 | - | 109 | Microlite | 12 |
| 4 | 1/2 | .50 | .01 | .15 | .43 | .62 | .74 | .90 | 1.9 | CKAL 671-12 | 109 | Spin-glas | 11 |
| 4 | 1/2 | .55 | .04 | .13 | .41 | .75 | .91 | .99 | 2.8 | CKAL 671-16 | 109 | Spin-glas | 11,18 |
| 4 | 1 | .60 | .14 | .25 | .51 | .80 | .78 | .76 | .75 | - | 109 | Microlite | 12 |
| 4 | 1 | .60 | .13 | .30 | .64 | .76 | .78 | .82 | .85 | CKAL 671-9 | 109 | Spin-glas | 11,18 |
| 4 | 1 | .65 | .15 | .33 | .62 | .76 | .82 | .83 | .75 | RAL A71-193 | 109 | Microlite | 12,18 |
| 4 | 1 | .70 | .12 | .30 | .68 | .94 | .82 | .80 | .75 | - | 109 | Microlite | 12 |
| 4 | 1 | .75 | .07 | .36 | .76 | .91 | .96 | .97 | 1.9 | CKAL 671-13 | 109 | Spin-glas | 11,18 |
| 4 | 1 | .75 | .23 | .50 | .73 | .88 | .91 | .97 | 3 | CKAL 671-8-31 | 109 | Spin-glas | 11,18 |
| 4 | 1 | .80 | .08 | .34 | .93 | .99 | .99 | .99 | 2.8 | CKAL 671-17 | 109 | Spin-glas | 11,18 |
| 4 | 1-1/2 | .70 | .24 | .60 | .99 | .75 | .35 | .16 | - | RAL A71-21 | 109 | Rigid Roll | 13 |
| 4 | 1-1/2 | .75 | .18 | .44 | .77 | .92 | .81 | .77 | .75 | - | 109 | Microlite | 12 |
| 4 | 2 | .77 | .31 | .58 | .86 | .81 | .83 | .85 | 1 | - | 109 | Microlite | 12,18 |
| 4 | 2 | .80 | .45 | .77 | .98 | .89 | .61 | .39 | .75 | - | 109 | Microlite | 7,12 |
| 4 | 2 | .90 | .33 | .68 | .96 | .95 | .95 | .99 | .75 | RAL A71-195 | 109 | Microlite | 12,18 |
| 4 | 2 | .90 | .31 | .70 | .99 | .99 | .97 | .99 | .85 | CKAL 671-10 | 109 | Spin-glas | 11,18 |
| 4 | 2 | .95 | .27 | .81 | .99 | .99 | .99 | .99 | 1.9 | CKAL 671-14 | 109 | Spin-glas | 11,18 |
| 4 | 2 | .95 | .29 | .99 | .99 | .99 | .99 | .99 | 2.8 | CKAL 671-18 | 109 | Spin-glas | 11,18 |
| 4 | 4 | .95 | .99 | .99 | .99 | .99 | .99 | .99 | 2.8 | CKAL 671-19 | 109 | Spin-glas | 11,18 |
| 4 | 4 | .95 | .84 | .99 | .99 | .99 | .99 | .99 | 1.9 | CKAL 671-15 | 109 | Spin-glas | 11,18 |
| 4 | 4 | .95 | .65 | .99 | .99 | .99 | .99 | .99 | .85 | CKAL 671-11 | 109 | Spin-glas | 11,18 |

TABLE 2B GLASS FIBER TESTED WITH MOUNTING NO. 6 AND THICKNESSES UP TO 1/2 INCH

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1/4 | .25 | .17 | .33 | .13 | .15 | .29 | .28 | 6 | RAL A73-89 | 109 | Exact-O-Board | 14,18 |
| 6 | 1/4 | .30 | .18 | .34 | .20 | .28 | .40 | .45 | 3 | RAL A73-90 | 109 | Exact-O-Board | 14,18 |
| 6 | 1/4 | .35 | .19 | .35 | .24 | .33 | .49 | .74 | 3 | RAL A72-113 | 109 | Exact-O-Mat | 15,18 |
| 6 | 1/4 | .35 | .07 | .31 | .20 | .29 | .56 | .66 | 1 | CT | 132 | PF 336 | 19 |
| 6 | 1/4 | .35 | .07 | .31 | .21 | .34 | .60 | .69 | 1.5 | CT | 132 | PF 338 | 19 |
| 6 | 1/4 | .40 | .07 | .31 | .23 | .41 | .66 | .73 | 2.5 | CT | 132 | PF 391 | 19 |
| 6 | 1/4 | .40 | .07 | .31 | .22 | .38 | .64 | .71 | 2 | CT | 132 | PF 339 | 19 |
| 6 | 1/4 | .45 | .06 | .45 | .27 | .48 | .67 | .72 | 3 | CT | 132 | Type 3.0 (plain) | 8,19 |
| 6 | 1/4 | .50 | .08 | .44 | .28 | .51 | .73 | .82 | 3 | CT | 132 | Type 3.0 | 9,19 |
| 6 | 1/4 | .50 | .09 | .38 | .37 | .60 | .73 | .76 | 3 | CT | 132 | PF 382 | 19 |
| 6 | 3/8 | .40 | .17 | .38 | .31 | .41 | .49 | .53 | 2 | RAL A73-91 | 109 | Exact-O-Board | 14,18 |
| 6 | 3/8 | .45 | .17 | .40 | .34 | .45 | .58 | .76 | 2 | - | 109 | Exact-O-Board | 15,18 |
| 6 | 1/2 | .40 | .12 | .40 | .31 | .40 | .50 | .57 | .75 | CT | 132 | PF 335 | 9 |
| 6 | 1/2 | .45 | .18 | .44 | .38 | .47 | .59 | .70 | 1.50 | - | 109 | Exact-O-Mat | 15,18 |
| 6 | 1/2 | .45 | .09 | .40 | .32 | .43 | .64 | .70 | .5 | CT | 132 | PF 334 | 19 |
| 6 | 1/2 | .45 | .11 | .40 | .32 | .47 | .62 | .71 | - | CT | 132 | RA 26 | 19 |
| 6 | 1/2 | .45 | .10 | .41 | .33 | .50 | .64 | .74 | - | CT | 132 | RA 25 | 19 |
| 6 | 1/2 | .50 | .19 | .40 | .40 | .56 | .72 | .92 | 2 | RAL A72-115 | 109 | Exact-O-Mat | 15,18 |
| 6 | 1/2 | .55 | .14 | .43 | .45 | .42 | .39 | .25 | .75 | CT | 132 | PF 335 | 1,19 |
| 6 | 1/2 | .55 | .09 | .40 | .38 | .63 | .76 | .78 | 1.5 | CT | 132 | PF 338 | 19 |
| 6 | 1/2 | .55 | .09 | .40 | .39 | .68 | .79 | .80 | 2 | CT | 132 | PF 339 | 19 |
| 6 | 1/2 | .60 | .12 | .46 | .36 | .73 | .86 | .86 | 3 | - | 6 | Mid-nite Blanket or board | 2 |
| 6 | 1/2 | .60 | .13 | .48 | .39 | .70 | .83 | .84 | 2 | - | 6 | Mid-nite Blanket or Board | 2 |

TABLE 28 GLASS FIBER TESTED WITH MOUNTING NO. 6 AND THICKNESSES UP TO 1/2 INCH (Concl)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1/2 | .60 | .14 | .51 | .42 | .67 | .80 | .82 | 1.5 | - | 6 | Mid-nite Blanket or Board | 2 |
| 6 | 1/2 | .60 | .28 | .42 | .49 | .62 | .76 | .77 | 1.5 | - | 109 | Microlite | 12,17 |
| 6 | 1/2 | .60 | .09 | .40 | .40 | .72 | .81 | .81 | 2.5 | - | 132 | PF 331 | 19 |
| 6 | 1/2 | .60 | .14 | .43 | .40 | .64 | .99 | .49 | .75 | - | 132 | PF 335 | 5,8, 19 |
| 6 | 1/2 | .60 | .43 | .42 | .39 | .62 | .99 | .58 | .75 | - | 132 | PF 335 | 4 |
| 6 | 1/2 | .50 | .10 | .42 | .55 | .53 | .69 | .79 | - | CT | 132 | RA 24 | 19 |
| 6 | 1/2 | .50 | .10 | .42 | .36 | .54 | .70 | .81 | - | CT | 132 | RA 236 | 19 |
| 6 | 1/2 | .50 | .10 | .41 | .36 | .54 | .72 | .84 | - | CT | 132 | RA 23 | 19 |
| 6 | 1/2 | .50 | .10 | .41 | .36 | .54 | .71 | .83 | 4.2 | CT | 132 | 704 Insulation | 19 |
| 6 | 1/2 | .50 | .13 | .40 | .37 | .56 | .73 | .87 | 2 | CT | 132 | PF 339 | 9,19 |
| 6 | 1/2 | .50 | .09 | .40 | .34 | .50 | .68 | .73 | .75 | CT | 132 | PF 335 | 19 |
| 6 | 1/2 | .50 | .09 | .40 | .36 | .55 | .71 | .75 | 1 | CT | 132 | PF 336 | 19 |
| 6 | 1/2 | .50 | .12 | .38 | .32 | .54 | .77 | .88 | 6 | CT | 132 | 705 Insulation | 19 |
| 6 | 1/2 | .55 | .23 | .44 | .43 | .64 | .76 | .80 | 3 | CKAL 671-20 | 109 | Spinglas | 11,18 |
| 6 | 1/2 | .60 | .11 | .53 | .46 | .73 | .77 | .81 | 2 | CT | 132 | Type 2.0 | 8,19 |
| 6 | 1/2 | .60 | .15 | .44 | .51 | .74 | .81 | .21 | .75 | CT | 132 | PF 335 | 6,9, 19,20 |
| 6 | 1/2 | .60 | .09 | .53 | .44 | .63 | .76 | .79 | 1.5 | CT | 132 | Type 1.5 | 8,19, 20 |
| 6 | 1/2 | .65 | .11 | .40 | .33 | .89 | .94 | .50 | 2 | CT | 132 | PF 339 | 19 |
| 6 | 1/2 | .65 | .11 | .46 | .52 | .83 | .84 | .83 | 3 | CT | 132 | PF 382 | 19 |

TABLE 2C GLASS FIBER TESTED WITH MOUNTING NO. 6 AND THICKNESS RANGE OF 3/4 INCH THROUGH 1 INCH

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 3/4 | .55 | .14 | .46 | .41 | .61 | .72 | .80 | - | CT | 132 | RA-26 | 19 |
| 6 | 3/4 | .60 | .14 | .47 | .48 | .64 | .74 | .83 | - | CT | 132 | RA-25 | 19 |
| 6 | 3/4 | .60 | .14 | .48 | .48 | .67 | .79 | .88 | - | CT | 132 | RA-24 | 19 |
| 6 | 3/4 | .60 | .13 | .48 | .50 | .69 | .81 | .90 | - | CT | 132 | RA-236 | 19 |
| 6 | 3/4 | .65 | .13 | .47 | .51 | .70 | .83 | .92 | - | CT | 132 | RA-23 | 19 |
| 6 | 1 | .55 | .28 | .53 | .47 | .56 | .68 | .78 | .6 | RAL A72-137 | 109 | Exact-O-Mat | 15,18 |
| 6 | 1 | .65 | .17 | .60 | .57 | .68 | .76 | .82 | 1 | - | 109 | Exact-O-Mat | 15,18 |
| 6 | 1 | .65 | .10 | .51 | .54 | .73 | .79 | .79 | .5 | CT | 132 | PF 334 | 19 |
| 6 | 1 | .65 | .17 | .52 | .61 | .75 | .81 | .89 | - | CT | 132 | RA-26 | 19 |
| 6 | 1 | .70 | .17 | .52 | .62 | .77 | .84 | .92 | - | CT | 132 | RA-24 | 19 |
| 6 | 1 | .70 | .17 | .52 | .62 | .77 | .84 | .92 | - | CT | 132 | RA-25 | 19 |
| 6 | 1 | .70 | .28 | .58 | .66 | .76 | .89 | .92 | 1.5 | - | 109 | Exact-O-Mat | 15,18 |
| 6 | 1 | .70 | .10 | .51 | .56 | .81 | .83 | .81 | .75 | CT | 132 | PF 335 | 19 |
| 6 | 1 | .70 | .10 | .51 | .58 | .86 | .85 | .83 | 1 | CT | 132 | PF 336 | 19 |
| 6 | 1 | .70 | .35 | .45 | .64 | .89 | .87 | .84 | 1.5 | - | 109 | Microlite | 3,18 |
| 6 | 1 | .70 | .19 | .51 | .63 | .88 | .83 | .78 | 1.58 | CT | 132 | 701 Insulation | 19 |
| 6 | 1 | .75 | .23 | .50 | .73 | .88 | .91 | .97 | 3 | CKAL 671-21 | 109 | Spin-glas | 11 |
| 6 | 1 | .75 | .18 | .56 | .66 | .96 | .89 | .83 | 4.2 | CT | 132 | 704 Insulation | 19 |
| 6 | 1 | .75 | .16 | .54 | .64 | .83 | .92 | .98 | - | CT | 132 | RA-236 | 19 |
| 6 | 1 | .75 | .10 | .51 | .61 | .90 | .89 | .85 | 1.5 | CT | 132 | PF 338 | 19 |
| 6 | 1 | .75 | .10 | .51 | .63 | .94 | .91 | .87 | 2 | CT | 132 | PF 339 | 19 |
| 6 | 1 | .75 | .16 | .53 | .65 | .85 | .94 | .99 | - | CT | 132 | RA-23 | 19 |
| 6 | 1 | .75 | .19 | .54 | .63 | .92 | .87 | .82 | 2.25 | CT | 132 | 702 Insulation | 19 |
| 6 | 1 | .75 | .23 | .50 | .73 | .88 | .91 | .97 | 3.25 | - | 109 | Micro-Aire | 16,19 |

TABLE 2C GLASS FIBER TESTED WITH MOUNTING NO. 6 AND THICKNESS RANGE OF 3/4 INCH THROUGH 1 INCH (Concl)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft3 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1 | .75 | .23 | .54 | .68 | .83 | .92 | .89 | 1.5 | RAL A71-115 | 109 | Lina-Coustic A | 17,18 |
| 6 | 1 | .75 | .23 | .53 | .67 | .97 | .89 | .82 | 3 | CT | 132 | 703 Insulation | 19 |
| 6 | 1 | .75 | .26 | .49 | .63 | .95 | .87 | .82 | 6 | CT | 132 | 705 Insulation | 8,19 |
| 6 | 1 | .80 | .20 | .67 | .73 | .96 | .90 | .84 | 2 | CT | 132 | Type 2.0 | 8,19 |
| 6 | 1 | .80 | .24 | .70 | .72 | .93 | .90 | .83 | 1.5 | CT | 132 | Type 1.5 | 8,19 |
| 6 | 1 | .80 | .16 | .63 | .70 | .95 | .89 | .84 | 1.5 | - | 6 | Mid-nite Blanket or Board | 2 |
| 6 | 1 | .80 | .17 | .63 | .74 | .97 | .90 | .86 | 2 | - | 6 | Mid-nite Blanket or Board | 2 |
| 6 | 1 | .85 | .19 | .62 | .78 | .99 | .92 | .88 | 3 | - | 6 | Mid-nite Blanket or Board | 2 |

TABLE 2D GLASS FIBER TESTED WITH MOUNTING NO. 6 AND THICKNESSES GREATER THAN 1 INCH

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 1-1/2 | .75 | .11 | .58 | .69 | .90 | .87 | .83 | .5 | CT | 132 | PF 334 | 19 |
| 6 | 1-1/2 | .80 | .11 | .58 | .77 | .99 | .95 | .90 | 2 | CT | 132 | PF 339 | 19 |
| 6 | 1-1/2 | .80 | .11 | .58 | .75 | .98 | .94 | .89 | 1.5 | CT | 132 | PF 338 | 19 |
| 6 | 1-1/2 | .80 | .11 | .58 | .73 | .96 | .92 | .87 | 1 | CT | 132 | PF 336 | 19 |
| 6 | 1-1/2 | .80 | .11 | .58 | .71 | .94 | .90 | .86 | .75 | CT | 132 | PF 335 | 19 |
| 6 | 1-1/2 | .85 | .24 | .62 | .93 | .97 | .88 | .86 | 3 | CKAL 671-22 | 109 | Spin-glas | 11,18 |
| 6 | 1-1/2 | .90 | .36 | .67 | .87 | .97 | .99 | .95 | 1.5 | RAL A72-139 | 109 | Exact-O-Mat | 15,18 |
| 6 | 1-1/2 | .90 | .32 | .68 | .92 | .99 | .99 | .94 | 1.5-2.3 | RAL A71-116 | 109 | Lina-Coustic | 17 |
| 6 | 2 | .90 | .42 | .83 | 1.02 | 1.05 | 1.04 | .48 | 1.5 | RAL A71-117 | 109 | Lina-Coustic | 17,18 |
| 6 | 2 | .95 | .28 | .82 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-236 | 19 |
| 6 | 2 | .95 | .29 | .82 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-23 | 19 |
| 6 | 2 | .95 | .27 | .81 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-24 | 19 |
| 6 | 2 | .95 | .25 | .79 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-25 | 19 |
| 6 | 2 | .95 | .23 | .78 | .99 | .98 | .99 | .99 | - | CT | 132 | RA-26 | 19 |
| 6 | 3 | .90 | .44 | .72 | .99 | .99 | .95 | .93 | 3 | CKAL 671-23 | 109 | Spin-glas | 11,18 |
| 6 | 3 | .95 | .41 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-26 | 19 |
| 6 | 3 | .95 | .45 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-25 | 19 |
| 6 | 3 | .95 | .45 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-24 | 19 |
| 6 | 3 | .95 | .53 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-23 | 19 |
| 6 | 3 | .95 | .52 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | RA-236 | 19 |

TABLE 2E GLASS FIBER TESTED WITH MOUNTING NO. 7

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 1 | .70 | .67 | .72 | .64 | .75 | .63 | .45 | - | - | 109 | Microlite Blanket | 7,12 |
| 7 | 1 | .70 | .73 | .72 | .62 | .83 | .70 | .52 | - | RAL A63-72 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 1-1/4 | .95 | .99 | .90 | .97 | .99 | .85 | .57 | - | RAL A63-87 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 1-1/2 | .70 | .24 | .60 | .99 | .75 | .35 | .16 | - | RAL A71-21 | 109 | Rigid Roll Fiberglass | 13 |
| 7 | 1-1/2 | .75 | .95 | .71 | .73 | .91 | .69 | .45 | - | RAL A63-66 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 1-1/2 | .80 | .86 | .91 | .80 | .89 | .62 | .47 | - | - | 109 | Thermal-Acoustical Batts | |
| 7 | 2 | .80 | .84 | .87 | .85 | .87 | .64 | .48 | - | - | 109 | Microlite Blanket | 7,12 |
| 7 | 2 | .90 | .99 | .96 | .89 | .94 | .77 | .60 | - | RAL A63-74 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 2-1/2 | .90 | .89 | .88 | .89 | .91 | .83 | .55 | - | RAL A63-75 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 3 | .90 | .93 | .94 | .92 | .91 | .82 | .56 | - | RAL A63-76 | 6 | Acoustiflex Rolls and Pads | 10,20 |
| 7 | 5-3/8 | .90 | .97 | 1.00 | 1.00 | .88 | .69 | .49 | - | - | 109 | Thermal-Acoustical Batts | |

FOOTNOTES FOR TABLE 2A, 2B, 2C, 2D, and 2E

GLASS FIBER MATERIALS

1. Faced with Duplex laminated kraft paper (reinforced with fiberglass yarn).
2. Neoprene coated blanket, UL standard 723 flame spread does not exceed 25, meets requirements of NFPA90A.
3. Neoprene coated, temperature range to 250°F, UL Fire Hazard Rating 25/50/50, product meets NFPA90A standards when tested by UL 723, good resistance to chemicals.
4. Aluminum foil faced (0.0007").
5. Aluminum foil faced (0.001").
6. Vinyl faced (0.003").
7. With perforated transite panels, fire spread rating 0-25.
8. Mat faced equipment insulation.
9. Neoprene coated.
10. Rated "incombustible" by UL. Available as pads or rolls. Roll thicknesses: 1", 1-1/2", 2", 2-1/2", 3". Pad thickness: 1", 1-1/4". Roll widths 23-5/8", 25-5/8", 47-5/8". Pad size: 11-7/8" x 23-7/8".
11. 1000 Series Spin-Glas is a semi-rigid board produced by combining Spin-Glas fiber and organic binder. Available in board form only in thicknesses from 1" to 6" in 1/2" increments; width of 24", lengths 24", 36", and 48". Also custom sizes. Temperature limit 850°F. 800 Series Spin-Glas is duct insulation manufactured from inorganic glass fibers bonded by a thermosetting resin. With certain facings, meets the fire standard requirements of NFPA90A and 90B. Temperature limit of 350°F unfaced and 250°F faced. Available in sheet and roll form. Density range 1.08 lb/cu ft to 6 lb/cu ft. Thicknesses: 1", 2", 2-1/2", 3", 4". Foil-scrim-kraft, plastic-scrim-foil, and glass cloth vapor barrier facings available.
12. Microlite-resin bonded fiber glass blanket. Light weight. Temperature range subzero to 300°F. Thicknesses 1/2" to 4". Density range 0.6 lb/cu ft to 3 lb/cu ft. Widths 24", 36", 48", 72". Made-to-order widths from 3" to 120". Foil, foil-scrim-kraft, vinyl film, kraft paper facings. available. UL Fire Hazard classification - flame spread 10, fuel contributed 20, smoke developed 0.
13. Rigid Roll (trademark) is fiber glass insulation board for ceilings or walls. Available in rolls 5' wide, thicknesses 1-1/2" and 2". Cut length 40' to 110'. UL Fire Hazard classification 25/50/50.

FOOTNOTES FOR TABLE 2A, 2B, 2C, 2D, and 2E (Concl)

GLASS FIBER MATERIALS

14. Exacto-Board: Board-type thermal and acoustical insulation with smooth surface. Available in sheets and rolls in various sizes. UL Fire Hazard classification: flame spread 10, fuel contributed 20, smoke developed 0.

15. Exact-O-Mat: Fiber glass blanket faced on one side with a black plastic bonded fiberglass mat. Available in rolls 100' long, widths 43" to 48" and 65" to 72". Density range 0.6 lb/cu ft to 3 lb/cu ft. Thickness range 1/4" to 1-1/2". Temperature range to 250°F. UL Fire Hazard classification 25/0/15.

16. Micro-Aire (trademark) SR is a preformed fiber glass duct. Supplied as round duct with internal diameter for 4" through 40" and 6' long. Complies with UL 181 standards of safety for air ducts. Fire hazard classification 25/50/50.

17. Lina-Coustic A (trademark) is a glass fiber duct liner insulation covered with black fiber glass mat. Available in rolls 36", 48", and 60" wide, 50' long. Thicknesses 1", 1-1/2", and 2". Temperature range to 250°F. Fire hazard classification 25/50/50. Good resistance to chemicals.

18. Tested and evaluated according to ASTM C423-66. Reverberation room tested.

19. Tests conducted in reverberation room.

20. Tested and evaluated according to ASTM C423-60T.

TABLE 3

SPRAY-ON ABSORPTION MATERIALS

The sound absorption properties of spray-on materials are listed. Sound absorption provided by the spray-on coating is dependent upon the sprayed material, the thickness of the applied material and the base material on which the spray was applied. Accordingly the table shows the sound absorption properties of the materials sprayed to different thicknesses and sprayed on different base materials. The manufacturers' suggested spraying techniques are essentially comprised of spraying the material through a nozzle on a prepared surface. The companies (by numbers shown in Section II) with products listed in Table 3 are: 127, 175.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. AND ILLUSTRATED IN FIGURE I-11.

GLOSSARY

Lath: Thin, lightweight structure used as groundwork for plastering, tiles, etc. It may be in a form of perforated metal, wire cloth, thin wood strips, etc.

TABLE 3 SPRAY-ON ABSORPTION MATERIALS

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Absorption Coefficients | | | | | | | | | | |
| 4 | 1/4 | .30 | .04 | .04 | .20 | .39 | .60 | .81 | .45* | RAL | 175 | Cafco Sound-Shield "85"(Solid base) | 1,4, 6 |
| 4 | 3/8 | .45 | .02 | .08 | .26 | .60 | .84 | .89 | - | RAL A67-17 | 175 | Cafco Sound-Shield "85"(Solid base) | 1,3, 6 |
| 4 | 1/2 | .85 | .26 | .51 | .98 | .99 | .95 | .86 | - | RAL A63-152 | 175 | Cafco Sound-Shield "85"(Metal lath base) | 1,4, 6 |
| 4 | 5/8 | .55 | .05 | .16 | .44 | .79 | .90 | .91 | 2.5 | RAL A68-45 | 127 | K-13 (Solid base) | 2,3, 4,6 |
| 4 | 3/4 | .75 | .11 | .22 | .71 | 1.13 | 1.26 | 1.38 | - | CKAL 701-23 | 175 | Cafco Deck-Shield (Gypsum lath base) | 1,3, 6 |
| 4 | 1 | .75 | .08 | .29 | .75 | .98 | .93 | .76 | 2.5 | RAL A65-376 | 127 | K-13 | 2,4, 5,6 |
| 4 | 1 | .95 | .47 | .90 | 1.10 | 1.03 | 1.05 | 1.03 | 2.5 | RAL A68-218 | 127 | K-13 (Metal lath base) | 2,3, 4,6 |
| 4 | 1-1/4 | .75 | .10 | .30 | .73 | .92 | .98 | .98 | 2.5 | RAL A70-102 | 127 | K-13 Painted surfac (Solid 1/2" plywood) | 2,3, 4,6 |
| 7 | 3/8 | .49 | .63 | .59 | .76 | .88 | .94 | .70 | .88* | RAL A68-116 | 175 | Cafco Sound-Shield "85"(Metal lath base) | 1,3, 6 |

* Weight in lb/ft²

FOOTNOTES FOR TABLE 3
SPRAY-ON ABSORPTION MATERIALS

1. White, hard, textured surface. Does not contain asbestos or free crystalline silica.
2. Spray-on cellulose fiber for thermal and acoustical control. Thickness and density can be varied during application. Textured surface. Temperature range: -25°F to 200°F. Thickness range: 1/2" to 3". Relative humidity range: 0% to 85%.
3. Tested and evaluated according to ASTM C 423-66.
4. Tested and evaluated according to ASTM C 423-60T.
5. K-13 type spray-on inside of a 25000 sq ft aluminum dome reduced the reverberation time as shown below:

| Frequency, Hz. | 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|
| Reduction in the reverberation time, sec. | 2.2 | 4.1 | 5.9 | 6.6 | 6.2 | 5.6 |

6. Thickness of material represents acoustical plaster only.

## TABLE 4
## FELT AND OTHER FIBERS

The sound absorption properties of various types of felts are listed. Felt is made of fibers worked together by pressure, heat, chemical action etc., without weaving or knitting. Felts in general have average to good sound absorption properties, but have poor barrier properties. (See Table 18 for additional listing of felts.) The companies (by numbers shown in Section II) with products listed in Table 4 are : 34, 38, 51, 69, 109, 157, 161.

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. AND ILLUSTRATED IN FIGURE I-11.

TABLE 4 FELT AND OTHER FIBERS

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1/2 | .40 | .02 | .07 | .25 | .49 | .68 | .87 | 8 | KAL A72-181 | 34 | Jute felt | 1,8 |
| 4 | 1 | .78 | .34 | .70 | .74 | .84 | .79 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| 4 | 2 | .82 | .61 | .70 | .77 | .90 | .90 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| 4 | 3 | .83 | .52 | .69 | .78 | .92 | .93 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| 4 | 4 | .84 | .63 | .76 | .81 | .90 | .89 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| 4 | 5 | .86 | .65 | .79 | .80 | .94 | .91 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| 4 | 6 | .88 | .70 | .84 | .83 | .94 | .89 | .90 | 8 | CT | 109 | J-M Cerafelt | 2,8 |
| - | - | - | | | | | | | 6.667 | - | 51 | Jute Felt | 3 |
| - | - | - | | | | | | | - | - | 69 | Industrial felts | 4 |
| - | 1/2 | - | | | | | | | - | - | 157 | Felt | 5 |
| - | 1 | - | .08 | .33 | .80 | .88 | .89 | .89 | - | - | 161 | Felt wood or synthetic | 6 |
| - | - | .79 | | | | | | | 3 | - | 38 | Carney Sound Attenuation blankets, 0" air space | 7 |
| - | - | .82 | | | | | | | 3 | - | 38 | Carney Sound Attenuation blankets, 1/2" air space | 7 |
| - | - | .91 | | | | | | | 3 | - | 38 | Carney Sound Attenuation blankets, 1" air space | 7 |

FOOTNOTES FOR TABLE 4
FELT AND OTHER FIBERS

1. Garnetted, needled belted jute padding. Temperature range approximately 50-175°F. Relative humidity range 0-95%. Flame spread less than 4"/minute. Used as domestic and automotive carpet underlay. Supplied in rolls or die cut patterns.

2. Refractory fiber insulation. Supplied in rolls 25' long or as 4' and 8' long sheets. Density range 3 to 8 lb/cu ft. Various thicknesses available. Maximum temperature 2300°F. Humidity range 0-100%.

3. Used as domestic and automotive carpet underlay. Sizes ranging from 3' x 6' to 12' x 60'. Maximum humidity 70%. Does not exceed flammability of interior materials federal MVSS 302.

4. Industrial felts available in rolls or fabricated to custom specifications. Many colors and compositions available. Primary ingredient - wool. Temperature range: -50°F to 225°F.

5. Standard size 36" x 72" x 12". Oil resistant. May be die-cut, can be supplied with pressure sensitive coating. Mainly used to reduce shock and vibration.

6. Acoustic data extracted from a graph. Mounting method not specified. Preferred density for acoustic felt is 107 gm/cc and optimum absorption for 1" thickness. Thicknesses available are 1/12", 1/8", 1/2", 3/4", 1", 1-1/2". Temperature range: -80° to 200°F, flame resistance; F.R. treated, less than 3-1/2" vent burn.

7. High calcium fiberglas felt. Temperature range: -50° to 500°F, humidity range: 0-95%. Flame resistance: 25, conforms to ASTM C 384-58. The table shows changes in NRC's as the air space in the back of the blanket is changed.

8. Tested and evaluated according to ASTM C 423-66.

TABLE 5
CONCRETE BLOCKS

The sound absorption of concrete blocks with built-in cavities are listed. These cavities act as damped (Helmholtz) resonators to absorb sound. Figure 5 shows three concrete blocks with cavities and cuts of different shapes or sizes. The block can be "tuned" to a certain frequency band by proper selection of the cavities and the cuts. These blocks are good sound barriers too (see Table 29 for transmission loss of some of the concrete blocks listed in this table). The companies (by numbers shown in Section II) with products listed in Table 5 are: 75, 141.

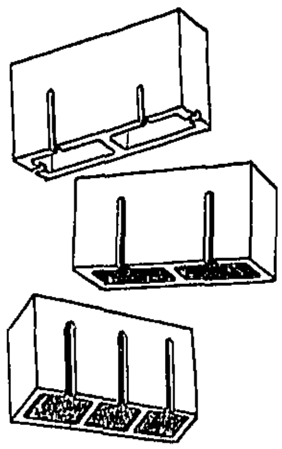


Figure 5 Sound Absorbing Concrete Blocks

| CAUTION |
|---|
| 1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2. |
| 2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. and ILLUSTRATED IN FIGURE I-11. |

TABLE 5 CONCRETE BLOCKS

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft3 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 3-5/8 | .30 | .14 | .47 | .34 | .18 | .13 | .14 | 32 | RAL A67-71 | 75 | Concrete Blocks | 1,2 |
| 4 | 4-1/2 | .51 | .19 | .83 | .41 | .38 | .42 | .40 | 19* | G&H | 141 | Sound Blox, Type A | 3 |
| 4 | 4-1/2 | .70 | .20 | .95 | .85 | .49 | .53 | .50 | 17* | G&H | 141 | Sound Blox, Type B | 2 |
| 4 | 6-1/2 | .47 | .62 | .84 | .36 | .43 | .27 | .50 | 23.4* | G&H | 141 | Sound Blox, Type A | 3 |
| 4 | 6-1/2 | .63 | .31 | .97 | .56 | .47 | .51 | .53 | 24* | G&H | 141 | Sound Blox, Type B | 3 |
| 4 | 8-1/2 | .45 | .97 | .44 | .38 | .39 | .50 | .60 | 28* | G&H | 141 | Sound Blox, Type A-1 | 2 |
| 4 | 8-1/2 | .45 | .74 | .57 | .45 | .35 | .36 | .34 | 35* | G&H | 141 | Sound Blox, Type B | 2 |
| 4 | 8-1/2 | .55 | .60 | .72 | .56 | .48 | .46 | .47 | 37.5* | G&H | 141 | Sound Blox, Type BB | 2 |
| 4 | 9-3/8 | .90 | .80 | .97 | 1.02 | .90 | .77 | .71 | 30* | G&H | 141 | Sound Blox, Type BB | 2 |

* Density entry shown is the weight in lbs/block (approximate).

FOOTNOTES FOR TABLE 5
CONCRETE BLOCKS

1. 5 cell, 4" x 8" x 16", partition block wall are face-sawcut and acoustically treated with 7/16" thick core (3-7/8" x 6-7/8") of glass fiber.
2. Tested and evaluated according to ASTM C 423-66. Block size 8" x 16".
3. Tested and evaluated according to ASTM C 423-60T. Block size 8" x 16".

## TABLE 6
## COMPOSITES VINYL/FOAM

The composite products made from vinyl and foam are listed. Vinyl is laminated onto a foam layer either to protect the foam surface or to provide a sound barrier. Protective vinyl facing on foam is perforated to expose the foam to sound while barrier vinyl sheet is comparatively thick and is not perforated.

Both types of composites -- one where vinyl is merely a protective facing and another where vinyl acts as a sound barrier -- are referred to here as vinyl/foam composites but this table shows only the sound absorption data for such products. Transmission loss of vinyl sheets can be determined by referring to some of the vinyl products listed in Tables 10 and 18. Figure 6 shows a product with perforated vinyl facing laminated on a foam layer Figure 12 illustrates a product where vinyl is used as a barrier material. The companies (by numbers shown in Section II) with products listed in Table 6 are: 12, 59, 77, 111, 135, 149, 150, 157.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. AND ILLUSTRATED IN FIGURE I-11.
3. ABSORPTION COEFFICIENTS ARE SHOWN EITHER AS PERCENTAGES (NORMAL INCIDENCE DATA) OR AS DECIMAL FRACTIONS (RANDOM INCIDENCE DATA). THE DIFFERENCES BETWEEN THESE TWO DATA ARE DISCUSSED IN SECTION I-3.2.

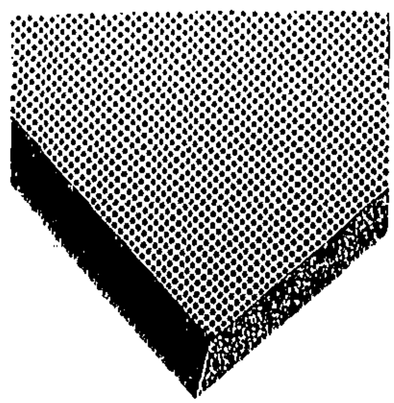


Figure 6  Perforated Vinyl Facing on Foam

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

TABLE 6 COMPOSITES VINYL/FOAM

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Open-cell polyester urethane foam flame-bonded to vinyl fabric backing | | | | | | | | | |
| - | 1/4 | .35 | 2.8% | 3% | 3.8% | 8% | 53% | 49% | - | IATL 5-250-12/18/71 | 12 | Bondtite Acoustic Upholstery | 1,15 |
| | | | | Perforated vinyl facing flame-laminated to foam | | | | | | | | | |
| - | 1/4 | - | 10% | 13% | 22% | 41% | 56% | 68% | - | - | 157 | Perforated vinyl on foam | 2,3 |
| | | | | Polyurethane foam on filled vinyl backing | | | | | | | | | |
| - | 1/4 | - | | .05 | .09 | .20 | .44 | .80 | - | - | 149 | Sound/Eaze TL-Alpha | 4,5, 6,13 |
| | | | | Polyurethane foam on flexible, dense vinyl TLB-M backing | | | | | | | | | |
| - | 1/4 | - | | .05 | .09 | .20 | .44 | .80 | - | - | 111 | Sound/Eaze TL-Alpha | 6,7, 13 |
| | | | | Polyurethane foam fused to a high-strength, high-density polyvinyl backing | | | | | | | | | |
| - | 5/16 | - | | .05 | .10 | .22 | .48 | .85 | - | - | 59 | Eckoustic Noise Barrier | 8,9 |
| | | | | Open-cell polyester urethane foam; flame-bonded to vinyl fabric backing | | | | | | | | | |
| - | 1/2 | .60 | 3.2% | 4.2% | 7.2% | 22% | 84% | 74% | - | IATL 5-250-12/18/71 | 12 | Bondtite Acoustic Upholstery | 1,15 |
| | | | | Perforated vinyl facing flame-laminated to foam | | | | | | | | | |
| - | 1/2 | - | 15% | 22% | 41% | 45% | 87% | 92% | - | - | 157 | Perforated vinyl on foam | 2,10 |
| | | | | Polyurethane foam on filled vinyl backing | | | | | | | | | |
| - | 1/2 | - | | .11 | .24. | .58 | .89 | .96 | - | - | 149 | Sound/Eaze TL-Alpha | 4,5 6,13 |
| | | | | Polyurethane foam on filled vinyl backing | | | | | | | | | |
| - | 1/2 | - | | .11 | .29 | .58 | .89 | .96 | - | - | 111 | Sound/Eaze TL-Alpha | 6,7 13 |
| | | | | Acoustical polyurethane foam fused to high-strength, high-density polyvinyl backing | | | | | | | | | |
| - | 9/16 | - | | .10 | .28 | .50 | .85 | .95 | - | - | 59 | Eckoustic Noise Barrier | 8,9 |
| | | | | Perforated vinyl facing flame-laminated to foam | | | | | | | | | |
| - | 3/4 | - | 22% | 29% | 60% | 82% | 91% | 96% | - | - | 157 | Perforated Vinyl on Foam | 2,11 |

TABLE 6 COMPOSITES VINYL/FOAM (Concl)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Perforated vinyl; facing flame-laminated foam | | | | | | | | | |
| 4 | 1 | .70 | .10 | .26 | .70 | 1.06 | .87 | .87 | - | G&H 4/28/72 | 77 | Foamade Product 22 373 | 14 |
| | | | | Perforated vinyl; facing 54" wide/60' long | | | | | | | | | |
| - | 1 | .50 | .07 | .23 | .66 | .63 | .51 | .55 | - | CT | 150 | Perforated Vinyl Pyrell | 16 |
| | | | | Open-cell polyester urethane foam flame-bonded to vinyl fabric backing | | | | | | | | | |
| - | 1 | .70 | 7.5% | 10.2% | 21% | 66% | 79% | 50% | - | IATL 5-250-12/8/71 | 12 | Bondtite Acoustic Upholstery | 1,15 |
| | | | | Perforated vinyl facing flame-laminated to foam | | | | | | | | | |
| - | 1 | - | 30% | 40% | 70% | 89% | 95% | 98% | - | - | 157 | Perforated Vinyl on Foam | 2,12 |
| | | | | Polyurethane foam on filled vinyl backing | | | | | | | | | |
| - | 1 | - | .11 | .29 | .66 | .91 | .98 | .90 | - | - | 149 | Sound/Eaze TL-Alpha | 4,5, 13 |
| | | | | Polyurethane foam on flexible, dense vinyl TLB-M backing | | | | | | | | | |
| - | 1 | - | .11 | .29 | .66 | .91 | .98 | .90 | - | - | 111 | Sound/Eaze TL-Alpha | 6,7, 13 |
| | | | | Perforated vinyl facing on polyurethane foam | | | | | | | | | |
| - | 1 | .75 | .19 | .42 | .70 | .98 | .84 | .85 | 3.3 | KAL 1393-2-72 | 135 | Parafoam | 17 |
| | | | | Perforated vinyl facing flame-laminated to foam | | | | | | | | | |
| - | 2 | - | 38% | 67% | 91% | 98% | 99% | 99% | - | - | 157 | Perforated Vinyl on Foam | 2,3 |
| | | | | Foam bonded to vinyl fabric backing | | | | | | | | | |
| - | 2 | .77 | 18.5% | 24% | 46% | 80% | 62% | 61% | - | IATL 5-250-12/18/71 | 12 | Acoustic Upholstery | 1,15 |

FOOTNOTES FOR TABLE 6

COMPOSITES VINYL/FOAM

1. Available in rolls 54" wide or as cut sheets. Weight 2 lb/cu ft. Provides thermal insulation.
2. Custom thickness available.
3. Available in rolls 54" wide.
4. Available in a wide range of configurations using different foam thicknesses, septum weights, decorative surfaces and with pressure sensitive adhesive.
5. Random incidence absorption coefficients computed from normal incidence data.
6. Septum density - 1 lb/sq ft. Foam density - 2 lb/cu ft. The coefficients shown are random incidence absorption coefficients.
7. For standard 1 $lb/ft^2$ septum STC-26.
8. Self-extinguishing ASTM 1692-S7T.
9. Temperature range - 20° to 200°F. Gasoline, oil, and abrasion resistant.
10. Available in rolls 54" wide, 50' long.
11. Available in rolls 54" wide 35' long.
12. Available in rolls 54" wide 25' long.
13. Optional Tedlar surface.
14. Available in sheets or rolls. The test conducted with vinyl side exposed.
15. Conforms to ASTM C384-58, impedance tube tested.
16. Impedance tube tested.
17. Conforms to C423-66, reverberation room tested.

TABLE 7
FILM/FOAM

Various film protected foams and their sound absorption coefficients are listed. These coefficients are based on tests made with protective film side exposed to sound. The protective film can reduce the amount of sound absorption at high frequencies but in certain types of environments, the protection of a film is absolutely essential. It is possible to have protection against water, oils, fuels, solvents, particles, sunlight, etc., using an appropriate film and still get a product with the desired sound absorption.

Figure 7 shows a foam pad covered by a metallic film on both sides. The companies (by numbers shown in Section II) with products listed in Table 7 are: 11, 12, 150, 160.

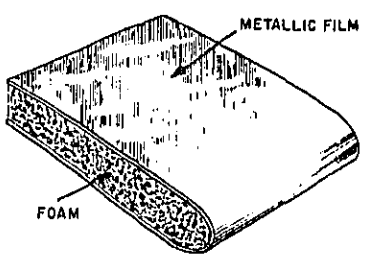



Figure 7 Foam Pad with a Protective Metallic Film Covering

| CAUTION |
| --- |
| ABSORPTION COEFFICIENTS ARE SHOWN EITHER AS PERCENTAGES (NORMAL INCIDENCE DATA) OR AS DECIMAL FRACTIONS (RANDOM INCIDENCE DATA). THE DIFFERENCES BETWEEN THESE TWO DATA ARE DISCUSSED IN SECTION I-3.2. |

TABLE 7 FILM/FOAM

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Absorption Coefficients | | | | | | | | | | |
| - | 1/2 | .54 | - | .16 | .43 | .70 | .88 | .91 | - | - | 160 | Tufcote Acoustical Foam | 14 |
| - | 1/2 | .57 | 3.5% | 7.0% | 36% | 43% | 15% | 28% | - | IATL | 12 | Foamkote No. 748 on Foam No. 4100 | 1,2,11 13 |
| - | 1/2 | .58 | 3.0% | 6.3% | 44% | 38% | 27% | 35% | - | IATL 3/5/73 | 12 | Film No. 766 on Foam | 3,11 |
| - | 1/2 | .60 | 4.6% | 7.5% | 44% | 49% | 23% | 39% | - | IATL 3/5/73 | 12 | Film No. 764 on Foam | 4,11 |
| - | 1/2 | .62 | 5.0% | 6.0% | 42% | 57% | 31% | 49% | - | IATL 3/5/73 | 12 | Film No. 761 on Foam | 5,11 |
| - | 1/2 | .65 | 3.5% | 5.5% | 20% | 74% | 46% | 49% | - | IATL | 12 | Foamkote No. 746 on Foam No. 4100 | 2,6,11 13 |
| - | 1/2 | .65 | 3.0% | 4.8% | 11.5% | 46% | 86% | 56% | - | IATL | 12 | Foamkote No. 749 on Foam No. 2950 | 7,8,11 13 |
| - | 1/2 | .67 | 3.6% | 9.2% | 25% | 75% | 47% | 32% | - | IATL | 12 | Foamkote No. 749 on Foam No. 4100 | 2,7,11 13 |
| - | 1 | .25 | - | .11 | .18 | .29 | .57 | .45 | - | CT | 150 | Urethane Laminate on Foam | 9 |
| - | 1 | .40 | .15 | .68 | .40 | .35 | .38 | .45 | - | CT | 150 | Metalized Polyester Film | 10,12 |
| - | 1 | .40 | - | .15 | .68 | .40 | .35 | .30 | - | CT | 150 | Metalized Film Laminate on Foam | 10 |
| - | 1 | .50 | 4.8% | 9.8% | 34% | 16% | 11% | 20% | - | IATL | 12 | Protective Film 748 on Foam 4100 | 1,2,11 |
| - | 1 | .54 | 5.0% | 16.5% | 30% | 24% | 20% | 29% | - | IATL | 12 | Protective Film 766 on Foam | 3,11 |
| - | 1 | .57 | 5.8% | 15% | 45% | 20% | 29% | 30% | - | IATL | 12 | Protective Film 764 on Foam | 1,4 |
| - | 1 | .63 | 11% | 35% | 35% | 49% | 15.5% | 30% | - | IATL | 12 | Foamkote No. 748 on Foam No. 4100 | 1,2, 11,13 |
| - | 1 | .69 | 6.0% | 11% | 45% | 71% | 40% | 45% | - | IATL | 12 | Foamkote No. 746 on Foam No. 4100 | 2,6, 11,13 |
| - | 1 | .72 | 8.0% | 19% | 43% | 74% | 47% | 38% | - | IATL | 12 | Foamkote No. 749 on Foam No. 4100 | 2,7, 11,13 |
| - | 1 | .72 | - | .27 | .63 | 1.0 | .99 | .96 | - | - | 160 | Tufcoat Acoustical Foam | 14 |
| - | 1 | .73 | 5.0% | 9.0% | 30% | 98.5% | 52% | 71% | - | IATL | 12 | Foamkote No. 749 on Foam No. 2950 | 7,8, 11,13 |
| - | 2 | .57 | 9.2% | 15% | 32% | 29% | 31% | 26% | - | IATL | 12 | Protective Film 764 on Foam | 4,11 |
| - | 2 | .55 | 12% | 16% | 26% | 24% | 28% | 36% | - | IATL | 12 | Protective Film 766 on Foam | 3,11 |
| - | - | | | .002" to .050" thick urethane films pressure sensitized on polyethylene foam; Temperature range - 40 to 180°F. Humidity up to 100%. | | | | | | - | 11 | Urethane films | - |

FOOTNOTES FOR TABLE 7
FILM/FOAM

1. Foamkote 748 is a two coat system with 0.015" thickness of Hypalon and a 0.005" layer of finishing coat to provide a sealed surface resistant to weather, acid, oils, solvents, fuels, etc.

2. No. 4100 is Airtex Industrial Foam 4100, 2 lb/cu ft polyester urethane foam.

3. Film No. 766 is a polyvinyl fluoride film which can be adhesive bonded to foam. Protects against contaminants or warmth of sunlight.

4. Film No. 764 is urethane film. Protects against liquids and dirt.

5. Film No. 761 is metalized film. For engine compartment use, etc.

6. Foamkote No. 746 is a single sprayed 0.015" thickness coating of Hypalon. Resistant to moisture and weather.

7. Foamkote No. 749 is a 0.0025" thick sheet of polyethylene to totally enclose simple shapes of urethane foam. Sheeting is chemically inert, impervious to all normal contaminants and has high tear and puncture strength.

8. No. 2950 is Airtex Industrial Foam 2950, 2 lb/cu ft polyether urethane foam.

9. Nonporous urethane film. Resistant to chemicals. Temperature range: -40° to 250°F. Flame resistance ASTM 1692-59T.

10. Metalized polyester fiber.

11. Conforms to ASTM C 384-58, impedance tube test.

12. Temperature range: -40° to 225°F. Excellent resistance to chemicals.

13. Conforms to ASTM C 423-66, reverberation room test.

14. Random incidence coefficients calculated from normal by means of B&K conversion chart. The foam has aluminized polyester film or cast urethane film facing. The film protects against gasoline, water, oil or solvents. Passes UL 94.

## TABLE 8
## LEAD/FOAM

The composite products manufactured using a lead and foam combination are listed. These products combine the sound barrier property of lead with sound absorption provided by foam. They are often used in machinery enclosures and accordingly, most of the test data shown in this table are noise reduction and not transmission loss. In these cases the products were tested with an enclosure and therefore the footnotes for the table should be studied carefully before interpreting the noise reduction data. A few products listed in the table were tested for transmission loss however, and this is clearly indicated. Additional information about transmission loss of some lead and lead loaded products is available in Tables 13 and 18. The companies (by numbers shown in Section II) with products listed in Table 8 are: 12, 18, 36, 143, 149, 153, 184.

**CAUTION**

1. NOISE REDUCTION VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED. REFER TO THE APPROPRIATE FOOTNOTE FOR THE TEST SPECIMEN DESCRIPTION.
2. VALUES PRESENTED IN TABLE 8A ARE NOISE REDUCTIONS AND THOSE IN TABLE 8B ARE TRANSMISSION LOSSES. SEE SECTION I-3.6. FOR EXPLANATION OF DIFFERENCES.

### GLOSSARY

Lead Loaded: Lead added to a base material such as vinyl to increase sound transmission loss.

## TABLE 8A LEAD/FOAM

| Thickness* (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | - | 17 | | | 17 | | | 19 | | | 22 | | | 36 | | | 36 | 1.0 | CLC | 18 | Hushcloth II | 1,10 |
| 1/2 | - | 17 | | | 17 | | | 19 | | | 22 | | | 36 | | | 36 | 1.0 | CLC | 184 | Hushcloth II | 1,10 |
| 1/2 | - | 27.8 | | | 31.6 | | | 44.3 | | | 55.5 | | | 60.4 | | | 66 | - | IATL | 12 | Airtex Acoustic Laminate 9510 | 6 |
| 1 | 31 | 19 | | | 22 | | | 24 | | | 27 | | | 36 | | | 41 | 1.0 | CLC | 36 | Sheald Noise Control Product I (NCP-I) | 3 |
| 1 | - | 18 | | | 22 | | | 24 | | | 27 | | | 40 | | | 41 | 1.0 | CLC | 184 | Hushcloth III | 4,10 |
| 1 | - | 18 | | | 22 | | | 24 | | | 27 | | | 40 | | | 41 | 1.0 | CLC | 18 | Hushcloth III | 4,11 |
| 1 | - | 18 | | | 22 | | | 27 | | | 29 | | | 41 | | | 41 | 1.0 | CLC | 184 | Hushcloth IV | 5,10 |
| 1 | - | 18 | | | 22 | | | 27 | | | 29 | | | 41 | | | 41 | 1.0 | CLC | 18 | Hushcloth IV | 5,11 |
| - | 31 | 17 | | | 22 | | | 26 | | | 37 | | | 45 | | | 47 | 1.0 | CLC | 36 | Sheald Noise Control Product II (NCP II) | 7 |
| .037 | 20 | 9 | 8 | 10 | 12 | 12 | 14 | 15 | 17 | 19 | 22 | 22 | 24 | 26 | 27 | 28 | 30 | .44 | RAL TL72-232 | 143 | Lead Vinyl, Stock No. 15-12949 | 8,9 |
| | | | | | 3' x 75' rolls used as surface barrier on inside walls, curtains, etc. | | | | | | | | | | | | | | | | | |
| - | 18 | 7 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 16 | 18 | 19 | 21 | 23 | 23 | 25 | 26 | .33 | RAL TL73-27 | 153 | Sound Stopper Leaded vinyl on foam | 8,9 |
| | | | | | Flexible noise control enclosures, dust wrappints, and drapes, etc. | | | | | | | | | | | | | | | | | |
| - | 20 | 8 | 8 | 10 | 13 | 11 | 14 | 14 | 17 | 20 | 21 | 22 | 25 | 26 | 29 | 30 | 31 | .5 | RAL TL70-235 | 149 | Leaded vinyl on foam | 2 |

*Note: The thickness of the foam does not have significant effect on transmission loss. Different overall thicknesses will provide similar results.

FOOTNOTES FOR TABLE 8A AND 8B

LEAD/FOAM

1. 1 lb/sq ft lead laminated to a single layer of polyurethane. Supplied in rolls 36" wide by 120" long. The data show noise reduction achieved by installing a 20 ga steel machine enclosure, 24" x 24" x 30", lined with Hushcloth II (lead face bonded to the steel).

2. Special Nonstandard test.

3. 1 lb/sq ft Sheald laminated to 1" thick polyurethane foam. Sheald or foam side can be laminated directly to the enclosure panel. The data shows noise reduction achieved by 24 ga steel machine enclosure, 24" x 24" x 30", lined with NCP-1 (Sheald face bonded to the inside faces).

4. 1 lb/sq ft lead sandwiched between two 1/2" layers of foam. Supplied in roll form. Standard rolls are 1" thick, 3' x 10'. Nonstandard sizes available. The data show noise reduction achieved by installing a 20 ga steel machine enclosure, 24" x 24" x 30", lined with Hushcloth III.

5. 1 lb/sq ft lead between two layers of 1/2" thick foam with an outer skin of 0.004" vinyl impervious to oil or moisture. Standard rolls are 1" thick, 3' x 10'. Nonstandard sizes available. The test data show noise reduction achieved by installing a 20 ga steel machine enclosure, 24" x 24" x 30", lined with Hushcloth IV.

6. 1 lb/sq ft lead sandwiched between two layers of 1/4" thick Industrial Acoustic foam 4100. Other combinations of laminates available. The test data show transmission reduction obtained by the General Motor's test utilizing reverberation room and an anechoic chamber, except that samples were adhered to 16 ga steel plate.

7. 1 lb/sq ft Sheald sandwiched between two layers of 1" thick foam. One foam layer has a plastic facing to protect the foam from oil and water. The test data show noise reduction achieved by the installation of a 24 ga steel machine enclosure, 24" x 24" x 30", lined with NCP-II.

8. Tested and evaluated according to E413-70T.

9. Tested and evaluated according to ASTM E 90-70.

10. Conforms to Fire retardant test. UL-94 and ASTM 1692-59T. Temperature range: -45° to 250°F; 100% humidity range.

11. Reverberation room test method used.

TABLE 9

OTHER BARRIER MATERIALS AND FOAM

The composite products which combine foam with materials other than vinyl, film, or lead are listed. The table is divided in two parts. Table 9A shows the transmission loss data while Table 9B shows absorption coefficients of the products (none of the products appears in both tables). Foam composites with rubber, steel, and vinyl materials are represented in this table. The companies (by numbers shown in Section II) with products listed in Table 9 are: 12, 18, 45, 59, 65, 67, 72, 119, 157, 160.

GLOSSARY

Loaded: A foreign substance added to the base material. In noise control materials this usually means addition of a dense material to a fabric type material to increase sound transmission loss.

TABLE 9A OTHER BARRIER MATERIAL AND FOAM (TRANSMISSION LOSS)

| Thickness (inches) | STC | | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/16 | - | Polyurethane foam fused to polyvinyl | | | | 15 | | | 20 | | | 26 | | | 32 | | | 36 | - | - | 59 | Eckoustic Noise Barrier Type 250 | 1 |
| 9/16 | - | Polyurethane foam fused to polyvinyl | | | | 15 | | | 20 | | | 28 | | | 32 | | | 36 | - | - | 59 | Eckoustic Noise Barrier Type 500 | 1 |
| 1 | - | Steel sandwiched between two layers of polyurethane foam | 18 | 16 | 19 | 20 | 21 | 25 | 25 | 30 | 31 | 35 | | | 48 | | | 53 | - | CT | 119 | Foam faced steel | 9,10 |
| 1.08 | 24 | Loaded vinyl (reinforced with fibers) and open cell foam composite | 15 | 13 | 14 | 16 | 16 | 18 | 19 | 22 | 23 | 25 | 27 | 29 | 31 | 33 | 34 | 36 | - | RAL TL71-197 | 45 &72 | Cousticomposite 0-10-100 | 2,3 |
| 1 1/8 | - | 1" thick foam rubber bonded to 1/8" layer of perforated gray foam | | | | .14 | | | .34 | | | .76 | | | .85 | | | .63 | - | CKL 722-10 | 67 | "Anechoic Pad" | 4,5 |
| 1 1/8 | 30 | Polyurethane foam laminated to elastomeric barrier material 54" x 120" high | 18 | 18 | 19 | 20 | 22 | 23 | 25 | 27 | 30 | 32 | 35 | 35 | 34 | 33 | 33 | 36 | 1.2 | RAL TL73-77 | 18 | Hushcloth I (Whispermat) | 2,3 |
| 1.54 | - | Loaded vinyl (reinforced with fibers) and open cell foam composite | 11 | 9 | 10 | 12 | 12 | 14 | 15 | 17 | 19 | 20 | 21 | 24 | 26 | 28 | 29 | 32 | .75 | RAL TL71-197 | 45 &72 | Cousti-Composite 5-100 | 2,3 |
| - | - | Polyurethane foam fused to polyvinyl | | 15 | 17 | 20 | 19 | 21 | 20 | 20 | 24 | 27 | 28 | 32 | 32 | 33 | 36 | 37 | - | HLB | 59 | Eckoustic Noise Barrier | |
| - | - | Plain or convoluted foam backed by a barrier material | | | | | | | | | | | | | | | | | - | - | 157 | DEE BEE Dropper Plastic Barrier Insulation | 8 |
| - | - | Foam and black dead rubber sheeting | | | | | | | | | | | | | | | | | - | - | 12 | Airtex Acoustic Laminates | |
| - | - | 1 lb/sq ft loaded urethane elastomer backed by 1/4" thick isolation foam. Pressure sensitive adhesive backing optional | | | | | | | | | | | | | | | | | - | - | 160 | Tufcote Noise Barrier 101 | 11 |

TABLE 9B OTHER BARRIER MATERIAL AND FOAM (SOUND ABSORPTION)

| Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 sq ft sheet, rubber mat material and 1/2 foam, useful for blocking and absorbing noise close to source | | | | | | | | | | | | |
| 1/2 | - | .11 | .13 | .30 | .40 | .75 | .82 | 1.0 | CT | 65 | Acousta Damp 5 | 6,7 |
| 24 sq ft sheet, rubber mat material 1" foam, useful for blocking and absorbing noise close to source | | | | | | | | | | | | |
| 1 | - | .16 | .30 | .60 | .72 | .93 | .94 | 1.0 | CT | 65 | Acousta Damp 10 | 6,7 |
| 24 sq ft sheet, rubber mat material and 2" foam | | | | | | | | | | | | |
| 2 | - | .33 | .55 | .78 | .85 | .96 | .91 | 1.0 | CT | 65 | Acousta Damp 20 | 6,7 |
| Rubber base mat material bonded with acoustical foam | | | | | | | | | | | | |
| 1/2 | - | .11 | .13 | .22 | .40 | .74 | .82 | - | CT | 65 | Acousta Damp 125 | 6,7 |
| Rubber base mat material bonded with acoustic foam | | | | | | | | | | | | |
| 1 | - | .16 | .31 | .75 | .72 | .93 | .92 | - | - | 65 | Acousta Damp 225 | 6,7 |
| Rubber base mat material bonded with acoustic foam | | | | | | | | | | | | |
| 2 | - | .34 | .57 | .75 | .84 | .96 | .92 | - | - | 65 | Acousta Damp 425 | 6,7 |

FOOTNOTES FOR TABLES 9A AND 9B
OTHER BARRIER MATERIALS AND FOAM

1. Self-extinguishing per ASTM 1692-57T. Temperature range: -20° to 200°F, gasoline, oil and abrasion resistant.
2. Tested and evaluated according to E90-70.
3. Tested and evaluated according to E413-70T.
4. Tested and evaluated according to ASTM C 384-58.
5. Good tack strength up to 180°F, chemical; solvent and weather resistant. Non-toxic and odorless.
6. Reverberation room test method used.
7. Data extracted from a graph.
8. Temperature range: -50° to 450°F. Resistant to gasoline, alkalis, $H_2O$.
9. Self-extinguishing per ASTM D 1692. Temperature range: 0 to 150°F.
10. Tested and evaluated according to ASTM E90.
11. Temperature range: -40°F to 250°F

TABLE 10

BARRIER MATERIAL/FIBERGLASS

The composite products comprising fiberglass to provide sound absorption and a dense material backing, e.g., lead asbestos, felt, mastic, etc., to provide the sound transmission barrier are listed. Figure 10A shows a lead/fiberglass combination with a protective vinyl film and Figure 10B shows a mastic/fiberglass composite with pressure sensitive adhesive on the mastic side. The sound absorption provided by the products depends mainly upon the surface characteristics, thickness, and density of the fiberglass.

Sound absorption data are not presented in the table. The products are usually available with various fiberglass thicknesses to suit different absorption requirements. The table does provide sound barrier information. Table 10A shows noise reduction data and Table 10B shows transmission losses of the products and lists additional products for which acoustic data were not available. Appropriate footnotes should be referred to before interpreting the data in this table.

Products of this type have multiple uses. Typically they are used in machine enclosures, as pipe wrappings, or in large rooms to reduce the reverberation time of the room. The companies (by numbers shown in Section II) with products listed in Table 10 are: 6, 18, 36, 79, 86, 107, 184.

CAUTION

1. NOISE REDUCTION AND TRANSMISSION LOSS VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED. REFER TO THE APPROPRIATE FOOTNOTE FOR THE TEST SPECIMEN DESCRIPTION.

2. VALUES PRESENTED IN TABLE 10A ARE NOISE REDUCTIONS AND THOSE IN TABLE 10B ARE TRANSMISSION LOSSES. SEE SECTION I-3.6 FOR EXPLANATION OF DIFFERENCES.

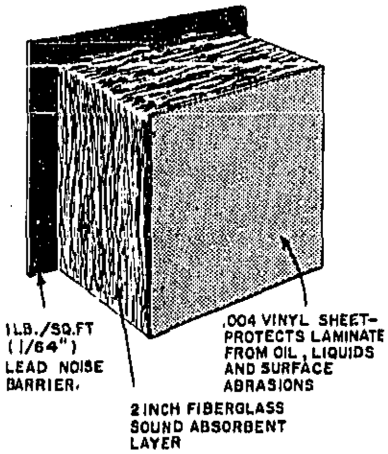



Figure 10A Lead/Fiberglass Composite with a Protective Facing

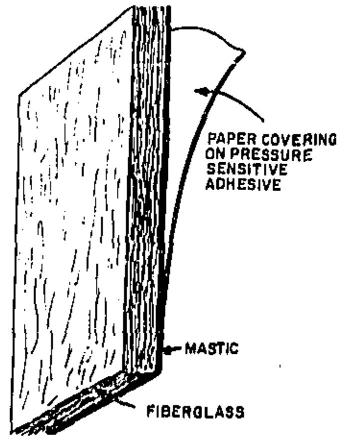



Figure 10B Mastic/Fiberglass Composite with Pressure Sensitive Adhesive

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Mastic: Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product.

Scrim: A light, loosely woven cotton or woolen cloth.

TABLE 10A BARRIER MATERIAL/FIBERGLASS (NOISE REDUCTION)

| Thickness (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1" fiberglass and 1/8" lead | | | | | | | | | | | | | | | | | |
| 1 | - | 14 | | | 16 | | | 38 | | | 48 | | | 49 | | | 55 | 1.0 | CLC | 104 | Hushcloth V | 1,3, 13 |
| | | | | | fiberglass and lead | | | | | | | | | | | | | | | | | |
| 3 | - | 18 | | | 24 | | | 25 | | | 29 | | | 42 | | | 43 | 1.0 | CLC | 18 | Hushcloth VI | 1,2 |

## TABLE 10B BARRIER MATERIAL/FIBERGLASS (TRANSMISSION LOSS)

| Thickness (inches) | STC | Description | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight (lb/ft²) | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 27 | 1" thick fiberglass with 1 lb/sq ft mastic | | | | | | | | | | | | | | | | | 1.0 | G&H | 86 | Acoustipad L 24-48(100) | 4 |
| 1-1/2 | - | Stitched blanket assembly of glass fabric membrane, glass fibers and glass textile scrim. For absorption data see Table 12. | | | | | | | | | | | | | | | | | - | - | 107 | Insul-Quilt Studio blanket | 11,12 |
| 2 | 31 | 1 lb/sq ft Sheald barrier with 2" thick fiberglass and .004" thick vinyl facing | 18 | | | 23 | | | 24 | | | 28 | | | 43 | | | 43 | 2.8 | CLC #738 | 36 | Sheald Noise Control Product III | 5,6 |
| 2 | 47 | Glass fiber and felt | 23 | 33 | 38 | 42 | 47 | 50 | 53 | 55 | 56 | 57 | 57 | 56 | 51 | 48 | 50 | 53 | - | RAL TL73-107 | 79 | Acoustifiber | 6,7,8 |
| - | 38 | Asbestos and foil faced glass fiber. For data see Table 34. | | | | | | | | | | | | | | | | | - | - | 6 | Sound Control Blanket | 9 |
| - | 26 | 1/2" thick fiberglass with 1 lb/sq ft mastic and pressure sensitive adhesive on mastic | | | | | | | | | | | | | | | | | - | - | 86 | Acoustipad L 24-49 (100) | 10 |

### FOOTNOTES FOR TABLES 10A AND 10B
### BARRIER MATERIAL/FIBERGLASS

1. Temperature range: to 350°F. Data show Noise Reduction (dB) achieved after the product was bonded on fiberglass face to a 20 gage steel panel.
2. NFPA flame spread 10.
3. NFPA flame spread 20.
4. Sound absorption coefficient = .65.
5. Data shows Transmission Loss of the product cemented to 20 ga steel.
6. Tested and evaluated according to ASTM E 90-70.
7. Tested and evaluated according to ASTM E 413-70T. The test specimen was 5.91 lb/sq ft wall with its cavity filled with 2 inch by 2 feet by 4 feet Acoustifiber.
8. Temperature range: to 450°F.
9. Available in 1", 2", 3" thicknesses and 24", 26", 48" widths on 100 ft roll lengths.
10. Temperature range: -20° to 200°F.
11. Tested and evaluated according to ASTM C 384-58.
12. Temperature range: -65° to 250°F. Resistant to fuels, oils, alkalies, salt atmospheres.
13. Conforms to fire retardant test. UL-94 ASTM 1692-59T.

TABLE 11
OTHER COMPOSITE MATERIALS

The composite products which for one reason or another cannot be placed in any one of the Tables 6 through 10 are listed. These products include clay tiles with fiberglass pads (see Figure 11A), fabric bonded to foam, mastic with foam, and other products using various combinations of materials. The combinations are used to impart extra strength (see Figure 11B), to provide protection to the absorption material, or to increase the sound transmission loss of the product. The table, however, shows only the sound absorption of the listed products except a few for which no acoustic information is given. The companies (by numbers shown in Section II) with products listed in Table 11 are: 3, 6, 25, 86, 107, 118, 119, 127, 160, 162.

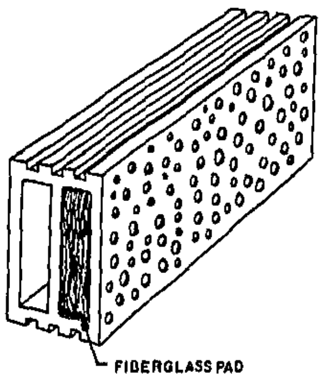



Figure 11A Perforated Clay Tile with Fiberglass Pad in Core

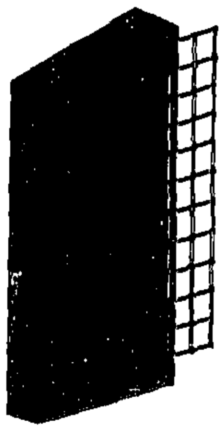


Figure 11B Reinforced Foam

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3. AND ILLUSTRATED IN FIGURE I-11.

## GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other outside surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |
| Mastic: | Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product. |
| Scrim: | A light, loosely woven cotton or woolen cloth. |

TABLE 11 OTHER COMPOSITE MATERIALS

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Absorption Coefficients | | | | | | | | | |
| | | | | Stitched blanket assembly of glass fabric membrane, glass fibers, and glass textile scrim | | | | | | | | | |
| 2 | 1 | .50 to .60 | .09 | .15 | .41 | .78 | .90 | .90 | - | - | 107 | Insul-Quilt Studio Blankets | 11,12 |
| | | | | Stitched blanket assembly of glass fibric membrane, glass fibers, and glass textile scrim | | | | | | | | | |
| 2 | 2 | .65 to .75 | .02 | .21 | .60 | .99 | .95 | .91 | - | - | 107 | Insul-Quilt Studio Blankets | 11,12 |
| | | | | Perforated, fiberglas structural tile with fiberglas pad, 8" x 16" | | | | | | | | | |
| 2 | 4 | .55 | .19 | .64 | .73 | .62 | .20 | .14 | 80* | RAL A66-19 | 162 | Starkustic Acoustile | 5,13 |
| | | | | Randomly perforated structural clay tile with fiberglas pads 5" x 12". | | | | | | | | | |
| 4 | 4 | .60 | .06 | .66 | .79 | .62 | .29 | .16 | 80* | RAL A54-128 | 162 | Starkustic Acoustile | 5,13 |
| | | | | Aluminized nylon or Korel film on Polyester or Polyether | | | | | | | | | |
| - | 1/2 | .54 | - | .16 | .43 | .70 | .88 | .91 | 1 | CT | 160 | Tuf coat Acoustical foam | 7,11, 15 |
| | | | | Aluminized nylon or Korel film on Polyester or Polyether | | | | | | | | | |
| - | 1 | .72 | - | .27 | .63 | 1.0 | .99 | .96 | 1 | CT | 160 | Tuf coat Acoustical foam | 7,11, 15 |
| | | | | 1-1/2" thick 0.8 lb/cu.ft. fiberglass faced with 12 .06 lb/ft² asbestos felt. | | | | | | | | | |
| - | 1-1/2 | .90 | .18 | .59 | .96 | .49 | .21 | .19 | .16 | G&H | 6 | Sound control Blanket | 2 |
| | | | | Perforated, glazed tile with 2 fiberglass inserts. 15 3/4" x 7 3/4". | | | | | | | | | |
| - | 3-3/4 | .65 | (.28) | .67 | .99 | .48 | (.37) | .37 | 23.75 | RAL A59-399 | 25 | Sound Bar | 3,4 |
| | | | | Open, porous weave fabric bonded to plastic foam 1/8" thick | | | | | | | | | |
| - | - | .45 | .04 | .26 | .55 | .54 | .48 | .51 | - | G&H | 3 | Acoustidrape | 8,9, 16 |

*Density in lb/ft³.

TABLE 11 OTHER COMPOSITE MATERIALS (Concl)

| Mounting | Thickness (Inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Absorption Coefficients | | | | | | | | | | | |
| - | - | .65 | .10 | .49 | .69 | .73 | .68 | .71 | Open, porous weave fabric bonded to 1/8" thick foamed urethane | - | G&H | 3 | Acoustidrape | 9, 10,16 |
| - | - | .65 | .09 | .23 | .60 | .80 | .86 | .75 | 1" thick fiberglas with 1 lb/sq ft mastic on pressure sensitive adhesives | - | CT | 86 | Acoustipad L24-48 | 6,14 |
| - | - | - | - | | | | | | Interlacing of cellulose fibers laminated to polyethylene | .25 | - | 127 | K-13 Acoustical Blankets | 1 |
| - | - | - | - | | | | | | .5 to 2 lb/sq ft mastic with 1/8" polyethylene foam | - | - | 118 | KFO Series | |
| - | - | - | - | | | | | | .5 to 2 lb/sq ft mastic with 1/8" polyethylene foam | - | - | 118 | KA Series | |
| - | - | - | - | | | | | | .5 to 2 lb/sq ft mastic with 3/4" polyethylene foam | - | - | 118 | CPJ Series Chipboard | |
| - | - | - | | | | | | | Polyurethane foam adhered to LD-400 damping sheets tiles: 1 ft. x 1 ft. foam: 1/4" to 6" thick. | - | CT | 119 | LD-400 with foam | |
| - | - | - | | | | | | | Reinforcing media of fabric or scrim is introduced during the foaming process. Increased strength and stability are possible by the reinforcement. | - | - | 160 | Reinforced Tuf-cote foam | - |

FOOTNOTES FOR TABLE 11
OTHER COMPOSITE MATERIALS

1. Available as 4' x 8' sheet: Lead or felt paper used as backing to provide sound transmission loss. For acoustical data see Table 43. Temperature range: 200°F.
2. Available in 20/S 100' long and 24", 26" or 48" wide.
3. Resistant to all chemicals except hydrofluoric acid. Temperature range: -50°F to 200°F.
4. Numbers in the brackets refer to frequencies of 100 Hz and 2400 Hz respectively.
5. STC of the tile is 46. Random hole pattern of the facing.
6. Maximum width 69". Available in sizes; 30" x 24", 36" x 60", 30" x 36", and 30" x 48".
7. Available as rolls, sheets, die cut parts. Temperature range: -40°F to 250°F. Good chemical resistance.
8. Special mounting method used for the test (simulated as a stretched flat hung curtain).
9. Flameproof.
10. Hung in simulation of draped 100% fullness curtain.
11. Tested and evaluated according to ASTM C384-58.
12. Temperature Range: -65°F to 250°F, resistance to fuels, oils, and alkalis.
13. Tested and evaluated according to ASTM C423-60T.
14. Derived from Graph.
15. Meets ASTM 1692 and U.L. 94 Flame Spread.
16. Tested and evaluated according to ASTM C423-66.

TABLE 12

FOAM/BARRIER/FOAM

Some products which perform a dual function of sound absorption and sound transmission reduction are listed. The composite product is a sandwich form with the barrier material in the center. Figures 12A and 12B show two such products with protective facings added on one side of each product. Figure 12A shows a product with lead septum and Figure 12B shows a product with vinyl septum. Both lead and vinyl are good sound barriers. Foam layers provide sound absorption and can also provide vibration insulation if necessary. Figures 12A and 12B show products where foam on one side is used to absorb sound and foam on the other side acts as a vibration damping layer or spacer. When the product is glued to a vibrating component, foam on one side floats the septum away from the component and the foam on the other side absorbs the incident sound energy. For this reason foam/barrier/foam products are often used to line the inside surfaces of machinery enclosures. Sound absorption coefficients and transmission loss for some of the products listed in this table can be found in Tables 6, 8 and 9. The companies (by numbers shown in Section II) with products listed in Table 12 are: 12, 18, 36, 65, 111, 149, 156, 157, 160, 184.

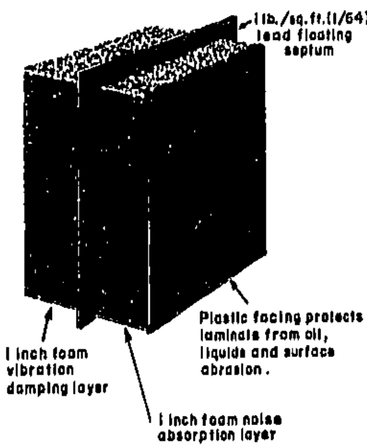



Figure 12A Foam/Lead/Foam Composite with Plastic Facing

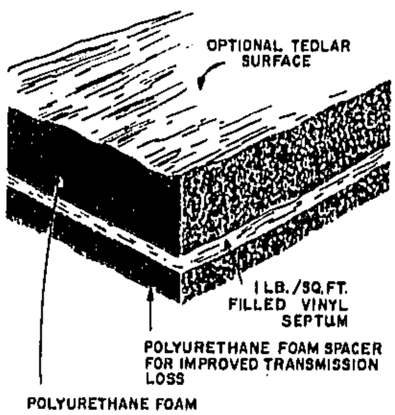



Figure 12B Foam/Vinyl/Foam Composite with Tedlar Surface

## GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other outside surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |

TABLE 12 FOAM/BARRIER/FOAM

| Description | Application | Company | Product |
| --- | --- | --- | --- |
| Sandwich combination of 1" of foam, 1 lb/sq ft (1/64") Sheald, and 1" of foam with a plastic facing. The facing protects the foam against oil and other fluids. (For transmission loss see Table 8.) | Can be bonded to steel plywood, aluminum and used in enclosures, housing, screens, etc. | 36 | Sheald Noise Control Product II |
| Rubber base, mat material between foam. Available in different sizes. Nos. 125, 225, 425 have 1/2", 1", and 2" foam pieces respectively. Rubber base mat weighs 1 lb/sq ft. (For sound barrier property see Table 18, for sound absorption information see Table 6, 8.) | Blocks and absorbs noise close to the source. | 65 | Acousta-Damp 125, 225, 425 |
| Two layers of foam with a sheet of 0.6 pound lead foil between them. 1/6" foam on one side, 1/2" foam on the other side. Available in 48" x 24" x 3/4" size. SFB-1 has standard finish, SFB-1T has Tedlar finish. | Used to line lightweight enclosures. The 1/4" foam can be cemented to the inside of the enclosure to separate the foil from the enclosure wall. | 156 | Barrier sheets with lead septum (SFB-1/ SFB-1T) |
| Standard sheet size 36"x56". Different foam thicknesses and 1 or 2 lb/sq ft lead insulators. Flat or convoluted surface faces with thickness range of 1/4" to 2-1/2" available. pressure-sensitive backing available. resistant to solvents. Temperature range from 80°F to 450°F. | Used in any application where sound transmission and sound absorption are required. | 157 | Foam/Lead/Foam insulation |
| Two layers of flexible foam with 1 lb/sq ft floating lead septum. Self-extinguishing. Dust free and nontoxic. (For transmission loss information see Table 8.) Hushcloth IV has an extra layer of .004" vinyl facing which is impervious to oil or moisture. | In industrial problem areas and linings of office equipment etc. where absorption and barrier properties are required. | 184 | Hushcloth III and IV |
| Two layers of flexible foam with 1 lb/sq ft floacrap lead septum. Self-extinguishing, dust free and nontoxic. (For transmission loss information see Table 8.) Hushcloth IV has an extra layer of vinyl facing which is impervious to oil and moisture. | In industrial problem areas and linings of office equipment etc. where absorption and barrier properties are required | 18 | Hushcloth III and IV |
| 1 or 2 lb/sq ft filled vinyl septum between acoustical foams of various thicknesses. Available in rolls or pads in various configurations. | In enclosure linings, pipe and duct wrapping, open plan partitions, etc. | 111<br>149 | Sound/Eaze, TL-Alpha |
| 1 lb/sq ft loaded urethane elastomer between two foam layers. Pressure sensitive adhesive on one side optional. Other side protected against foreign elements by Aluminized Mylar film. Foam thicknesses available are 1/4", 1/2", 3/4", 1". | Machinery enclosures and interior cab linings. | 198 | Tufcote Noise Barrier Series 104 |
| Acoustic mass laminated to 1/4", 1/2", or 1/2" of 4100 foam on one side and 1/4" of 4100 foam on other side. | Application for vibration isolation, damping, sound absorption and barrier. | 12 | Acoustic Laminates Nos. 9505, 9510, 9550. |

TABLE 13
LEAD

Lead products and the transmission loss data for some of them are listed. Lead is a dense material and is comparatively inexpensive. Also a thin lead sheet effectively simulates a limp mass. These considerations make it a very useful barrier material. Usually lead is used in combination with other materials which provide sound absorption, create a floating lead septum away from a vibrating surface, or simply cover up the exposed lead surfaces. Table 9 shows the noise reduction achieved by the lead products in combination with foam. Transmission losses of other lead products specially used as curtains are shown in Table 36. Transmission losses of some lead-fiberglass composites are shown in Table 11. The companies (by numbers shown in Section II) with products listed in Table 13 are: 16, 21, 28, 36, 129, 165, 166, 180.

TABLE 13 LEAD

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 3 ft x 75 ft lead/vinyl sheet. | | | | | | | | | | | | | | | | | |
| .035 | 18 | 7 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 16 | 18 | 19 | 21 | 23 | 23 | 25 | 26 | .33 | RAL TL73-27 | 166 | Lead/vinyl sheet | 1,2,3 |
| | | | | | Lead loaded vinyl. | | | | | | | | | | | | | | | | | |
| - | 18 | 13 | [13] | | 14 | [13] | | 15 | [18] | | 21 | [23] | | 27 | [30] | | 32 | 0.50 | RAL | 28 | Lead X | 9 |
| | | | | | Nonreinforced material with pulverized lead core sandwiched between two layers of vinyl. | | | | | | | | | | | | | | | | | |
| - | 22 | 16 | | | 17 | | | 18 | | | 24 | | | 30 | | | 35 | 0.75 | KAL | 129 | NMC Lead X Sheeting | 4 |
| | | | | | Lead loaded vinyl. | | | | | | | | | | | | | | | | | |
| - | 22 | 16 | [16] | | 17 | [16] | | 18 | [22] | | 24 | [26] | | 30 | [33] | | 35 | 0.75 | RAL | 28 | Lead X | 9 |
| | | | | | Nonreinforced material with pulverized lead core sandwiched between two layers of vinyl. | | | | | | | | | | | | | | | | | |
| - | 28 | 22 | | | 23 | | | 25 | | | 31 | | | 35 | | | 42 | 1.50 | KAL | 129 | NMC Lead X Sheeting | 4 |
| | | | | | Lead loaded vinyl. | | | | | | | | | | | | | | | | | |
| - | 28 | 22 | [22] | | 23 | [23] | | 25 | [28] | | 31 | [33] | | 35 | [40] | | 42 | 1.50 | RAL | 28 | Lead X | 9 |
| | | | | | Nonreinforced material with pulverized lead core sandwiched between two layers of vinyl. | | | | | | | | | | | | | | | | | |
| - | 34 | 26 | | | 28 | | | 30 | | | 35 | | | 41 | | | 46 | 3 | KAL | 129 | NMC Lead X sheeting | 4 |
| | | | | | Lead loaded vinyl. | | | | | | | | | | | | | | | | | |
| - | 34 | 26 | [26] | | 28 | [28] | | 30 | [32] | | 35 | [38] | | 41 | [44] | | 46 | 3 | RAL | 28 | Lead X | 9 |
| - | - | | | | Rolled foil with 4% tin, 4% antimony and 92% lead. Available in thicknesses ranging from .0025" to .006". | | | | | | | | | | | | | - | - | 16 | Plain lead foil | 5 |
| .007 | - | | | | Rolled lead sheet available in .007", .008", and .009" thicknesses. | | | | | | | | | | | | | - | - | 16 | Heavy sheet lead | 5 |
| 1/64 | - | | | | Continuously cast lead sheet | | | | | | | | | | | | | 1 | - | 21 | Acoustilead | |
| | | | | | Continuously cast lead sheet | | | | | | | | | | | | | | | | | |
| 1/64 | - | 11* | | | 19* | | | 24* | | | 25* | | | 32* | | | 29* | 1 | G&H | 36 | Sheald plenum barrier and ceiling blankets | 6,7 |

*See Footnote No. 7.

TABLE 13 LEAD (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Continuously cast lead sheet | | | | | | | | | | | | | | | | | | | | |
| 1/64 | - | 11* | | | 19* | | | 24* | | | 25* | | | 32* | | | 29* | 2 | G&H | 36 | Sheald plenum barrier and ceiling blankets | 6,7 |
| | | Continuously cast lead sheet | | | | | | | | | | | | | | | | | | | | |
| 1/64 | - | 11* | | | 19* | | | 24* | | | 25* | | | 32* | | | 29* | 3 | G&H | 36 | Sheald plenum barrier and ceiling blankets | 6,7 |
| | | Foil laminated to .015" thick backing board (waterproof bristol) | | | | | | | | | | | | | | | | | | | | |
| .002 to .010 | - | | | | | | | | | | | | | | | | | .72 | - | 16 | X-ray foil laminated | |
| | | Medium-strength lead alloy sheet/strip, widths up to 14" in coil form, 4' wide in sheets | | | | | | | | | | | | | | | | | | | | |
| .016 | - | | | | | | | | | | | | | | | | | 1 | - | 165 | STM 3165 | 8 |
| | | High-strength lead alloy sheet/strip, widths up to 14" in coil form, 4' wide sheet/plate available on custom basic | | | | | | | | | | | | | | | | | | | | |
| .016 | - | | | | | | | | | | | | | | | | | 1 | - | 165 | STM 6205 | 8 |
| | | 48" x 120" maximum size | | | | | | | | | | | | | | | | | | | | |
| - | - | | | | | | | | | | | | | | | | | .625 to 8 | - | 180 | Lead veneer metal | 5 |

*See Footnote No. 7.

FOOTNOTES FOR TABLE 13
LEAD

1. Tested and evaluated according to ASTM E90-70.
2. Tested and evaluated according to E413-70T.
3. Temperature Range from -38°F to 170°F.
4. Tested and Evaluated according to E90-61T
5. Temperature Range to 300°F.
6. Available in 3 sizes: 36' x 3' x 1/64" (1 lb/ft²),<br>78' x 3' x 1/64" (2 lb/ft²),<br>12' x 3' x 1/64" (3 lb/ft²).
7. Data represents difference in attenuation of 0.6 lb/ft² ceiling board with and without Sheald materials. Ceiling board STC was increased from 18 to 46 by using this plenum barrier. (Data derived from graph.)
8. Temperature Range to 125°F.
9. Numbers in the brackets refer to 175, 350, 700, 1400, 2800 Hz respectively. Lead X supplied in rolls. Can be attached to walls or hung on overhead tracks to provide sound reduction enclosures.

## TABLE 14
## MASTIC

Mastic products are listed. Their pliability ranges from flexible to semirigid. They are heavyweight products used as sound barrier or damping materials in automobiles, hollow core doors, appliances, etc. The companies (by numbers shown in Section II) with products listed in Table 14 are: 81, 86, 118.

## GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Creped Kraft: Crinkled, strong paper

Mastic: Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product.

TABLE 14 MASTIC

| Thickness (inches) | STC | Description | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| 0.120 | - | Flexible mastic. | 14 | 15 | 15 | 15 | 14 | 15 | 17 | 22 | 31 | 35 | 34 | 37 | 33 | 34 | 40 | 41 | 1.0 | CT | 81 | #619 | 5 |
| 0.120 | - | Film faced flexible mastic, | 19 | 20 | 19 | 19 | 20 | 21 | 22 | 27 | 30 | 31 | 30 | 38 | 34 | 36 | 41 | 41 | 1.0 | CT | 81 | #623 | 5 |
| 0.125 | 25 | Creped kraft, mastic tissue; KW-003-100 sheet with Amber-lite, 8' x 4'; transmission area = 32 sq ft. | 10 | 11 | 13 | 17 | 18 | 19 | 20 | 22 | 23 | 26 | 28 | 31 | 33 | 35 | 36 | 38 | 1 | RAL TL73-195 | 118 | KW Series -003-100 | 4 |
| 0.625 | 27 | Creped kraft, mastic tissue; KW-003-100 sheet with amber-lite, 8' x 4'; transmission area = 32 sq ft. | 13 | 14 | 15 | 17 | 17 | 19 | 21 | 24 | 28 | 30 | 32 | 35 | 38 | 41 | 45 | 46 | 1.3 | RAL TL73-196 | 118 | KW Series -003-100 | 4 |
| - | 26 | Manufactured in different sizes (30" x 24", 30" x 36", width-69", 30" x 48", 36" x 60") with paper facing on pressure sensitive adhesive and backing of polyethylene film. | 12 | | | 32 | | | 43 | | | 54 | | | 62 | | | 67 | - | G&H GL-1T | 86 | Acousti-pad L24-80(100) | 2 |
| - | 42 | Manufactured with 1 lb/sq ft of mastic core, using 40 lb creped kraft as backing and 12 lb of tissue as facing | 23 | | | 32 | | | 38 | | | 48 | | | 52 | | | 58 | 1 | G&H GL-10ST | 86 | Acousti-pad L-134-100 | 1 |
| - | 49 | Manufactured with 1 lb/sq ft of mastic core, using 40 lb creped kraft as backing and 12 lb of tissue as facing | 25 | | | 43 | | | 49 | | | 54 | | | 54 | | | 58 | 1 | G&H GL-8ST | 86 | Acousti-pad L-134-100 | 1 |
| - | 51 | Manufactured with 1 lb/sq ft of mastic core, using 40 lb creped kraft as backing and 12 lb of tissue as facing | 29 | | | 45 | | | 50 | | | 54 | | | 54 | | | 60 | - | G&H GL-9ST | 86 | Acousti-pad L-134-100 | 1 |
| - | - | Manufactured in different standard sizes (30" x 24", 30" x 36", 30" x 48", 32" x 48") with wide choices of facings and pressure sensitive adhesive on creped kraft mastic | | | | | | | | | | | | | | | | | Varied Densities | G&H 1969-1973 | 86 | Acousti-pad | 1 |
| - | - | Mastic creped kraft | | | | | | | | | | | | | | | | | .5-2 | - | 118 | KK Series plain kraft | 3 |
| - | - | Mastic jute | | | | | | | | | | | | | | | | | .5-2 | - | 118 | KJ Series creped kraft | |

FOOTNOTES FOR TABLE 14
MASTIC

1. Tested and evaluated according to ASTM E90-66T. Used in construction - industrial.
2. Tested and evaluated according to ASTM E90-66T. Also tested for insertion loss (rating 24.4).
3. Used extensively in automotive industry for sound deadening.
4. Tested and evaluated according to ASTM E90-70, E413-70T. Used in automotive industry for sound deadening.
5. Maximum use temperature is of the order of 180°F. Can be used in hollow core doors, appliances, etc.

TABLE 15
MASTIC WITH COTTON

Mastic products with cotton paddings are listed. Resinated cotton is added to mastic to provide vibration damping and to avoid direct contact between mastic and other surfaces in certain cases. Like mastic products, these products also have pliability ranging from flexible to semirigid and can be used in door or wall cavities, enclosures, etc., to increase the transmission loss of existing structures. The companies (by numbers shown in Section II) with product listed in Table 15 are: 81, 86, 118.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Creped Kraft: Crinkled, strong paper

Mastic: Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product

## TABLE 15 MASTIC WITH COTTON

| Thickness (inches) | STC | | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .35 | 22 | Creped kraft, mastic, and laminated cotton fiber pad | 15 | 15 | 15 | 15 | 15 | 16 | 18 | 24 | 30 | 35 | 33 | 36 | 33 | 35 | 40 | 41 | 1.05 | CT | 81 | #620 | 10 |
| 3/8 | 25 | 1 lb/sq ft mastic with 28 gram resinated cotton padding, 1/4" thick | 14 | | | 17 | | | 22 | | | 30 | | | 34 | | | 42 | - | G&H GL-4T | 86 | Acousti-pad L-24-60(100) | 1,2,7 |
| 3/8 | | Heavy Kraft stock, 1/8" mastic, and 28 gram/sq ft resinated cotton padding | | | | | | | | | | | | | | | | | 1 | G&H GL-1ST 2ST, 3ST, GL-22ST, 25ST, 31ST | 86 | Acousti-pad L-160-100-A (The Centurion) | 6,8 |
| 0.5 | 25 | Creped Kraft, mastic, with 1/4" thick resinated cotton fiber pad core | 20 | 21 | 21 | 19 | 17 | 17 | 20 | 29 | 39 | 44 | 42 | 48 | 49 | 55 | 56 | 57 | - | CT | 81 | #643 | |
| 5/8 | 27 | Creped Kraft, mastic with resinated cotton | 13 | 14 | 15 | 17 | 17 | 19 | 21 | 24 | 28 | 30 | 32 | 35 | 38 | 41 | 45 | 46 | 1.3 | RAL TL73-196 | 118 | Sound Deadener KA-204-100 | 3,9 |
| 7/8 | 26 | 1 lb/sq ft mastic with 85 gram resinated cotton padding, 3/4" thick | 9 | | | 16 | | | 22 | | | 28 | | | 38 | | | 44 | - | G&H GL-5T | 86 | Acousti-pad L-24-75(100) | 1,2 |
| - | - | Chipboard, mastic, and resinated cotton | | | | | | | | | | | | | | | | | - | - | 118 | CA Series Sound Deadener | 4 |
| - | - | 1 lb/sq ft mastic with 1/4" thick 28 gram resinated cotton | | | | | | | | | | | | | | | | | - | G&H GL-CST GL-11ST | 86 | Acousti-pad L-02-60(100) | 5 |

### FOOTNOTES FOR TABLE 15
### MASTIC WITH COTTON

1. Has pressure sensitive or crepe Kraft paper backing. Can be cut to specification. Standard sizes available are 30" x 24", 30" x 36", 30" x 48", 36" x 60". Maximum width is 69". Temperature range: -20°F to +200°F.
2. Humidity range to 100%. Can be used in walls, floors, ceilings. An approximate transmission loss due to the insertion of the mastic product was determined from a chart supplied by the company.
3. Mastic weight ranges from 0.5 lb to 2.0 lb/sq ft, 28 to 100 gram resinated cotton used in the KA Series.
4. Various compositions available in the CA series 0.5 lb to 2.0 lb/sq ft mastic 28 to 100 gram resinated cotton.
5. The results of the tests show that when L-02-60(100) was applied to both sides of an assembly, the STC of the assembly was increased from 35 dB to 47 dB, i.e., by 12 dB.
6. GL-1ST, 2ST, 3ST were made on one specific assembly. One layer of Acousti-pad increased STC by 3 dB, and two layers of Acousti-pad increased STC by 6 dB. GL-22ST, 25ST, and 31ST were made on another assembly. In this case, addition of one layer of Acousti-pad resulted in 6 dB gain in STC while the addition of two layers of Acousti-pad increased the STC by 9 dB.
7. Insertion loss rating is 24.8 decibels.
8. The test procedure conforms to ASTM E-90-66T.
9. The test procedure conforms to ASTM E-90-70, ASTM E-413-70T.
10. Maximum temperature is of the order of 180°F. Can be used in hollow core doors, appliances, etc.

TABLE 16
GLASS AND PLASTIC

Sound transmission losses of glass panels, glass products with plastic inner layer, and glass panels separated by an air space are listed. The additions of a plastic inner layer or an air space provide increased thermal as well as acoustical insulation. The products are arranged in the order of increasing thicknesses ranging from 1/8 inch to 3-1/8 inches with the greater thicknesses reflecting the measured thicknesses due to air spaces. Table 33 shows the transmission losses of windows and it can be seen that the sound transmission loss values shown in Table 16 are comparable to the sound transmission loss of windows of equal thicknesses, and using a similar glass panel system. The companies (by numbers shown in Section II) with products listed in Table 16 are: 40, 47, 55, 61, 85, 115, 138, 148, 152.

TABLE 16 GLASS AND PLASTIC

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plain surface structure, core of cast acrylic plastic sheet | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 27 | 16 | 18 | 18 | 17 | 20 | 21 | 22 | 24 | 25 | 28 | 30 | 31 | 33 | 33 | 35 | 35 | 1.45 | KAL 1481-1 | 148 | Plexiglas | 1,9,10 |
| Two layers of 1/8" thick glass with 0.015" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 32 | 26 | 27 | 27 | 26 | 27 | 29 | 29 | 32 | 33 | 34 | 34 | 34 | 30 | 32 | 35 | 39 | 3.3 | RAL TL71-157 | 61 | Laminated Acoustical Glass | 2,9,10 |
| Two layers of 1/8" thick glass with 0.045" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 33 | 27 | 28 | 29 | 27 | 29 | 29 | 30 | 32 | 34 | 35 | 35 | 35 | 33 | 34 | 36 | 40 | 3.5 | RAL TL71-158 | 61 | Laminated Acoustical Glass | 4,9,10 |
| Two layers of 1/8" thick glass with 0.015" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 34 | 29 | 27 | 28 | 28 | 28 | 29 | 30 | 31 | 34 | 36 | 36 | 37 | 37 | 36 | 37 | 40 | 3.3 | RAL TL71-273 | 61 | Laminated Acoustical Glass | 2,9,10 |
| Two layers of 1/8" thick glass with 0.030" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 34 | 26 | 24 | 26 | 27 | 27 | 27 | 29 | 31 | 33 | 36 | 37 | 37 | 38 | 37 | 37 | 39 | 3.3 | RAL TL72-43 | 61 | Laminated Acoustical Glass | 3,9,10 |
| Two layers of 1/8" thick glass with 0.030" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 34 | 28 | 26 | 27 | 28 | 28 | 29 | 29 | 32 | 34 | 36 | 37 | 38 | 38 | 38 | 37 | 38 | 3.3 | RAL TL71-277 | 61 | Laminated Acoustical Glass | 3,9,10 |
| Two layers of 1/8" thick glass with 0.090" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 34 | 27 | 28 | 29 | 28 | 30 | 31 | 31 | 33 | 34 | 35 | 35 | 35 | 34 | 35 | 38 | 41 | 3.8 | RAL TL71-159 | 61 | Laminated Acoustical Glass | 5,9,10 |
| Glass with Saflex polyvinyl Butyral interlayer. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 34 | 29 | 30 | 31 | 34 | 33 | 35 | 35 | 35 | 35 | 33 | 34 | 38 | 41 | 45 | 46 | | - | RAL | 115 | Architectural Saflex | 11 |
| Two layers of 1/8" thick glass with 0.045" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 35 | 27 | 27 | 27 | 29 | 29 | 30 | 30 | 33 | 34 | 35 | 37 | 39 | 60 | 40 | 38 | 38 | 3.5 | RAL TL71-274 | 61 | Laminated Acoustic Glass | 4,9,10 |
| Two layers of 1/8" thick glass with 0.045" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 35 | 28 | 27 | 28 | 28 | 28 | 30 | 31 | 33 | 35 | 36 | 37 | 38 | 37 | 36 | 36 | 38 | 3.5 | RAL TL71-275 | 61 | Laminated Acoustic Glass | 9,10 |
| Two layers of 1/8" thick glass with 0.090" thick Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 36 | 28 | 27 | 28 | 29 | 29 | 30 | 31 | 33 | 35 | 37 | 39 | 40 | 40 | 40 | 39 | 38 | 3.8 | RAL TL71-276 | 61 | Laminated Acoustical Glass | 5,9,10 |
| 2-ply laminated glass with 0.045" plastic core. | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 36 | 27 | | | 30 | | | 32 | | | 36 | | | 38 | | | 40 | - | RAL TL66-315 | 47 | Soundtropane 36 | 14 |

TABLE 16 GLASS AND PLASTIC (Contd)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Textured viscoelastic interlayer. | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 35 | [24] | [28] | | [29] | [30] | | [31] | [33] | | [35] | [35] | | [35] | [34] | | [38] | 3.2 | RAL TL66-315 | 55 | Soundtropane | 12,15 |
| Single glazing unit consisting of thin layers of glass, laminated with specially designed interlayers of soft, transparent plastic | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 36 | [25] | [28] | | [28] | [30] | | [33] | [35] | | [36] | [36] | | [35] | [35] | | [39] | 3.4 | RAL TL65-27 | 85 | Acousta-pane 36 | 13,15 |
| Two layers of 1/8" glass with 0.060" plastic core. | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 36 | 27 | 25 | 27 | 28 | 29 | 30 | 31 | 33 | 35 | 37 | 38 | 39 | 41 | 41 | 41 | 38 | 3.7 | RAL TL72-9 | 152 | Shatterproof sound control glass | 9,10 |
| Glass | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 36 | | | | 28 | | | 33 | | | 36 | | | 35 | | | | - | - | 115 | Hushlite | |
| 9/32" 2-ply laminated Hushlite. | | | | | | | | | | | | | | | | | | | | | | |
| 9/32 | 36 | [29] | [26] | | [29] | [31] | | [32] | [34] | | [36] | [37] | | [39] | [37] | | [38] | - | RAL TL66-244 | 115 | Hushlite | 13,15 |
| Glass with 0.045" Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 3/8 | 36 | 31 | 30 | 31 | 32 | 33 | 33 | 34 | 36 | 34 | 32 | 33 | 36 | 40 | 43 | 46 | 48 | 6.6 | RAL TL71-156 | 61 | Laminated Acoustic Glass | 7 |
| Core of cast acrylic plastic sheets. Plain surface structure. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 30 | 21 | 21 | 24 | 23 | 25 | 27 | 26 | 28 | 31 | 32 | 33 | 34 | 32 | 26 | 31 | 37 | 2.9 | KAL 1481-1 | 148 | Plexiglas | 1,9,10 |
| Two layers of 1/4" glass with 0.045" Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 37 | 29 | 28 | 30 | 31 | 32 | 32 | 32 | 34 | 36 | 38 | 37 | 37 | 40 | 43 | 45 | 47 | 6.2 | RAL TL72-42 | 61 | Laminated Acoustic Glass | 6,9,10 |
| Two layers of 1/4" glass with 0.030" Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 37 | 29 | 28 | 31 | 31 | 32 | 32 | 32 | 34 | 36 | 37 | 37 | 38 | 30 | 42 | 44 | 48 | 6.2 | RAL TL72-41 | 61 | Laminated Acoustic Glass | 9,10 |
| Two layers of 1/4" glass with 0.045" Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 37 | 31 | 30 | 31 | 32 | 32 | 33 | 34 | 36 | 36 | 35 | 34 | 36 | 40 | 43 | 45 | 47 | 6.2 | RAL TL71-154 | 61 | Laminated Acoustic Glass | 6,9,10 |
| Two layers of 1/4" glass with 0.090" Butacite core. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 37 | 31 | 30 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 34 | 36 | 40 | 41 | 45 | 47 | 6.4 | RAL TL71-164 | 61 | Laminated Acoustic Glass | 7 |
| Clear or textured glass with viscoelastic interlayer. | | | | | | | | | | | | | | | | | | | | | | |
| 1/2 | 39 | 36 | 35 | 32 | 33 | 34 | 34 | 35 | 37 | 38 | 38 | 39 | 39 | 30 | 32 | 45 | 47 | 6.4 | RAL TL67-219 | 47 | Soundtropane-40 | 11 |

TABLE 16 GLASS AND PLASTIC (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Two layers of 1/4" glass with 0.045" plastic core. | | | | | | | | | | | | | | | | | | |
| 1/2 | 39 | 31 | 29 | 31 | 32 | 34 | 35 | 35 | 36 | 38 | 38 | 39 | 39 | 40 | 43 | 45 | 47 | 6.8 | RAL TL72-105 | 152 | Shatterproof Sound Control Glass | 9,10 |
| 1/2 | 40 | 30 | | 1/2" plate glass. | | | | | | | | | | | | | | - | - | 115 | Hushlite | |
| | | | | 2-ply (1/4") laminated glass. | | | | | | | | | | | | | | | | | | |
| 1/2 | - | [31] | [32] | | [34] | [36] | | [38] | [40] | | [40] | [40] | | [37] | [41] | | [46] | 6.7 | RAL TL66-293 | 85 | Acousta-pane 40 | 13,15 |
| | | | | 1/8" glass, 0.060" Butacite, 1/4" air, 3/16" glass. | | | | | | | | | | | | | | | | | | |
| 9/16 | 36 | 30 | 28 | 26 | 24 | 28 | 33 | 33 | 37 | 37 | 39 | 40 | 40 | 38 | 35 | 40 | 43 | 6.4 | RAL TL71-165 | 61 | Laminated Acoustic Glass | 7 |
| | | | | 3/16" and 3/8" glass layers with 0.045" Butacite core. | | | | | | | | | | | | | | | | | | |
| 9/16 | 37 | 32 | 31 | 33 | 33 | 34 | 34 | 35 | 37 | 34 | 33 | 35 | 39 | 42 | 46 | 46 | 49 | 7.6 | RAL TL71-155 | 61 | Laminated Acoustic Glass | 7 |
| | | | | Two layers of 3/8" glass with 0.045" plastic core. | | | | | | | | | | | | | | | | | | |
| 3/4 | 42 | 33 | 32 | 35 | 35 | 36 | 38 | 38 | 39 | 40 | 42 | 42 | 43 | 45 | 47 | 49 | 50 | 10.2 | RAL TL72-104 | 152 | Shatterproof Sound Control Glass | 9,10 |
| | | | | 3/4" plate glass | | | | | | | | | | | | | | | | | | |
| 3/4 | 43 | 33 | | | 35 | | | 40 | | | 43 | | | 41 | | | | - | - | 115 | Hushlite | |
| | | | | 3-ply (triple 1/4") laminated glass single glazing unit. | | | | | | | | | | | | | | | | | | |
| 3/4 | 43 | [34] | [35] | | [36] | [39] | | [41] | [43] | | [43] | [43] | | [41] | [45] | | [50] | 10.1 | RAL TL66-294 | 85 | Acousta-pane 43 | 13,15 |
| | | | | 2-ply laminated glass with 0.045" plastic core. | | | | | | | | | | | | | | | | | | |
| 3/4 | 43 | 31 | | | 37 | | | 39 | | | 40 | | | 45 | | | 50 | - | RAL | 47 | Soundtropane 43 | 14 |
| | | | | Plain surface cast acrylic plastic core. | | | | | | | | | | | | | | | | | | |
| 1 | 32 | 25 | 26 | 27 | 28 | 29 | 32 | 32 | 33 | 34 | 32 | 28 | 31 | 34 | 36 | 40 | 46 | 5.82 | KAL 1481-1 | 148 | Plexiglas | 9,10 |
| | | | | Two layers of 1/4" plate glass with 1/2" air space. | | | | | | | | | | | | | | | | | | |
| 1 | 31 | 25 | 25 | 22 | 20 | 24 | 27 | 27 | 30 | 32 | 33 | 35 | 34 | 29 | 31 | 33 | 36 | 6.2 | RAL .71-166 | 61 | 1" thermal insulating glass | 9,10 |
| | | | | Insulating glass with 1/2" air space. | | | | | | | | | | | | | | | | | | |
| 1 | 32 | 19 | 18 | 18 | 17 | 17 | 20 | 25 | 33 | 35 | 36 | 35 | 33 | 30 | 29 | 32 | | - | G&H | 115 | Architectural Saflex | 11 |
| | | | | Glass with 7/16" air space. | | | | | | | | | | | | | | | | | | |
| 1 | 38 | 30 | 29 | 26 | 28 | 31 | 34 | 35 | 37 | 37 | 38 | 38 | 40 | 41 | 40 | 41 | 44 | - | RAL TL71-252 | 138 | Twindow | 8,9 |

TABLE 16 GLASS AND PLASTIC (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 39 | | | | | | | | Glass | | | | | | | | | - | - | 85 | Insulated Acousta pane I 39 | |
| 1-1/4 | 42 | | | | | | | | Glass | | | | | | | | | - | - | 85 | Insulated Acousta pane I 42 | |
| 1-3/4 | 45 | | | | | | | | Glass | | | | | | | | | - | - | 85 | Insulated Acousta pane I 45 | |
| | | | | | | | | | Glass with 2" air space. | | | | | | | | | | | | | |
| 2-9/16 | 42 | 32 | 33 | 35 | 38 | 40 | 42 | 43 | 43 | 43 | 44 | 42 | 41 | 41 | 41 | 43 | 46 | - | RAL TL66-172 | 40 | Polarpane Corp. | 13 |
| 3-1/8 | 49 | | | | | | | | Glass | | | | | | | | | - | - | 85 | Insulated Acousta pane I 49 | |

FOOTNOTES FOR TABLE 16
GLASS AND PLASTIC

1. Temperature range to 200°F, 0 to 100% humidity, a combustible thermoplastic. Lower esters, aromatic hydrocarbons, phenols, aryl halides, aliphatic acids and alkyl poly halides usually have a solvent action.
2. Test report Nos. TL71-157 and TL71-273 present TL for the same product when tested using slightly different mounting procedures.
3. Test report Nos. TL72-43 and TL71-277 present TL for the same product when tested using slightly different mounting procedures.
4. Test report Nos. TL71-158 and TL71-274 present TL for the same product when tested using slightly different mounting procedures.
5. Test report Nos. TL71-159 and TL71-276 present TL for the same product when tested using slightly different mounting procedures.
6. Test report Nos. TL71-154 and TL72-42 present TL for the same product when tested using slightly different mounting procedures.
7. Nonstandard test.
8. Temperature range: -35° to 135°F, excellent resistance to chemicals.
9. Meets ASTM E90-70.
10. Meets ASTM E413-70T.
11. Conforms to ASTM E90-66T.
12. Conforms to ASTM E90-61T.
13. Conforms to ASTM E90-61T and ASARP-224.19-1957.
14. Conforms to E90-66.
15. Numbers in brackets refer to one-third octave center frequencies of 125, 175, 250, 350, 500, 700, 1000, 1400, 2000, 2800, 4000 Hz, respectively.

TABLE 17

SPRAY-ON MATERIAL (BARRIER)

Spray-on materials used to increase the sound transmission loss of a system, usually by spraying the product in the cavity of an existing structure are listed. Two spray compounds which reduce the structureborne noise by damping the structure are also listed in the table. It should be noted that the transmission losses shown in the table are for the composite assembly described in the table and as such they include the transmission loss provided by the boards used in the assembly. The spray-on materials effectively stop the sound leaks and increase the acoustic resistance of the cavities in which they are sprayed. The companies (by numbers shown in Section II) with products listed in Table 17 are: 24, 119, 127, 175.

CAUTION

THE TRANSMISSION LOSS VALUES INCLUDE THE TRANSMISSION LOSS OF THE PARTITION USED.

## TABLE 17 SPRAY-ON MATERIAL (BARRIER)

| Thickness* (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Description | Weight* lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 48 | 24 | 31 | 35 | 36 | 39 | 43 | 47 | 50 | 52 | 53 | 55 | 55 | 52 | 51 | 53 | 55 | K-13 sprayed on interior of dry wall partition, faced on both sides with 5/8" thick gypsum board, 1-5/8" metal studs. | 6.3 | RAL TL69-171 | 127 | Dry wall partition filled with K-13 | 1,2 |
| 5 | 49 | 29 | 35 | 38 | 41 | 41 | 44 | 45 | 49 | 52 | 52 | 53 | 53 | 51 | 50 | 53 | 55 | K-13 sprayed between layers of 5/8" gypsum board, 3-5/8" metal studs. | 6.6 | RAL TL69-173 | 127 | Dry wall partition filled with K-13 | |
| 8 | 54 | 34 | 38 | 41 | 45 | 48 | 51 | 52 | 53 | 55 | 56 | 58 | 58 | 57 | 57 | 58 | 60 | Staggered wood studs, double layer of 5/8" gypsum board, K-13 spray on material, single 5/8" gypsum board other side. | 12.2 | RAL TL70-120 | 127 | Dry wall partition filled with K-13 | 1 |
| - | 40 | 23 | 23 | 22 | 29 | 38 | 34 | 35 | 40 | 44 | 46 | 49 | 49 | 42 | 43 | 48 | 51 | K-13 sprayed between 5/8" layer of gypsum board and 1/2" plywood with 5/8" gypsum board on other side. | - | RAL TL70-118 | 127 | Dry wall partition filled with K-13 | 1 |
| - | 41 | 21 | 20 | 26 | 33 | 37 | 38 | 40 | 44 | 45 | 49 | 52 | 54 | 53 | 51 | 52 | 54 | K-13 sprayed between layers 1/2" thick gypsum board. | 6.3 | RAL TL69-131 | 127 | Dry wall partition filled with K-13 | 1,2 |
| - | 52 | 32 | 36 | 37 | 42 | 47 | 48 | 51 | 52 | 55 | 57 | 58 | 57 | 54 | 54 | 56 | 59 | 2" x 4" wood studs spaced 46" o.c., K-13 sprayed to interior of assembly. | - | RAL TL69-130 | 127 | Dry wall partition filled with K-13 | 1,2 |
| - | - | | | | | | | | | | | | | | | | | Spray fiber for walls or partitions. Non-crystalline. Refractory fibers and binders provide thermal and acoustical resistance. Does not contain asbestos. | - | - | 175 | CAFCO | |
| - | - | | | | | | | | | | | | | | | | | Viscoelastic compound. Can be applied with spray, brush, or roller. Reduces resonance response on panels and structures. | - | - | 119 | LDS sprayable damping material | |
| - | - | | | | | | | | | | | | | | | | | Synthetic resin. Dispersion in water, sprayed or brushed on vibrating plates (dried spray should be 2X thicknesses of plate) to reduce structure borne noise. Density = 80 $lb/ft.^3$ | - | - | 24 | Antiphon D-444 | |

*Thickness and weight refers to the overall structure.

### FOOTNOTES FOR TABLE 17
### SPRAY-ON MATERIAL (BARRIER)

1. Tested and evaluated according to ASTM E90-66T.
2. Tested and evaluated according to recommended practice ASARP-Z24.19-1957.

## TABLE 18

## OTHER BARRIER AND DAMPING MATERIALS

The products which for one reason or another could not be included in Tables 13 through 17 are listed. These include products made from loaded vinyl, glass fibers, asbestos fabric, felt, cork, aluminum, etc. It should be noted that some of the flexible sheet-like products listed in the table can be used as sound barrier curtains with appropriate provision for hanging (see also Table 36 for products listed as sound barrier curtains). Some of the products listed in Table 18 are specially designed to be used in high temperature or other hostile environments and they are better suited to the job than the more commonly used sound barrier material under those circumstances.

The products are listed in the order of their thicknesses without regard to their potential uses. All products are good sound barriers and they can be used in a variety of situations. The companies (by numbers shown in Section II) with products listed in Table 18 are: 12, 38, 41, 45, 52, 54, 65, 72, 79, 81, 94, 107, 111, 132, 149, 155, 161, 166.

**CAUTION**

TRANSMISSION LOSS VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED. WHEN THE TEST SPECIMEN DESCRIPTION IS NOT CLEARLY SHOWN IN THE TABLE, THE MANUFACTURER MAY BE CONTACTED IF NECESSARY.

### GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other outside surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |
| Loaded: | Foreign substance added to the base material |
| Leaded or Lead Loaded: | Lead was added to the base material -- usually fabric type materials -- to increase the sound transmission loss |

## TABLE 18 OTHER BARRIER AND DAMPING MATERIALS

| | Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fiberglass with lead-filled vinyl coating | .012 | - | | | | 8 | | | 16 | | | 18 | | | 20 | | | 26 | .208 | - | 54 | 30 oz/sq yd Dura-Sonic | 1,2 |
| Fiberglass with lead-filled vinyl coating | .025 | - | | | | 13 | | | 12 | | | 18 | | | 22 | | | 28 | .416 | - | 54 | 60 oz/sq yd Dura-Sonic | 1,2 |
| Vinyl loaded sheet | .025 | 13 | 1 | | | 5 | | | 10 | | | 15 | | | 22 | | | 27 | .3 | RAL KAL | 45 72 | Custifilm 3R | 7,10 |
| Nylon fabric coated on both sides with Hypalon | .025 | 19 | 8 | 8 | 9 | 11 | 11 | 13 | 14 | 16 | 18 | 20 | 23 | 24 | 27 | 28 | 30 | 31 | .45 | RAL TL72-79 | 41 | Chem-Tone | 5,7 |
| Fiberglass coated with lead loaded vinyl | .030 | 21 | 12 | 10 | 11 | 13 | 13 | 15 | 16 | 18 | 20 | 21 | 23 | 25 | 27 | 29 | 31 | 32 | .48 | RAL TL71-198 | 45 72 | Coustifab CC-488-B | 3,7 |
| Loaded vinyl with Beta glass fiber | .037 | 19 | 5 | | | 9 | | | 15 | | | 21 | | | 27 | | | 33 | .50 | KAL 1083-1-71 | 45 72 | KNC-50 | 11 |
| Lead vinyl | .037 | 20 | 9 | 8 | 10 | 12 | 12 | 14 | 15 | 17 | 19 | 20 | 22 | 24 | 26 | 27 | 28 | 30 | .44 | RAL TL72-232 | 155 | Sound Stopper Material, Stock # 15-12949 | 7 |
| Loaded vinyl | .04 | 21 | 8 | | | 12 | | | 15 | | | 20 | | | 24 | | | 30 | .50 | KAL | 45 72 | Coustifilm 5 and 5R | 7,10 |
| Lead loaded Neoprene coating on glass fabric | .045 | 21 | 11 | 11 | 12 | 13 | 14 | 14 | 16 | 18 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | .50 | RAL 73-150 | 94 | S/8050G | 7,12 |
| Regenerated paper felt, asphalt saturated | .05 | - | | | | | | | | | | | | | | | | | 0.14 | CT | 81 | #263 - Saturated felt | 25,26 |
| Fiberglass with lead loaded vinyl | .055 | 24 | 15 | 13 | 14 | 16 | 16 | 18 | 19 | 22 | 23 | 25 | 27 | 29 | 31 | 33 | 34 | 36 | .87 | RAL | 45 72 | Coustifab CC-488-C | 3,7 |
| Lead loaded Neoprene coating on glass fabric | .055 | 25 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 21 | 24 | 25 | 27 | 28 | 30 | 31 | 32 | 34 | .71 | RAL TL73-149 | 94 | S/8075G | 7,12 |
| Fiberglass with lead filled vinyl coating | .06 | 25 | 12 | 12 | 13 | 18 | 18 | 20 | 21 | 22 | 25 | 27 | 27 | 29 | 32 | 34 | 35 | 36 | .84 | RAL TL73-48 | 54 | 120 oz/sq yd Dura-Sonic | 1,4,7 |
| Lead loaded vinyl, unsupported film | .06 | 26 | 12 | 13 | 15 | 18 | 18 | 20 | 21 | 23 | 24 | 26 | 28 | 30 | 31 | 33 | 34 | 35 | 1 | RAL TL72-212 | 149 111 | Sound/Eaze TLB-L | 7 |

TABLE 18 OTHER BARRIER AND DAMPING MATERIALS (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leaded vinyl | | | | | | | | | | | | | | | | | | | | | | |
| .064 | 25 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 24 | 26 | 27 | 29 | 31 | 33 | 34 | 35 | .70 | RAL TL73-67 | 155 | Stock No. 15-13949 | 7 |
| Reinforced leaded vinyl product | | | | | | | | | | | | | | | | | | | | | | |
| .065 | 26 | 13 | 13 | 15 | 18 | 17 | 19 | 20 | 24 | 26 | 27 | 28 | 31 | 32 | 34 | 35 | 37 | 1 | RAL TL70-234 | 149 111 | Sound/Eaze TLB/G | 13, 15,16 |
| Loaded vinyl with Beta glass fiber | | | | | | | | | | | | | | | | | | | | | | |
| .072 | 27 | 15 | | | 17 | | | 21 | | | 28 | | | 33 | | | 37 | 1 | KAL 1083-1-71 | 45 72 | KNC-100 | 14 |
| Regenerated paper felt, asphalt saturated | | | | | | | | | | | | | | | | | | | | | | |
| .077 | 11 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 6 | 9 | 14 | 23 | 26 | 24 | 20 | 21 | - | 28 | .25 | CT | 81 | #236 Saturated felt | 25 |
| Loaded vinyl sheet | | | | | | | | | | | | | | | | | | | | | | |
| .080 | 27 | 15 | | | 19 | | | 21 | | | 28 | | | 33 | | | 37 | 1 | RAL | 45 72 | Coustifilm 10 and 10R | 7,10 |
| Regenerated paper felt, asphalt saturated | | | | | | | | | | | | | | | | | | | | | | |
| .080 | - | | | | | | | | | | | | | | | | | .18 | CT | 81 | #441N Saturated felt | 25,26 |
| Lead loaded asbestos fabric | | | | | | | | | | | | | | | | | | | | | | |
| .084 | 27 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 24 | 26 | 28 | 29 | 31 | 33 | 35 | 35 | 36 | 1 | RAL TL73-148 | 94 | S/8100 | 7,12 |
| Regenerated paper felt | | | | | | | | | | | | | | | | | | | | | | |
| .10 | 13 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 11 | 16 | 25 | 28 | 26 | 32 | 23 | - | 30 | .32 | CT | 81 | #493 Saturated felt | 25 |
| Loaded Vinyl, unsupported film | | | | | | | | | | | | | | | | | | | | | | |
| .125 | 26 | 12 | 13 | 15 | 18 | 19 | 20 | 20 | 23 | 25 | 27 | 30 | 32 | 35 | 37 | 39 | 40 | 1 | RAL TL73-82 | 149 111 | Sound/Eaze TLB-M | 7 |
| Cork attached to gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 1/8 | 48 | 32 | | | 43 | | | 49 | | | 61 | | | 57 | | | 65 | 12 | KAL 372-3-66 | 52 | Dodge 1462 Sound deadening cork | 24 |
| Lead loaded neoprene coating on asbestos fabric | | | | | | | | | | | | | | | | | | | | | | |
| .145 | 35 | 23 | 23 | 25 | 25 | 27 | 28 | 30 | 32 | 34 | 35 | 38 | 39 | 40 | 42 | 44 | 45 | 2.5 | RAL TL73-144 | 94 | S/8266 | 7,12 |
| Lead loaded vinly with woven asbestos | | | | | | | | | | | | | | | | | | | | | | |
| .145 | 39 | 15 | 22 | 27 | 28 | 34 | 37 | 40 | 44 | 47 | 49 | 51 | 51 | 53 | 54 | 55 | 56 | 2.4 | RAL TL73-145 | 94 | 8266 | 7 |
| Two-ply asphalt saturated felt | | | | | | | | | | | | | | | | | | | | | | |
| .15 | 12 | 6 | 7 | 6 | 7 | 7 | 6 | 8 | 10 | 16 | 27 | 31 | 28 | 24 | 28 | - | 33 | .40 | CT | 81 | #329D Saturated felt | 25 |
| Lead loaded neoprene coating on asbestos fabric | | | | | | | | | | | | | | | | | | | | | | |
| .155 | 32 | 20 | 21 | 23 | 24 | 24 | 25 | 27 | 29 | 31 | 32 | 34 | 36 | 37 | 39 | 41 | 43 | 1.5 | RAL TL73-147 | 94 | S/8150 | 7,12 |

TABLE 18 OTHER BARRIER AND DAMPING MATERIALS (Contd)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight $lb/ft^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Lead vinyl with woven asbestos; 2 layers, 1" air space | | | | | | | | | | | | | | | | | | |
| 1.26 | 39 | 15 | 19 | 26 | 28 | 32 | 35 | 38 | 42 | 45 | 49 | 51 | 52 | 54 | 55 | 56 | 57 | 1.8 | RAL TL73-146 | 94 | 8150,8266 | 7 |
| | | | | Facing of high calcium fiberglass felt | | | | | | | | | | | | | | | | | | |
| 2.05 | 35 | 7 | 9 | 12 | 13 | 14 | 14 | 15 | 13 | 12 | 12 | 11 | 11 | 14 | 15 | 10 | 10 | 3.0 | IATL | 38 | Carney sound attenuation blankets | 7,18 |
| | | | | Without insulation | | | | | | | | | | | | | | | | | | |
| 2.50 | - | 29 | 30 | 31 | 32 | 35 | 41 | 46 | 45 | 49 | 52 | 53 | 55 | 51 | 43 | 44 | 46 | - | CT | 132 | OCF #551 | 7, 17,19 |
| | | | | With fiberglass insulation | | | | | | | | | | | | | | | | | | |
| 2.50 | - | 33 | 35 | 37 | 42 | 47 | 53 | 55 | 56 | 59 | 59 | 60 | 62 | 62 | 55 | 47 | 56 | - | CT | 132 | OCF #551 | 7, 17,19 |
| | | | | 3" thick N1200 insulation on 16 gauge steel 12" x 36" to 23" x 36" | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 23 | 22 | 24 | 28 | 32 | 35 | 39 | 44 | 49 | 53 | 56 | 59 | 61 | 62 | 63 | 65 | 2.3 | RAL TL71-281 | 79 | Forty-eight N-1200 block insulation | 7, 8,21 |
| | | | | 3" thick felt insulation on 24" x 48" on 16 gauge steel | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 22 | 22 | 25 | 28 | 32 | 35 | 39 | 44 | 47 | 51 | 53 | 55 | 57 | 59 | 61 | 64 | 1.44 | RAL TL71-282 | 79 | Forty-eight CG felt insulation | 9,22 |
| | | | | 3" thick insulation on 24" x 48" on 16 gauge steel | | | | | | | | | | | | | | | | | | |
| 3 | 42 | 22 | 24 | 25 | 30 | 34 | 37 | 42 | 44 | 47 | 54 | 56 | 59 | 60 | 62 | 63 | 65 | 2.2 | RAL TL71-280 | 79 | Forty-eight ETR Insulation | 20,23 |
| | | | | Clear, transparent, fused vinyl core | | | | | | | | | | | | | | | | | | |
| - | 20 | 11 | | | 12 | | | 15 | | | 20 | | | 26 | | | 32 | .50 | - | 45 72 | Coustiview 5 | |
| | | | | Vinyl fiber glass foam on 4' x 8' x .36" sheet | | | | | | | | | | | | | | | | | | |
| - | 26 | 12 | 12 | 13 | 17 | 18 | 20 | 22 | 23 | 25 | 27 | 29 | 31 | 33 | 36 | 37 | 37 | 0.91 | RAL TL73-49 | 54 | 4848 Vinyl fiberglass foam | 1,4,7 |
| | | | | Rubber base mat with one or two foam layers. Thickness range: 1/2" to 2" | | | | | | | | | | | | | | | | | | |
| - | - | 18 | | | 25 | | | 23 | | | 26 | | | 32 | | | 36 | - | CT | 65 | Acousta-Damp | 6 |
| | | | | Combination of asbestos, aluminum, and fiberglass | | | | | | | | | | | | | | | | | | |
| - | - | 11 | | | 20 | | | 21 | | | 28 | | | 31 | | | 35 | - | - | 107 | IC Sound barrier | |
| | | | | Combination vinyl coated side with built-in fabric cord. Thickness.12" | | | | | | | | | | | | | | | | | | |
| - | 26 | 12 | | | 16 | | | 20 | | | 26 | | | 31 | | | 38 | - | CT | 65 | ATD 150 | 27 |
| | | | | ATD 150 bonded to 10 gauge steel 0.12" thick | | | | | | | | | | | | | | | | | | |
| - | - | 28 | | | 32 | | | 36 | | | 42 | | | 47 | | | 54 | - | CT | 65 | ATD 150 | 27 |

TABLE 18 OTHER BARRIER AND DAMPING MATERIALS (Concl)

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| | | 0.12" thick ATD 150 bonded to 14 gauge steel | | | | | | | | | | | | | | | | | | | | |
| - | - | 24 | | | 28 | | | 32 | | | 38 | | | 43 | | | 50 | - | CT | 65 | ATD 150 | 27 |
| | | 0.12" thick ATD 150 bonded to 16 gauge steel | | | | | | | | | | | | | | | | | | | | |
| - | - | 23 | | | 27 | | | 31 | | | 37 | | | 42 | | | 49 | - | CT | 65 | ATD 150 | 27 |
| | | 0.12" thick ATD 150 bonded to 18 gauge steel | | | | | | | | | | | | | | | | | | | | |
| - | - | 22 | | | 26 | | | 30 | | | 36 | | | 41 | | | 48 | - | CT | 65 | ATD 150 | 27 |
| | | 0.12" thick ATD 150 bonded to 20 gauge steel | | | | | | | | | | | | | | | | | | | | |
| - | - | 20 | | | 24 | | | 28 | | | 34 | | | 39 | | | 46 | - | CT | 65 | ATD 150 | 27 |
| - | - | Hardboard partitions for sound control | | | | | | | | | | | | | | | | - | - | 166 | Superwood Hardboard | |
| - | - | Felt wool in combination with natural or manmade fibers. Temperature range grom -80 to 200°F. Thickness range from 1/6" to 1" | | | | | | | | | | | | | | | | - | - | 161 | Wool or synthetic felt | |
| - | - | Grey supported lead impregnated vinyl | | | | | | | | | | | | | | | | 0.3 | - | 12 | Acoustic Mass-SIF | |

FOOTNOTES FOR TABLE 18
OTHER BARRIER AND DAMPING MATERIALS

1. Available in three thicknesses - .012", .025", .050" and designated as 30 oz. Dura-Sonic, 60 oz. Dura-Sonic, and 120 oz. Dura-Sonic respectively. 30 and 60 oz. Dura-Sonic available in 25 yd. long rolls 120 oz. Dura-Sonic supplied in 15 yd. long rolls. Width - 48". Temperature range: 0° - 200°F. Self-extinguishing. Impervious to water and petroleum. Available in various colors. Can be cut to any shape or size. Can be bonded to acoustic foam to provide sound absorption.
2. Acoustic data extracted from a plot of sound attenuation vs. frequency. Test conditions and standards unknown.
3. Nominal width 38". Other sizes available.
4. Nominal thickness of 120 oz. Dura-Sonic is 0.05". The test specimen measured 0.06".
5. Also available with 1/4" thick foam. Supplied in 54" wide rolls of 25 yd. length. Other thicknesses and fabrics such as Dacron or glass fabric available.
6. Data derived from graph.
7. Tested and evaluated according to ASTM E90-70 and ASTM E413-70T.
8. Temperature range: to 1200°F.
9. Temperature range: to 650°F.
10. Temperature range: -40° to 200°F, resistant to most acids, including alkalies and grease.
11. Tested and evaluated according to ASTM E90-70, does not crack at low temperatures, self-extinguishing.
12. Temperature range: -20° to 400°F, self-extinguishing, resistant to acids, alkalies, grease, and corrosive chemicals.
13. Tested and evaluated according to ASTM E90-66T.
14. Tested and evaluated according to ASTM E90-70.
15. Tested and evaluated according to ASARP Z24.19-1957.

FOOTNOTES FOR TABLE 18

OTHER BARRIER AND DAMPING MATERIALS (Concl)

16. Temperature range: -50° to 200°F. Resistant to chemicals, self-extinguishing.

17. Fiberglass noise barrier batts in a specific wall construction will change STC by 7 db and TL values in each of the 1/3 octave bands will change as below

| 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 30 | 31 | 32 | 35 | 41 | 46 | 45 | 49 | 52 | 53 | 55 | 51 | 43 | 44 |
| | | | | | | | to | | | | | | | |
| 33 | 35 | 37 | 42 | 47 | 53 | 56 | 59 | 59 | 60 | 62 | 62 | 55 | 47 | 50 |

18. Temperature range: -50° to 500°F. Relative humidity range: 30% to 90%. Flame spread 25.

19. Data from graph, fiberglass noise barrier batts raised STC by 7 db when installed in special wall construction.

20. Temperature range: to 1000°F.

21. Tested and evaluated according to ASTM C-612, class 4; semi-rigid thermal and acoustical block insulation 1600°F refraction fibers, bonded with intermediate temperature binders good to 1200°F. Asbestos free. Used on steam generators, vessels and equipment in refineries and chemical plants, and other applications requiring insulation over 1200°F. Water repellant and incombustible. 1-3" thicknesses available.

22. Resilient spun, high temperature refractory fibers with felted binders laminated to form durable, efficient, semi-rigid insulation. Water repellant, chemically stable. Applications on structural insulation (ships), heating equipment, cold storage lockers. Rated incombustible, Class A-60, (Coast Guard Approval No. 164.007/1/0). Available in 1-4" thicknesses.

23. Tested and evaluated according to ASTM C-262; C-612: Class 4; C-553, Type III, Class F-2, asbestos free, water repellant and incombustible. Used as acoustical or thermal insulation for power generators, boilers, ducts, breechings, petroleum chemical process equipment. Thicknesses: 1-4".

24. Tested and evaluated according to ASTM E90-61T, available in 48"x10' rolls.

25. Available as rolls, sheets, or die cut parts. Maximum temperature 350°F.

26. In the tests conducted by the manufacturer, the transmission losses in 1/3 octave bands were measured as follows:

| 1/3 octave center frequency, Hz | 25 | 50 | 100 | 200 | 400 | 800 | All pass |
|---|---|---|---|---|---|---|---|
| For #441N - Transmission loss, dB: | 0 | 4 | 6 | 5 | 4 | 11 | 15 |
| For #263 - Transmission loss, dB: | 0 | 2.1 | 2.9 | 2.5 | 2 | 5.5 | - |

27. Weight of ATD 150 is 1 lb/ft$^2$.

## TABLE 19
## UNIT ABSORBERS

Sound absorption inside a room can be increased by adding unit absorbers specially designed for this purpose. These units are easy to install and they are available in various forms, e.g., baffles, freestanding room dividers, drums, panels, blocks, etc. Figures 19A, 19B, and 19C show three different types of absorbers. Figure 19A shows a panel type absorber which can be mounted flush with the ceiling or wall and still have six sides exposed to the sound field. This type of panel should be mounted as patches on the walls separated from each other. Figure 19B shows a drum type of absorber which should be hung as close to the noise source as possible. Figure 19C shows a baffle type of absorber which can be hung along the length and breadth of a ceiling inside a production plant or an auditorium.

The amount of sound energy absorbed by a particular unit absorber is proportional to the area exposed to the incident sound energy and for this reason many absorbers are suspended from ceilings using wires to expose all surfaces to the sound field. For efficient usage, they should be placed as close to the noise source as practical. Table 19 shows sound absorption in Sabins/unit for various products. Sabins/unit is a more applicable unit for products of this nature because of their differences in shapes and sizes. The companies (by numbers shown in Section II) with products listed in Table 19 are: 18, 59, 107, 116, 119, 127, 128, 129, 132, 137, 183.

CAUTION

ABSORPTION DATA PRESENTED ARE TOTAL ABSORPTION FOR EACH ITEM (SABINS/UNIT). THE TERM UNIT REFERS TO THE MANUFACTURER'S STANDARD SIZE UNIT AS DESCRIBED IN THE TABLE. FOR EXPLANATION OF SABINS SEE SECTION I-3.1.1.

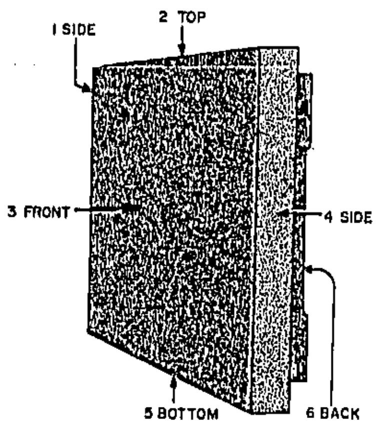



Figure 19A Panel Type Absorber Unit with Six Sides Exposed to Sound

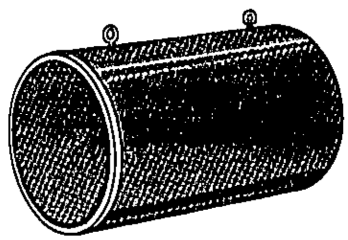


Figure 19B Drum Type Absorber Unit with Built-in Eyelet for Hanging

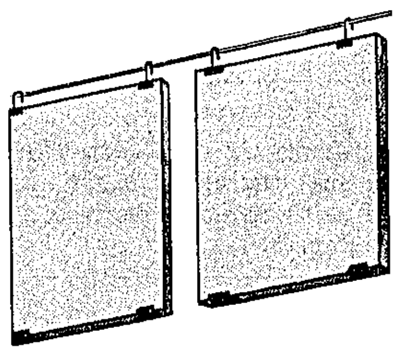


Figure 19C Baffle Type Absorber Unit Hanging from a Stretched Wire

TABLE 19 UNIT ABSORBERS

| Mounting | Thickness (Inches) | Average Sabins per Unit (250 - 2000 Hz) | Absorption in Sabins/Unit 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pressure molded glass fibers covered with unperforated textured vinyl. Standard size of 24"x48"x1-1/2", but 12"x24", 12"x48" and 24"x24" available. | | | | | | | | | | |
| - | 1-1/2 | 7.5 | 1.2 | 2.9 | 6.2 | 10.3 | 10.8 | 10.2 | .5 | KAL 1183-1-71-R | 129 | Functional noise control baffles | 8,15 |
| | | | 23"x48"x1-1/2" Fiberglas boards wrapped in a noncombustible washable plastic film, complete with mounting hardware for suspension from wires. | | | | | | | | | | |
| - | 1-1/2 | 10.2 | 2.1 | 5.9 | 9.8 | 13.3 | 11.6 | 7.6 | .56 | CT | 132 | Noise stop baffles | |
| | | | Pressure molded glass fibers covered with perforated vinyl. Standard size of 24"x48"x1-1/2", but 12x24, 12x48 and 24x24 available. | | | | | | | | | | |
| - | 1-1/2 | 10.8 | 4.3 | 6.6 | 9.8 | 13.3 | 13.6 | 10.8 | .5 | KAL | 129 | Functional noise control baffles | 9,15 |
| | | | 72"x52-1/2"x1-1/2". Frame of 3/4" square steel tubing filled with 1" thick 3/4# C.F. semi-rigid board fiberglass, covered with panels of washable nylon velvet fabric over 3/4" foam rubber on 1/10" perf. masonite. | | | | | | | | | | |
| - | 1-1/2 | 38.9 | 17.7 | 28.7 | 34.2 | 43.9 | 48.7 | 39.4 | - | KAL K37-1-72 | 183 | Planscape curved CR-CAR | 15,18 |
| | | | Size: 2'x4'x1-3/4". 1/4" masonite sandwiched between two layers of foam 1/2" and 1" thick | | | | | | | | | | |
| - | 1-3/4 | 9.44 | 2.7 | 6.0 | 10.6 | 11.0 | 10.0 | 10.0 | .375 | CT | 119 | Unit sound absorber | 10 |
| | | | 11-1/2"x16"x2" - mounted in 16" on center patches | | | | | | | | | | |
| - | 2 | - | 0.2 | 0.8 | 1.6 | 1.6 | 1.5 | 1.3 | 2 | RAL | 137 | Geocoustic II | 1,15 |
| | | | 11-1/2"x16"x2" mounted in 16" on center rectangles | | | | | | | | | | |
| - | 2 | - | 0.2 | 0.8 | 2.0 | 2.2 | 1.8 | 1.2 | 2 | RAL | 137 | Geocoustic II | 2,15 |
| | | | 11-1/2"x16"x2" - mounted in 24" on center patches | | | | | | | | | | |
| - | 2 | - | 0.2 | 0.7 | 2.0 | 2.2 | 2.0 | 1.7 | 2 | RAL | 137 | Geocoustic II | 3,15 |
| | | | 11-1/2"x16"x2" - mounted in 32" on center patches | | | | | | | | | | |
| - | 2 | - | 0.2 | 0.6 | 2.6 | 2.4 | 2.2 | 1.8 | 2 | RAL | 137 | Geocoustic II | 4,15 |
| | | | 16" square; rigid fiberglas core of 2" thickness; 3/8" particle board backing with surface vinyl wrapped all sides. | | | | | | | | | | |
| - | 2-3/8 | - | 0.39 | 1.18 | 2.64 | 2.84 | 2.51 | 2.27 | .16 | OCRL 35261-3 | 116 | Vicracoustic Blocks | 5,16 |

TABLE 19 UNIT ABSORBERS (Concl)

| Mounting | Thickness (inches) | Average Sabins per Unit (250 - 2000 Hz) | Absorption in Sabins Unit 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 16" square; rigid fiberglas core of 2" thickness; 3/8" particle board backing with surface vinyl wrapped all sides. | | | | | | | | | | |
| - | 2-3/8 | - | 0.37 | 1.29 | 2.92 | 3.37 | 2.91 | 2.46 | .16 | OCRL 35261-3 | 116 | Vicracoustic Blocks | 6,16 |
| | | | 16" square; rigid fiberglas core of 2" thickness; 3/8" particle board backing with surface vinyl wrapped all sides. | | | | | | | | | | |
| - | 2-3/8 | - | 0.43 | 1.31 | 3.41 | 3.92 | 3.41 | 2.79 | .16 | OCRL 35261-3 | 116 | Vicracoustic Blocks | 7,16 |
| | | | 30"x96"x3". Fabricated of 18 ga cold rolled steel perforated with 3/32" holes on 5/32" staggered centers, V-ridged on 6" centers to a depth of 1". | | | | | | | | | | |
| - | 3 | - | 4.7 | 17.6 | 30.9 | 27.8 | 24.9 | 21.7 | - | CKAL 691-4 | 59 | Eckoustic Functional Panels | 11,15 |
| - | 1-1/2 - 3-1/2 | 1.68 | 0.32 | 0.60 | 1.43 | 2.36 | 2.32 | 2.41 | - | G&H | 128 | Tectum Sound Blocks | 17 |
| - | 1-1/2- 3-1/2 | 1.91 | 0.38 | 0.62 | 1.56 | 2.77 | 2.68 | 2.67 | - | G&H | 128 | Tectum Sound Blocks | 17 |
| | | | 12" dia x 24" long cylinders of molded fiberglas protected by a reinforced screen. | | | | | | | | | | |
| - | - | - | 1.4 | 4.1 | 7.6 | 8.5 | 8.1 | 7.3 | - | KAL A71-162 | 18 | Acoustubes | 12,15 |
| | | | 12" diameter x 24" long cylinders of pressure molded glass fibers, placed 4' on center. | | | | | | | | | | |
| - | - | 7.4 | 3.7 | 5.8 | 7.1 | 8.2 | 8.4 | 10.0 | - | KAL 1128-1-71 | 129 | Functional Sound absorbers | 13,15 |
| | | | 12" diameter x 24" or 36" cylinders of pressure molded glass fibers. | | | | | | | | | | |
| - | - | - | 6.0 | 8.0 | 8.0 | 10.0 | 11.0 | 11.5 | - | CT | 107 | Drum Round Absorbers | 14,15 |
| | | | 4' x 6' panels of K-13 cellulose material on lightweight metal lath. | | | | | | | | | | |
| - | - | - | 8.4 | 17.1 | 30.0 | 39.7 | 41.6 | 41.6 | - | CT | 127 | K-13 Panel Systems | 15 |

FOOTNOTES FOR TABLE 19
UNIT ABSORBERS

1. Inorganic, incombustible sound absorbing units. Temperature range to 100°F. Relative humidity range to 100 percent. Resistant to all common chemicals except HF and strong alkalis. Mechanical fastener on adhesive mounting.

2. Same as Footnote 1 except mounted in 16" on center rectangles.

3. Same as Footnote 1 except mounted in 24" on center patches.

4. Same as Footnote 1 except mounted in 32" on center patches.

5. Unit sound absorbers. Laminar composite of perforated Vicrtex vinyl wall covering. Class B flame spread. Normal interior temperature and humidity ranges. Available in many patterns and colors. Excellent resistance to stain.

6. Same as Footnote 5 except 50 percent coverage.

7. Same as Footnote 5 except 70 percent coverage.

8. All flat exposed surfaces are covered with unperforated textured vinyl. Ends covered with PVC channel finish. Two hooks on upper edge for hanging. Noncombustible, temperature range to 200°F. Relative humidity range to 100 percent.

9. Same as Footnote 8 except covered with perforated vinyl.

10. Temperature range to 150°F. Relative humidity range to 95 percent. NRC based on surface area of 16 $ft^2$ per panel.

11. Panels filled with Owens-Corning type 701 industrial insulation wrapped in 1 mil plastic.

12. Temperature range to 350°F. Relative humidity to 100 percent. Flame spread: 20. Good resistance to petroleum and alkalis.

13. All exposed surfaces protected by a white fiber mesh. Units are moisture repelling, dustproof, and incombustible.

14. All exposed surfaces are protected with reinforcing mesh.

15. Test procedure conforms to ASTM C423-66.

16. AM specification No. 11 - Acoustical absorbers as published by the Acoustical & Insulating Materials Association, Feb. 1972.

17. AIMA Procedure, mounting spaces 24" on center. Temperature range: 150°F. Flame spread: 20, Resistant to chemicals.

18. Use in normal room temperature and humidity.

## TABLE 20

## WALL TREATMENTS AND FACINGS

Facings in the form of panels, boards, etc., which can be mounted on the walls to increase the sound absorption and thus improve the acoustic characteristics of the room are listed. The facings are made from a variety of materials and are available in various pleasing colors and surface textures. Figure 20A shows one such product with decorative facing backed by sound absorptive sheet and fibers. The facings can be mounted on a wall in a variety of ways. Figure 20B shows two simple mounting techniques. The table is subdivided into five parts representing five different thickness regions. This has been done because low frequency absorption is dependent upon the thickness of the absorbing material, and allows a comparative assessment of one material's potential for absorption relative to other materials, with the same general characteristics.

- 20A Wall treatments - 1 inch to 1-1/2 inches thick
- 20B Wall treatments - 2 inches to 2-1/2 inches thick
- 20C Wall treatments - 3 inches to 3-3/4 inches thick
- 20D Wall treatments - 4 inches to 4-1/2 inches thick
- 20E Wall treatments - 5 inches to 7 inches thick

The companies (by numbers shown in Section II) with products listed in Table 20 are: 6, 10, 57, 59, 73, 82, 104, 105, 106, 111, 116, 128, 129, 132, 147, 151, 172, 178, 181.

**CAUTION**

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

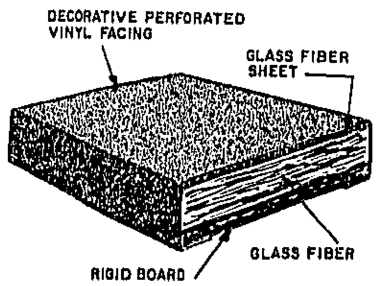



Figure 20A Vinyl Faced, Sound Absorbent Wall Covering

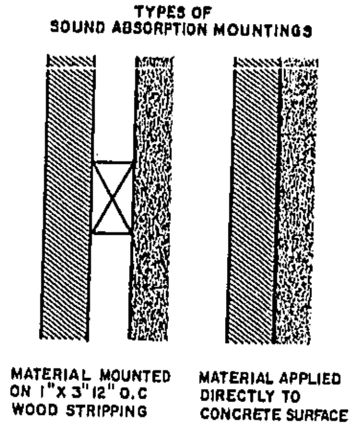



Figure 20B Typical Mounting of Sound Absorbent Materials

GLOSSARY

**Facing:** The outside surface of the specimen. In general the side facing the sound source

**Backing:** The other outside surface of the specimen. In general the side not facing the sound source

**Core:** The region between the facing and the backing

**Lath:** Thin lightweight structure used as groundwork for plastering, mounting tiles, etc. It may be in a form of gypsum board, perforated metal wire cloth, thin wood strips, etc.

TABLE 20A WALL TREATMENTS AND FACINGS (1 INCH TO 1-1/2 INCH THICKNESS)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Painted finish. Wood fibers and inorganic binders core. | | | | | | | | | |
| 2 | 1 | .40 | .08 | .14 | .27 | .57 | .59 | .63 | - | G&H | 128 | Tectum Interior Panels | 2 |
| | | | | Perforated vinyl wall facing, rigid glass fiber core | | | | | | | | | |
| 2 | 1-1/8 | .80 | .27 | .72 | .87 | .82 | .74 | .70 | 8.45 | CKAL 711-48 | 116 | Vicracoustic type A | 6,17 |
| | | | | Painted finish. Wood fibers and inorganic binders core. | | | | | | | | | |
| 4 | 1 | .40 | .07 | .12 | .24 | .44 | .70 | .54 | - | G&H | 128 | Tectum Interior Panels | 2 |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 1 | .55 | .24 | .30 | .57 | .69 | .70 | | 2 | - | 6 | Faced rigid sound control boards | |
| | | | | Perforated metal facing | | | | | | | | | |
| 4 | 1 | .65 | .27 | .35 | .68 | .77 | .76 | .71 | 3 | - | 6 | Faced rigid sound control boards | |
| | | | | Perforated metal facing | | | | | | | | | |
| 4 | 1 | .70 | .33 | .40 | .76 | .91 | .77 | .73 | 4 | - | 6 | Faced rigid sound control boards | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 1 | .75 | .11 | .30 | .72 | .97 | .97 | 1.01 | 4 | RAL A72-106 | 57 | MT-board #4 | 5,17 |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 1 | .75 | .33 | .45 | .81 | .88 | .78 | | 4 | - | 6 | Faced rigid sound control board | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 1 | .75 | .10 | .29 | .73 | .97 | .97 | 1.00 | 6 | RAL A73-110 | 57 | MT - board #6 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 1 | .75 | .11 | .28 | .73 | .97 | .98 | .98 | 8 | RAL A72-114 | 57 | MT - board #8 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 1 | .75 | .12 | .31 | .74 | .98 | .99 | 1.00 | 10 | RAL A72-118 | 57 | MT - board #10 | 5,17 |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 1 | .80 | .35 | .51 | .89 | .93 | .87 | | - | - | 6 | Faced rigid sound control boards | |
| | | | | Perforated vinyl wall facing, rigid glass fiber core | | | | | | | | | |
| 4 | 1-1/8 | .80 | .24 | .59 | .91 | .85 | .79 | .75 | 8.45 | CKAL 711-29 | 116 | Vicracoustic type A | 6,17 |
| | | | | Painted finish. Wood fibers inorganic binders core | | | | | | | | | |
| 8 | 1 | .80 | .18 | .53 | .96 | .90 | .71 | .90 | - | G&H | 128 | Tectum Interior Panels | 2 |

TABLE 20A WALL TREATMENTS AND FACINGS (1 INCH TO 1-1/2 INCH THICKNESS) (Concl)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Perforated vinyl wall facing, rigid glass fiber core | | | | | | | | | |
| 8 | 1-1/8 | .80 | .33 | .74 | .90 | .83 | .73 | .72 | 8.45 | CKAL 711-49 | 116 | Vicracoustic type A | 6,17 |
| | | | | Wood without mineral wool | | | | | | | | | |
| - | 1 | - | .08 | .36 | .44 | .59 | .71 | .47 | - | KAL | 129 | Panacoust Acoustical Panels | 1,17 |
| | | | | Wood with mineral wool | | | | | | | | | |
| - | 1 | - | .20 | .38 | .46 | .60 | .74 | .54 | - | KAL | 129 | Panacoust Acoustical Panels | 1,17 |
| | | | | 1" thermal insulating wool only | | | | | | | | | |
| - | 1 | .65 | .11 | .33 | .70 | .80 | .86 | .85 | - | CT | 132 | OCWT | 3,4, 17 |
| | | | | 1" 703 fiberglas core alone | | | | | | | | | |
| - | 1 | .70 | .06 | .20 | .65 | .90 | .95 | .98 | 3 | CT | 132 | OCWT | 3,4, 17 |
| | | | | 1" nubby design, glass cloth board facing | | | | | | | | | |
| - | 1 | .75 | .04 | .21 | .73 | .99 | .99 | .90 | - | CT | 132 | OCWT | 3,17 |
| | | | | Glass cloth facing | | | | | | | | | |
| - | 1 | .80 | .77 | .57 | .84 | .93 | .75 | .51 | - | - | 6 | Rigid sound control boards | |
| | | | | With rigid board backing, fabric glass facing | | | | | | | | | |
| - | 1 | .90 | .75 | .91 | .86 | .93 | .79 | .50 | - | - | 6 | Faced rigid sound control boards | |
| | | | | 1" 703 with 1/8" pegboard facing | | | | | | | | | |
| - | 1-1/8 | .55 | .09 | .35 | .99 | .58 | .24 | .10 | - | CT | 132 | OCWT | 3,17 |
| | | | | 1" 703 with 1/4" pegboard facing | | | | | | | | | |
| - | 1-1/4 | .60 | .08 | .32 | .99 | .76 | .34 | .12 | - | CT | 132 | OCWT | 3,17 |
| | | | | 1" thermal insulating wool 1/4" pegboard facing | | | | | | | | | |
| - | 1-1/4 | .60 | .08 | .41 | .99 | .82 | .26 | .32 | - | CT | 132 | OCWT | 3,17 |
| | | | | Screen protected facing | | | | | | | | | |
| - | 1-3/8 | .80 | .11 | .29 | .86 | .99 | .97 | .67 | 1.79 | RAL A72-217 | 105 | Si-lock noise control panels | |
| | | | | Perforated metal facing | | | | | | | | | |
| - | 1-1/2 | .90 | .38 | .88 | 1.15 | .97 | .71 | .51 | - | RAL A71-152 | 106 | L-21 Acoustical Liner with IW 21A exterior panels (Type L-21 Acousti-wall) | 7,17 |
| | | | | 1" unpainted linear design, glass cloth board facing | | | | | | | | | |
| - | - | .65 | .03 | .17 | .63 | .87 | .96 | .96 | - | CT | 132 | OCWT | 3,17 |

TABLE 20B WALL TREATMENTS AND FACINGS (2 INCH TO 2-1/2 INCH THICKNESS)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1/2" glass fiber facing with 2" of rigid fiberglas core | | | | | | | | | |
| 2 | 2-1/8 | .85 | .57 | .98 | .92 | .76 | .71 | .78 | 8.45 | OCRL 35261-2 | 116 | Vicracoustic Type A | 6 |
| | | | | Perforated masonite facing | | | | | | | | | |
| 2 | 2-1/2 | .90 | .43 | .88 | .99 | .92 | .81 | .81 | 4 | - | 6 | Faced rigid sound control boards | 10 |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 2 | .75 | .38 | .49 | .84 | .91 | .76 | | 2 | - | 6 | Faced rigid sound control boards | |
| | | | | Perforated metal facing | | | | | | | | | |
| 4 | 2 | .80 | .44 | .61 | .96 | .93 | .77 | .86 | 3 | - | 6 | Faced rigid sound control boards | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 2 | .85 | .28 | .58 | .88 | 1.01 | 1.00 | 1.00 | 4 | RAL A72-107 | 57 | MT - board #4 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 2 | .85 | .27 | .60 | .88 | 1.01 | 1.02 | 1.01 | 8 | RAL A72-116 | 57 | MT - board #8 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 2 | .85 | .29 | .58 | .88 | 1.01 | 1.01 | 1.00 | 6 | RAL A72-111 | 57 | MT - board #6 | 5,17 |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 2 | .90 | .54 | .68 | .99 | .99 | .88 | - | 4 | - | 6 | Faced rigid sound control boards | |
| | | | | Metal lath facing | | | | | | | | | |
| 4 | 2 | .90 | .55 | .79 | .99 | .99 | .91 | | 6 | - | 6 | Faced rigid sound control boards | |
| | | | | Muslin facing | | | | | | | | | |
| 4 | 2 | .90 | .62 | .85 | .99 | .99 | .86 | | - | - | 6 | Faced rigid sound control boards | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 2 | .90 | .31 | .61 | .90 | 1.02 | 1.03 | 1.04 | 10 | RAL A72-199 | 57 | MT - Board #10 | 5 |
| | | | | 1/8" glass fiber facing with 2" rigid fiberglas core | | | | | | | | | |
| 4 | 2-1/8 | .85 | .47 | .95 | .89 | .77 | .75 | .76 | 8.45 | OCRL 35261-2 | 116 | Vicracoustic Type A | 6 |
| | | | | 4' x 8' long laminated wood fiber board with one perforated face | | | | | | | | | |
| 4 | 2-1/4 | .65 | .27 | .39 | .51 | .77 | .89 | .84 | - | KAL 1306-1-72 | 129 | NMC Laminated Panel | |
| | | | | Asbestos paper facing | | | | | | | | | |
| 4 | 2-1/2 | .85 | .47 | .64 | .99 | .99 | .76 | .59 | 2 | - | 6 | Faced rigid sound control boards | |

TABLE 20B WALL TREATMENTS AND FACINGS (2 INCH TO 2-1/2 INCH THICKNESS)(Contd)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1" air space core with 1" unpainted linear glass board facing | | | | | | | | | |
| - | 2 | .75 | .04 | .26 | .78 | .99 | .99 | .98 | - | CT | 132 | OCWT | 3,17 |
| | | | | Perforated steel facing, solid steel backing, mineral wool core | | | | | | | | | |
| - | 2 | .84 | .26 | .63 | .87 | .97 | .88 | .75 | - | - | 82 | Modular Noise Control Panels | |
| | | | | Perforated metal facing, cold rolled steel backing with vibro-damper; core of glass or mineral wool with braided mat. | | | | | | | | | |
| - | 2 | .85 | .29 | .60 | .95 | .99 | .87 | .80 | - | - | 111 | Standard Noiseguard Panels | |
| | | | | 1" unpainted 703 with linear design, glass cloth board facing | | | | | | | | | |
| - | 2 | .90 | .18 | .71 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 2" Thermal insulating wool only. | | | | | | | | | |
| - | 2 | .90 | .25 | .64 | .99 | .97 | .88 | .92 | - | CT | 132 | OCWT | 3,8,17 |
| | | | | 1" thermal insulating wool with 1" linear design, glass cloth board facing | | | | | | | | | |
| - | 2 | .90 | .23 | .72 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Galvanized steel facing, galvanized steel with 23 percent perforation backing insulating material core. | | | | | | | | | |
| - | 2 | .90 | .40 | .75 | .94 | .97 | .99 | .96 | - | KAL 1180-1 71R | 151 | Semco Equipment Housing Panel | 9,17 |
| | | | | 2" 703 Fiberglas only | | | | | | | | | |
| - | 2 | .95 | .18 | .76 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3 |
| | | | | 2" 703 with perforated metal facing | | | | | | | | | |
| - | 2 | .95 | .18 | .73 | .99 | .99 | .97 | .93 | - | CT | 132 | OCWT | 3,8 |
| | | | | 1" 703 with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 2 | .95 | .25 | .76 | .99 | .99 | .99 | .97 | - | CT | 132 | OCWT | 3 |
| | | | | 2" Thermal insulating wool only | | | | | | | | | |
| - | 2 | .95 | .25 | .75 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3 |

TABLE 20B WALL TREATMENTS AND FACINGS (2 INCH TO 2-1/2 INCH THICKNESS)(Concl)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1" Thermal insulating wood with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 2 | .95 | .26 | .75 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3 |
| | | | | 2" thermal insulating wool with 1/4" pegboard facing | | | | | | | | | |
| - | 2-1/4 | .70 | .26 | .89 | .99 | .58 | .26 | .17 | - | CT | 132 | OCWT | 3,17 |
| | | | | 2" 703 with 1/4" pegboard facing | | | | | | | | | |
| - | 2-1/4 | .75 | .26 | .97 | .99 | .66 | .34 | .14 | - | CT | 132 | OCWT | 3,17 |
| | | | | Fiberglas 703 | | | | | | | | | |
| - | 2-1/4 | .85 | .30 | .69 | .94 | .92 | .92 | .98 | - | CT | 132 | OCWT | 17,18 |

TABLE 20C WALL TREATMENTS AND FACINGS (3 INCH TO 3-3/4 INCH THICKNESS)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Perforated metal facing | | | | | | | | | |
| 4 | 3 | .90 | .68 | .78 | .99 | .94 | .86 | .80 | 3 | - | 6 | Faced rigid sound control facing | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 3 | .95 | .45 | .85 | 1.03 | 1.04 | 1.02 | .98 | 4 | RAL A72-108 | 57 | MT - board #4 | 5,17 |
| | | | | Perforated metal facing | | | | | | | | | |
| 4 | 3 | .95 | .69 | .91 | .99 | .99 | .91 | .82 | 4 | - | 6 | Faced rigid sound control board | |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 3 | .95 | .47 | .85 | 1.03 | 1.04 | 1.03 | 1.00 | 6 | RAL A72-112 | 57 | MT - board #6 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 3 | .95 | .47 | .86 | 1.04 | 1.05 | 1.04 | 1.04 | 8 | RAL A72-115 | 57 | MT - board #8 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 3 | .95 | .49 | .87 | 1.05 | 1.05 | 1.05 | 1.05 | 10+ | RAL A72-120 | 57 | MT - Board #10 | 5,17 |
| | | | | 2" air space core with 1" unpainted linear design, glass cloth board facing | | | | | | | | | |
| - | 3 | .85 | .17 | .40 | .94 | .99 | .97 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Perforated metal facing | | | | | | | | | |
| - | 3 | .85 | .55 | .58 | .95 | .90 | .79 | .80 | 2 | - | 6 | Faced rigid sound control boards | |
| | | | | Perforated steel facing, solid sheet backing, mineral wool core | | | | | | | | | |
| - | 3 | .95 | .60 | .97 | .97 | .93 | .91 | .78 | - | - | 82 | Modular noise control panels | |
| | | | | 3" Thermal insulating wool only | | | | | | | | | |
| - | 3 | .95 | .46 | .99 | .99 | .99 | .99 | .99 | - | - | 132 | OCWT | 3,17 |
| | | | | 2" Thermal insulating wool with 1" unpainted linear glass cloth board | | | | | | | | | |
| - | 3 | .95 | .48 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 2" 703 with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 3 | .95 | .50 | .99 | .99 | .99 | .99 | .97 | - | CT | 132 | OCWT | 3,17 |
| | | | | 2" Thermal insulating wool with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 3 | .95 | .51 | .99 | .99 | .99 | .97 | .95 | - | CT | 132 | OCWT | 3,17 |

TABLE 20C WALL TREATMENTS AND FACINGS (3 INCH TO 3-3/4 INCH THICKNESS) (Concl)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft3 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fiberglas core only | | | | | | | | | |
| - | 3 | .95 | .53 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT - 3" 703 | 3,17 |
| | | | | 2" 703 with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 3 | .95 | .59 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 3" Thermal insulating wool with 1/4" pegboard | | | | | | | | | |
| - | 3-1/4 | .70 | .53 | .99 | .97 | .51 | .32 | .16 | - | CT | 132 | OCWT | 3, 4,17 |
| | | | | 3" 703 with 1/4" pegboard | | | | | | | | | |
| - | 3-1/4 | .75 | .49 | .99 | .99 | .69 | .37 | .15 | - | CT | 132 | OCWT | 3,17 |
| | | | | Paper faced acoustic insulation fiberglas | | | | | | | | | |
| - | 3-1/2 | .80 | .38 | .96 | .99 | .68 | .47 | .35 | - | CT | 132 | OCWT | 17,18 |
| | | | | Fiberglas acoustic insulation | | | | | | | | | |
| - | 3-1/2 | .95 | .34 | .80 | .99 | .97 | .97 | .92 | - | CT | 132 | OCWT | 17,18 |
| | | | | 3-1/2" fiberglas backing | | | | | | | | | |
| - | 3-1/2 | .95 | .67 | .99 | .99 | .99 | .99 | .98 | - | CT | 132 | OCWT | 17 |
| | | | | 3-1/2" paper faced fiberglas , 1/4" pegboard | | | | | | | | | |
| - | 3-3/4 | .60 | .50 | .99 | .70 | .41 | .38 | .27 | - | CT | 132 | OCWT | 17,18 |
| | | | | Fiberglas acoustic insulation and 1/4" pegboard | | | | | | | | | |
| - | 3-3/4 | .70 | .45 | .99 | .87 | .41 | .30 | .14 | - | CT | 132 | OCWT | 17,18 |

TABLE 20D WALL TREATMENTS AND FACINGS (4 INCH TO 4-1/2 INCH THICKNESS)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density $lb/ft^3$ | Lab. | Co. | Product | Foot-notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 4 | .95 | .61 | 1.10 | 1.17 | 1.06 | 1.03 | .98 | 4 | RAL A72-109 | 57 | MT - board #4 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 4 | .95 | .63 | 1.10 | 1.17 | 1.06 | 1.04 | .99 | 6 | RAL A72-113 | 57 | MT - board #6 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 4 | .95 | .65 | 1.11 | 1.18 | 1.07 | 1.05 | 1.06 | 8 | RAL A72-117 | 57 | MT - board #8 | 5,17 |
| | | | | Mineral fiber board | | | | | | | | | |
| 4 | 4 | .95 | .66 | 1.12 | 1.18 | 1.07 | 1.06 | 1.06 | 10 | RAL | 57 | MT - board #10 | 5,17 |
| | | | | Perforated metal facing. Solid metal backing. Sound deadening material core. | | | | | | | | | |
| 4 | 4 | .95 | .76 | .99 | .99 | .99 | .90 | .84 | - | RAL A62-242 | 6 | Metal sound control panels | 13,19 |
| | | | | Perforated metal facing. Solid metal backing. Sound deadening material core. | | | | | | | | | |
| 4 | 4 | .95 | .76 | .99 | .99 | .99 | .90 | .89 | - | RAL A62-242 | 6 | Metal Acoustic Panels | 13 |
| | | | | Facing: perforated sheet Backing: sheet metal Core: mineral wool | | | | | | | | | |
| 4 | 4 | .95 | .87 | .97 | .98 | .96 | .96 | .99 | 5.55* | KAL 1184-1-71 | 181 | Sona-guard panels on concrete | 17,20 |
| | | | | 3" Airspace core - 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 4 | .85 | .19 | .53 | .99 | .99 | .92 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Polyurethane core | | | | | | | | | |
| - | 4 | .95 | .36 | .85 | 1.03 | .97 | .94 | .83 | 2-1/2* | CT | 10 | Acousta Panels | 20 |
| | | | | Solid face damped for low frequency attenuation | | | | | | | | | |
| - | 4 | .95 | .51 | 1.10 | 1.12 | 1.06 | 1.05 | .93 | - | CKAL 694-10 | 59 | Panel System type HD or CD | 12,17 |
| | | | | 4" Thermal insulating wool only | | | | | | | | | |
| - | 4 | .95 | .57 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Galvanized steel backing, galvanized steel with 23% perforation facing insulation material core. | | | | | | | | | |
| - | 4 | .95 | .75 | .93 | .99 | .98 | .99 | .99 | 4.85* | KAL 1180-2-71R | 151 | Semco Equipment Housing Panel | 9, 17,20 |

*Weight in $lb/ft^2$

TABLE 20D WALL TREATMENTS AND FACINGS (4 INCH TO 4-1/2 INCH THICKNESS)(Contd)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Facing: 18 ga. metal Backing: 22 ga metal Core: mineral wool | | | | | | | | | |
| - | 4 | .95 | .58 | 1.05 | 1.11 | 1.07 | 1.05 | .96 | 6* | RAL A72-33 | 147 | Acoustical Panel | 11, 17,20 |
| | | | | Standard panel with one absorptive face | | | | | | | | | |
| - | 4 | .95 | .71 | 1.14 | 1.16 | 1.06 | 1.04 | 1.13 | - | CKAL 691-6 | 59 | Panel System type H or C | 17,12 |
| | | | | 3" Thermal insulating wool 1" nubby design, glass cloth board | | | | | | | | | |
| - | 4 | .95 | .71 | .99 | .99 | .99 | .99 | .92 | - | CT | 132 | OCWT | 3,17 |
| | | | | 3" 703 - 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 4 | .95 | .75 | .99 | .99 | .99 | .99 | .97 | - | CT | 132 | OCWT | 3,17 |
| | | | | 3" Thermal insulating wool unpainted linear design, glass cloth board | | | | | | | | | |
| - | 4 | .95 | .77 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Perforated metal facing, 24 ga 3-3/32" holes with cold rolled steel sheel vibrodamper facing & backing: glass or mineral wool with bonded material, core. | | | | | | | | | |
| - | 4 | .95 | .77 | .99 | .99 | .99 | .93 | .77 | - | | 111 | Standard Noiseguard Panels | |
| | | | | 3" 703 - 1" nubby design, glass cloth board | | | | | | | | | |
| - | 4 | .95 | .88 | .99 | .99 | .99 | .93 | .98 | - | CT | 132 | OCWT | 3,17 |
| | | | | 4" 703 Fiberglas | | | | | | | | | |
| - | 4 | .95 | .99 | .99 | .99 | .99 | .98 | .98 | - | CT | 132 | OCWT | 3,17 |
| | | | | Galvanized steel backing, Galvanized steel with 23 percent perforation facing, insulating material core. | | | | | | | | | |
| - | 4 | .95 | .58 | 1.05 | 1.11 | 1.07 | 1.05 | .96 | 5.8* | RAL A72-33 | 129 | NMC Acoustical Panel | 17,20 |
| | | | | Perforated steel facing, solid steel backing, mineral wool core | | | | | | | | | |
| - | 4 | .96 | .70 | .99 | .99 | .99 | .94 | .83 | - | | 82 | Modular Noise Control Panels | |

TABLE 20D WALL TREATMENTS AND FACINGS (4 INCH TO 4-1/2 INCH THICKNESS) (Concl)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Perforated facing and backing; fiberglas insulation core | | | | | | | | | |
| - | 4 | 1.10 | .63 | 1.09 | 1.17 | 1.08 | 1.03 | .97 | 5.1* | RAL | 172 | Uni-housing Panels | 14, 17,20 |
| | | | | Solid metal backing Perforated metal facing with liner for insulation and protection; Structural channel core. | | | | | | | | | |
| - | 4 | 1.10 | .63 | 1.09 | 1.17 | 1.08 | 1.03 | .97 | - | RAL A71-3 | 178 | HS Uni-housing Panel | 16,17 |
| | | | | Perforated steel facing, solid steel backing, acoustic fill in the core. | | | | | | | | | |
| - | 4 | 1.10 | .89 | 1.20 | 1.16 | 1.09 | 1.01 | 1.03 | 5.89* | CKAL 661-17 | 104 | Noishield Panel | 15,20 |
| | | | | 4" Thermal insulating wool with 1/4" pegboard | | | | | | | | | |
| - | 4-1/4 | .70 | .70 | .99 | .94 | .58 | .37 | .19 | - | CT | 132 | OCWT | 3,17 |
| | | | | 4" 703 with 1/4" pegboard | | | | | | | | | |
| - | 4-1/4 | .75 | .80 | .99 | .99 | .71 | .38 | .13 | - | CT | 132 | OCWT | 3,17 |
| | | | | 22 ga perforated steel (3/32" diameter holes on 5/32" centers). Air spnrn: 5/8". 3" of #703 fiberglas. 5/8" gypsum board glued to 16 ga steel. | | | | | | | | | |
| - | 4-1/4 | .95 | .64 | 1.15 | 1.13 | 1.02 | .98 | .99 | - | RAL A71-102 | 73 | Sound Wall | 17 |
| | | | | 3-1/2" paper faced fiberglass with 1" nubby design, glass cloth board facing. | | | | | | | | | |
| - | 4-1/2 | .95 | .66 | .99 | .99 | .98 | .99 | .95 | - | CT | 132 | OCWT | 17,18 |
| | | | | 3-1/2" paper faced fiberglass with 1" unpainted linear design, glass cloth board facing. | | | | | | | | | |
| - | 4-1/2 | .95 | .66 | .99 | .99 | .96 | .99 | .99 | - | CT | 132 | OCWT | 17,18 |
| | | | | 3-1/2" fiberglass insulation with 1" nubby design, glass cloth board facing. | | | | | | | | | |
| - | 4-1/2 | .95 | .67 | .99 | .99 | .99 | .99 | .90 | - | CT | 132 | OCWT | 17,18 |
| | | | | 1" unpainted linear design, glass cloth board facing. | | | | | | | | | |
| - | 4-1/2 | .95 | .66 | .99 | .99 | .99 | .99 | .97 | - | CT | 132 | OCWT | 17,18 |

TABLE 20E WALL TREATMENTS AND FACINGS (5 INCH TO 7 INCH THICKNESS)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnotes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 4" Thermal insulating wool with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 5 | .95 | .77 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 4" Thermal insulating wool with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 5 | .95 | .79 | .99 | .99 | .99 | .99 | .98 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" Thermal insulating wool only | | | | | | | | | |
| - | 5 | .95 | .83 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 4" 703 - 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 5 | .95 | .87 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 4" 703 with 1" nubby design glass cloth board | | | | | | | | | |
| - | 5 | .95 | .88 | .99 | .99 | .99 | .99 | .96 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" 703 Fiberglas | | | | | | | | | |
| | 5 | .95 | .95 | .99 | .99 | .99 | .99 | .99 | | CT | 132 | OCWT | 3,17 |
| | | | | 5" Thermal insulating wool with 1/4" plywood facing | | | | | | | | | |
| - | 5-1/4 | .70 | .78 | .99 | .89 | .63 | .34 | .14 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" 703 with 1/4" peg-board | | | | | | | | | |
| - | 5-1/4 | .75 | .98 | .99 | .99 | .71 | .40 | .20 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" Air space core with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 6 | .90 | .41 | .73 | .99 | .98 | .94 | .97 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" fiberglass backing | | | | | | | | | |
| - | 6 | .95 | .67 | .99 | .99 | .99 | .99 | .98 | - | CT | 132 | OCWT | 17,18 |
| | | | | 5" Thermal insulating wool with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 6 | .95 | .87 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" 703 with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 6 | .95 | .92 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" Thermal insulating wool with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 6 | .95 | .92 | .99 | .99 | .99 | .99 | .93 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" Thermal insulating wool only | | | | | | | | | |
| - | 6 | .95 | .93 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |

TABLE 20E WALL TREATMENTS AND FACINGS (5 INCH TO 7 INCH THICKNESS) (Concl)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 6" 703 only | | | | | | | | | |
| - | 6 | .95 | .99 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 5" 703 with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 6 | .95 | .99 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | Perforated metal facing. Solid metal backing. Sound deadening material core. | | | | | | | | | |
| 4 | 6 | .95 | .99 | .99 | .99 | .99 | .99 | .99 | - | RAL A62-243 | 6 | Metal sound control panels | 13,19 |
| | | | | 6" Thermal insulating wool with 1/4" pegboard | | | | | | | | | |
| - | 6-1/4 | .70 | .95 | .99 | .88 | .64 | .36 | .17 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" 703 with 1/4" pegboard | | | | | | | | | |
| - | 6-1/4 | .75 | .95 | .99 | .98 | .69 | .36 | .18 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" 703 with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .85 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" 703 with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .86 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" fiberglass insulation with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .89 | .89 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 17,18 |
| | | | | 7" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .99 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 17,18 |
| | | | | 6" Thermal insulating wool with 1" unpainted linear design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .95 | .99 | .99 | .99 | .99 | .99 | - | CT | 132 | OCWT | 3,17 |
| | | | | 6" Thermal insulating wool with 1" nubby design, glass cloth board | | | | | | | | | |
| - | 7 | .95 | .95 | .99 | .99 | .99 | .99 | .94 | - | CT | 132 | OCWT | 3,17 |

FOOTNOTES FOR TABLE 20A, 20B, 20C, 20D, 20E
WALL TREATMENTS AND FACINGS

1. Temperature range to 120°F. Normal wood resistance.
2. Temperature range to 150°F. Flame spread 20. Poor resistance to chemicals.
3. Owens-Corning wall treatment: fiberglas sound absorbent insulation. Temperature not to exceed 250°F. Series 700 core; plain, faced, and clear or black coated insulation - 700, 701, 702, flexible; 703, semirigid; 704, 705, rigid.
4. Absorption values would be unchanged for open facing such as wire mesh, metal lath, or light fabric.
5. Temperature range to 1050°F. Flame spread not greater than 25. Typical applications include ducts, ovens, boiler walls, etc.
6. Interior use, flame spread class B. Perforated vicroten vinyl wall facing, rigid glass fiber core. Used for decorative sound absorbent wall panels.
7. Inland-Ryerson type B wall panel insulation.
8. Perforated metal facing, 24 ga, 3/32" holes, 13 percent open area.
9. -40°F to 400°F temperature range. Flame spread - 15.
10. Facing of perforated masonite, 3/16" diameter holes, spaced 1/2" on center.
11. Temperature range to 600°F. Flame spread 15 - UL723.
12. C series same as H series, but has added connection system to be clamped together at joints.
13. Inert, corrosion resistant, noncombustible, vermin-proof.
14. Temperature range to 350°F. Facings have varying percent of open area.
15. Temperature range to 450°F.
16. Flame spread 10-20.
17. Tested and evaluated according to ASTM C423-66.
18. Not to be used over 250°F.
19. Tested and evaluated according to ASTM 423-60T.
20. Asterisk indicates weight in $lbs/ft^2$.

TABLE 21
CEILINGS

Ceiling tiles, panels, etc., and their sound absorption coefficients are listed. Ceilings provide an important sound absorption surface in a room. A variety of products are available for utilizing this ceiling surface to the best advantage. There are sound absorbing tiles or panels which have good appearance and other important features such as good light reflectance, structural integrity, and minimum fire hazard. A tremendous variety of products are available to fulfill these functions and therefore the table is subdivided into 10 parts:

21A Textured, finely perforated or smooth mineral fiber tiles
21B Perforated mineral fiber tiles
21C Fissured mineral fiber tiles
21D Cellulose fiber lay-in panels
21E Mineral fiber lay-in panels
21F Perforated metal panels with mineral fiber pads
21G Perforated asbestos cement board panels with mineral fiber pads
21H Ceiling systems
21I Special acoustical panels and units
21J Ceiling boards

The content of each subdivision is self-explanatory. The ceiling components are available in the forms of tiles, panels, boards, perforated metal lay-in panels, fiber pads, etc., and the complete ceiling systems are also available. Figure 21 shows four commonly used ceiling tile patterns using holes or fissures to increase sound absorption. The companies (by numbers shown in Section II) with products listed in Table 21 are: 15, 29, 53, 100, 109, 128, 132, 146.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.

2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

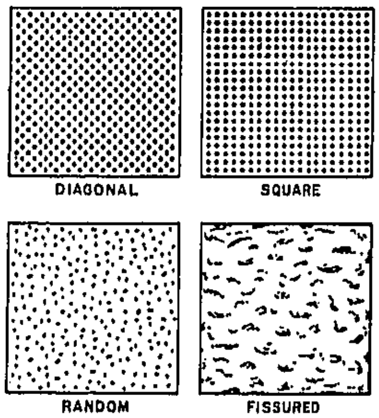



Figure 21 Ceiling Tile Facing Patterns for Increased Sound Absorbence

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

TABLE 21A CEILINGS
(Textured, finely perforated or smooth mineral fiber tile)

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .55 | .32 | .39 | .60 | .60 | .53 | .41 | - | RAL | 109 | Tenutone Concord | |
| | | | | Frescor pattern facing. Available size 12" x 12" | | | | | | | | | |
| 7 | 5/8 | .55 | .56 | .60 | .52 | .57 | .47 | .32 | - | RAL | 132 | Acoustical Tile | 1,27 |
| | | | | Available sizes 24" x 24", 24" x 36", 24"x 36" | | | | | | | | | |
| 7 | 5/8 | .60 | .27 | .29 | .70 | .82 | .67 | .55 | - | RAL | 109 | Spintone Concord | |
| | | | | Textured facing. Available size 12" x 12" | | | | | | | | | |
| 7 | 5/8 | .70 | .79 | .66 | .64 | .80 | .71 | .58 | - | RAL | 132 | Acoustical Tile | 1,27 |
| | | | | Frescor facing. Available size 12" x 12", 12" x 24", 24" x 24" | | | | | | | | | |
| 7 | 3/4 | .65 | .58 | .65 | .59 | .68 | .61 | .42 | - | RAL | 132 | Acoustical Tile | 1,27 |
| | | | | Textured film faced. Available sizes 12" x 12", 12" x 24" | | | | | | | | | |
| 7 | 3/4 | .75 | .93 | .71 | .72 | .80 | .70 | .51 | - | - | 132 | Acoustical Tile | 2,27 |

TABLE 21B CEILINGS
(Perforated mineral fiber tile)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 1 | 5/8 | .65 | .20 | .35 | .68 | .71 | .80 | .78 | - | RAL | 109 | Tenutone (random drilled) | 2 |
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 1 | 5/8 | .70 | .09 | .24 | .78 | .99 | .76 | .57 | - | RAL | 109 | Tenutone | 2,3 |
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 1 | 5/8 | .70 | .18 | .28 | .68 | .95 | .84 | .66 | - | RAL | 109 | Tenutone | 2,4 |
| | | | | Available in various sizes and edge patterns | | | | | | | | | |
| 7 | 5/8 | .55 | .31 | .33 | .58 | .75 | .62 | .47 | - | RAL | 109 | Acousti-Clad Tile (Firedike) | 2,5 |
| | | | | Pin perforated facing. Available size 12" x 12". Other sizes available with 3/4" thickness | | | | | | | | | |
| 7 | 5/8 | .60 | .69 | .59 | .62 | .64 | .54 | .32 | - | RAL | 132 | Acoustical Tile | 1,27 |
| | | | | Available in various sizes and edge patterns | | | | | | | | | |
| 7 | 5/8 | .60 | .32 | .32 | .51 | .81 | .77 | .55 | - | RAL | 109 | Acousti-Clad Tile diagonal perforated | 2,5 |
| | | | | Perforated metal face over mineral fiber tile size 28" x 28" | | | | | | | | | |
| 7 | 5/8 | .60 | .21 | .32 | .57 | .75 | .72 | .61 | - | RAL A70-80 | 53 | Lay-in Don Acoustic | 6 |
| | | | | Available in various sizes and edge patterns | | | | | | | | | |
| 7 | 5/8 | .65 | .36 | .39 | .57 | .83 | .71 | .54 | - | RAL | 109 | Acousti-clad S "Tile" | 2,5 |
| | | | | Perforated metal face on mineral fiber tile 30" x 30" | | | | | | | | | |
| 7 | 5/8 | .65 | .26 | .37 | .58 | .81 | .78 | .66 | - | RAL A70-84 | 53 | Lay-in Donn Acoustic | 6 |
| | | | | Tenutone Firedike Tile, pierced pattern 24" x 24" | | | | | | | | | |
| 7 | 5/8 | .65 | .42 | .38 | .57 | .83 | .78 | .62 | - | RAL | 109 | Tenutone Firedike Tile | 2 |
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .70 | .52 | .43 | .66 | .95 | .82 | .74 | - | RAL | 109 | Tenutone | 2,3 |
| | | | | Tenutone Firedike Tile - uniform drilled, 24" x 24", felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .70 | .26 | .36 | .54 | .92 | .98 | .79 | - | RAL | 109 | Tenutone Firedike | 2 |

TABLE 21B CEILINGS (Concl)
(Perforated mineral fiber tile)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .75 | .44 | .50 | .65 | .90 | .92 | .67 | - | RAL | 109 | Tenutone | 2,4 |
| | | | | Available size 12" x 12" Felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .75 | .58 | .50 | .67 | .92 | .91 | .72 | - | RAL | 109 | Tenutone | 2,7 |
| | | | | Random perforated facing. Available size 12" x 12". 12" x 12" and 12" x 24" sizes available with 3/4" thickness. | | | | | | | | | |
| 7 | 5/8 | .80 | .76 | .78 | .74 | .94 | .78 | .47 | - | - | 132 | Acoustical Tile - random perforated | 1,27 |
| | | | | Available in various sizes and edge patterns | | | | | | | | | |
| 7 | 7/8 | .50 | .42 | .38 | .45 | .56 | .65 | .52 | - | RAL | 109 | Acousti-Clad P "Tile" | 2,5 |

TABLE 21C CEILINGS
(Fissured mineral fiber tile)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Felted mineral fiber core. Available sizes 12" x 12", 12" x 24", 12" x 36" | | | | | | | | | |
| 1 | 3/4 | .65 | .05 | .17 | .66 | .99 | .95 | .90 | - | - | 109 | Tempertone 360 | 2 |
| | | | | Felted mineral fiber core. Nondirectional random sized fissures size 23 3/4" x 23 3/4" | | | | | | | | | |
| 7 | 5/8 | .60 | .27 | .30 | .54 | .74 | .79 | .77 | - | RAL | 109 | Quadrette | 2 |
| | | | | Felted mineral fiber core. Available sizes 24" x 24", 24" x 36", 24" x 48", 24" x 60" | | | | | | | | | |
| 7 | 5/8 | .60 | .30 | .27 | .67 | .82 | .73 | .63 | - | RAL | 109 | Spintone DCF | 2,8 |
| | | | | Available size 12" x 12" | | | | | | | | | |
| 7 | 5/8 | .65 | .40 | .38 | .56 | .81 | .88 | .92 | - | RAL | 109 | Tempertone 360 - Firedike Tile | 2 |
| | | | | Felted mineral fiber core. Available sizes 24" x 24", 24" x 36", 24" x 48", 24" x 60" | | | | | | | | | |
| 7 | 5/8 | .65 | .29 | .29 | .49 | .81 | .93 | .72 | - | RAL | 109 | Spintone standard fissured | 2 |
| | | | | Felted mineral fiber core. Available sizes 24" x 24", 24" x 36", 24" x 48", 24" x 60" | | | | | | | | | |
| 7 | 5/8 | .65 | .26 | .33 | .57 | .83 | .84 | .79 | - | RAL | 109 | Spintone 360 | 2,9 |
| | | | | Felted mineral fiber core. Available sizes 24" x 24", 24" x 36", 24" x 48", 24" x 60" | | | | | | | | | |
| 7 | 5/8 | .65 | .27 | .28 | .65 | .83 | .77 | .85 | - | RAL | 109 | Spintone 720 | 2,10 |
| | | | | Available size 12" x 12". Felted mineral fiber core | | | | | | | | | |
| 7 | 5/8 | .65 | .32 | .35 | .54 | .83 | .85 | .83 | - | RAL | 109 | Tenutone Omni - small non-directional fissures | 2 |
| | | | | Fissured facing. Available size 12" x 12" | | | | | | | | | |
| 7 | 5/8 | .80 | .71 | .87 | .66 | .85 | .82 | .58 | - | - | 132 | Acoustical Tile | 1,27 |
| | | | | Available size 12" x 12". Fine fissured core of mineral fibers blended with cementitious binders | | | | | | | | | |
| 7 | 3/4 | .55 | .33 | .41 | .45 | .59 | .59 | .81 | - | - | 128 | Travacoustic C Tiles | 1,11 |

TABLE 21C CEILINGS (Contd)
(Fissured mineral fiber tile)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Available size 12" x 12" | | | | | | | | | |
| 7 | 3/4 | .65 | .36 | .51 | .52 | .71 | .83 | .88 | - | - | 128 | Fire Shield Travacoustic C Tiles | 1,11 |
| | | | | Available size 12" x 12" Core of mineral fibers blended with cementitious binders - course fissured tile | | | | | | | | | |
| 7 | 3/4 | .65 | .41 | .50 | .52 | .69 | .85 | .94 | - | RAL | 128 | Travacoustic C Tiles (cumulus pattern) | 1,11 |
| | | | | Frescor style facing. Available in 12" x 12", 12" x 24", 24" x 24" sizes. | | | | | | | | | |
| 7 | 3/4 | .65 | .58 | .65 | .59 | .68 | .61 | .42 | - | - | 132 | Acoustical Tile | 1,27 |
| | | | | Available size 12" x 12". Felted mineral fiber core | | | | | | | | | |
| 7 | 3/4 | .65 | .32 | .39 | .74 | .74 | .78 | .91 | - | RAL | 109 | Tempertone DCF - small directional controlled fissures | 1 |
| | | | | Available size 12" x 12". Felted mineral fiber core | | | | | | | | | |
| 7 | 3/4 | .65 | .42 | .42 | .70 | .91 | .86 | .97 | - | RAL | 109 | Tempertone 360 | 1,12 |
| | | | | Felted mineral fiber core. Available size 12" x 24" | | | | | | | | | |
| 7 | 3/4 | .65 | .44 | .44 | .56 | .78 | .89 | .85 | - | RAL | 109 | Permacoustic Firedike Tile - standard fissured | 1 |
| | | | | Felted mineral fiber core. Nondirectional. random sized pattern - size 23-3/4" x 23-3/4" | | | | | | | | | |
| 7 | 3/4 | .65 | .29 | .33 | .59 | .77 | .81 | .80 | - | RAL | 109 | Quadrette | |
| | | | | Available size 12" x 12" | | | | | | | | | |
| 7 | 3/4 | .70 | .44 | .41 | .65 | .83 | .85 | .91 | - | G&H | 128 | Travacoustic C Tiles fissured ATN pattern | 11,17 |
| | | | | Mineral fibers blended with a cementitious binder | | | | | | | | | |
| 7 | 3/4 | .70 | .43 | .39 | .63 | .88 | .89 | .96 | - | G&H | 128 | Travacoustic C Tiles cumulus - ATN | 1,11, 17 |
| | | | | Fissured acoustic tiles | | | | | | | | | |
| 7 | 3/4 | .70 | .50 | .54 | .55 | .77 | .89 | .88 | - | G&H | 128 | Travacoustic C Tiles fissured pattern | 1,11, 17 |
| | | | | Felted mineral fiber acoustic tiles 12" x 12" uniformly dispersed nondirectional fissures | | | | | | | | | |
| 7 | 3/4 | .65 to .75 | .40 | .42 | .74 | .83 | .82 | .96 | - | - | 109 | Tempertone 720 | 2,13, 24 |

TABLE 21C CEILINGS (Concl)
(Fissured mineral fiber tile)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Felted mineral fiber acoustic tiles 12" x 24" fissured extra rough | | | | | | | | | |
| 7 | 3/4 | .70 to .80 | .55 | .61 | .57 | .81 | .98 | .95 | - | - | 109 | Permacoustic extra rough | 2,13, 24 |
| | | | | Cast mineral fibers 12" x 24" standard fissured | | | | | | | | | |
| 7 | 3/4 | .70 to .80 | .53 | .62 | .60 | .83 | .95 | .98 | - | - | 109 | Permacoustic - standard fissured | 2,13, 24 |
| | | | | Fissured facing. Available in sizes 12" x 12" and 12" x 24". | | | | | | | | | |
| 7 | 3/4 | .85 | .66 | .88 | .70 | .90 | .87 | .64 | - | - | 132 | Acoustical Tile | 1,27 |

TABLE 21D CEILINGS
(Cellulose fiber lay-in panels)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Textured panels with wood fibers and inorganic binders | | | | | | | | | |
| 7 | 1 | .40 | .37 | .41 | .26 | .37 | .48 | .67 | - | G&H | 128 | Tectum Ceiling Panels | 1,11, 17 |
| | | | | Textured panels with wood fibers and inorganic binders | | | | | | | | | |
| 7 | 1-1/2 | .45 | .40 | .41 | .28 | .45 | .66 | .76 | - | G&H | 128 | Tectum Ceiling Panels | 1,11, 17 |
| | | | | Textured panels with wood fibers and inorganic binders | | | | | | | | | |
| 7 | 2 | .50 | .43 | .46 | .34 | .53 | .70 | .77 | - | G&H | 128 | Tectum Ceiling Panels | 1,11, 17 |

TABLE 21E CEILINGS
(Mineral fiber lay-in panels)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Unpainted Linear pattern glass cloth faced board | | | | | | | | | |
| 2 | 1 | .80 | .13 | .87 | .85 | .99 | .99 | .97 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 27 |
| | | | | Linear pattern glass cloth faced | | | | | | | | | |
| 4 | 1 | .70 | .07 | .24 | .66 | .95 | .99 | .95 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 27 |
| | | | | Nubby pattern glass cloth faced | | | | | | | | | |
| 4 | 1 | .70 | .06 | .25 | .68 | .97 | .99 | .92 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 27 |
| | | | | Unpainted Linear pattern glass cloth faced | | | | | | | | | |
| 4 | 1 | .70 | .08 | .24 | .68 | .91 | .96 | .94 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 27 |
| | | | | Textured pattern glass cloth faced panels | | | | | | | | | |
| 4 | 1 | .75 | .10 | .27 | .75 | .99 | .99 | .84 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 27 |
| | | | | 0.024" aluminum, white stucco embossed, laid on Fiberglas pads. 50" x 12" | | | | | | | | | |
| 4 | 1-1/2 | .90 | .37 | .69 | .97 | .93 | .92 | .93 | - | - | 15 | Alpro Noise Control Panels | |
| | | | | 2' x 2' lay-in panels or panels of varying widths and lengths | | | | | | | | | |
| 4 | 1-1/2 | .90 | | | | | | | - | RAL | 15 | Alpro Ceiling and Wall Panels | 14,15 |
| | | | | Compressed glass fibors. Sizes 24" x 24", 24" x 48", or 48" x 48". Available with Vault, Coffer, or Flat facings | | | | | | | | | |
| 7 | 1/8 | .50 to .60 | .53 | .53 | .45 | .53 | .62 | .69 | - | - | 109 | Sculptured Fiberglas Acoustishell (Flat) Panels | 24 |
| | | | | Compressed glass fibers. Size 24" x 24". Available with Reveal Edge or Flat pattern facing | | | | | | | | | |
| 7 | 1/8 | .70 to .80 | .66 | .84 | .65 | .76 | .79 | .78 | - | - | 109 | Sculptured Fiberglas Profile Panels | 24 |
| | | | | Mineral fiber lay-in panel, smooth surface | | | | | | | | | |
| 7 | 5/8 | .45 to .55 | .18 | .33 | .62 | .60 | .40 | .26 | - | - | 109 | Particle-Gard LPC Firedike | 2,24 |
| | | | | Mineral fiber lay-in panel, smooth surface | | | | | | | | | |
| 7 | 5/8 | .45 | .18 | .33 | .62 | .60 | .44 | .26 | - | - | 109 | Particle-Gard LPC Firedike | |

TABLE 21E CEILINGS (Contd)
(Mineral fiber lay-in panels)

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mineral fiber lay-in panels, textured micro-perf pattern | | | | | | | | | |
| 7 | 5/8 | .50 | .30 | .34 | .53 | .64 | .52 | .38 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, textured micro-perf pattern, fire-shield | | | | | | | | | |
| 7 | 5/8 | .50 | .29 | .36 | .59 | .56 | .45 | .37 | - | G&H | 128 | Fireshield Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, ventilating, needle perf pattern. Fireshield | | | | | | | | | |
| 7 | 5/8 | .55 | .40 | .36 | .59 | .72 | .55 | .31 | - | G&H | 128 | Fireshield Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, ventilating, needle perf pattern | | | | | | | | | |
| 7 | 5/8 | .55 | .50 | .40 | .60 | .74 | .55 | .37 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, textured micro-perf. MR Fireshield | | | | | | | | | |
| 7 | 5/8 | .55 | .28 | .32 | .61 | .75 | .52 | .39 | - | G&H | 128 | MR Fireshield Solitude Panels | 1,11, 16,17 |
| | | | | Mineral fiber lay-in panels, fissured pattern | | | | | | | | | |
| 7 | 5/8 | .60 | .29 | .32 | .59 | .76 | .73 | .70 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, ventilating, fissured pattern | | | | | | | | | |
| 7 | 5/8 | .60 | .54 | .43 | .60 | .79 | .69 | .50 | - | G&H | 128 | Fire Shield Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, ventilating, fissured pattern | | | | | | | | | |
| 7 | 5/8 | .60 | .39 | .43 | .59 | .77 | .63 | .49 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, needle perf pattern. MR Fire-shield | | | | | | | | | |
| 7 | 5/8 | .60 | .28 | .33 | .51 | .79 | .75 | .57 | - | G&H | 128 | MR Fireshield Solitude Panels | 1,11, 17 |
| | | | | Mineral fiber lay-in panels, fissured pattern. MR Shield | | | | | | | | | |
| 7 | 5/8 | .60 | .28 | .32 | .56 | .76 | .66 | .61 | - | G&H | 128 | MR Shield Solitude Panels | 1,11, 17 |

TABLE 21E CEILINGS (Contd)
(Mineral fiber lay-in panels)

| Mounting | Thickness (inches) | SRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mineral fiber lay-in panels, fissured, perforated, nondirectional | | | | | | | | | | | | | |
| 7 | 5/8 | .60 | .27 | .30 | .69 | .81 | .70 | .66 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| Mineral fiber lay-in panels, perforated | | | | | | | | | | | | | |
| 7 | 5/8 | .60 to .70 | .28 | .28 | .52 | .87 | .83 | .58 | - | - | 109 | Spintone - pierced pattern | 2,24 |
| Mineral fiber lay-in panels, fissured Firedike | | | | | | | | | | | | | |
| 7 | 5/8 | .60 to .70 | .25 | .26 | .52 | .91 | .87 | .78 | - | - | 109 | Firedike - fissured panels | 2,24 |
| Mineral fiber lay-in panels, fissured and perforated Fireshield nondirectional | | | | | | | | | | | | | |
| 7 | 5/8 | .65 | .30 | .34 | .50 | .84 | .91 | .88 | - | G&H | 128 | Fireshield Solitude Panels | 1,11, 17 |
| Mineral fiber lay-in panels, pierced Firedike | | | | | | | | | | | | | |
| 7 | 5/8 | .60 to .70 | .33 | .35 | .54 | .90 | .81 | .57 | - | - | 109 | Firedike Pierced Panels | 2,24 |
| Mineral fiber lay-in panels, needle perforated pattern | | | | | | | | | | | | | |
| 7 | 5/8 | .65 | .34 | .38 | .65 | .90 | .63 | .55 | - | G&H | 128 | Solitude Panels | 1,11, 17 |
| Mineral fiber lay-in panels, fissured Fireshield pattern | | | | | | | | | | | | | |
| 7 | 5/8 | .70 | .58 | .46 | .59 | .85 | .87 | .84 | - | G&H | 128 | Fire Shield Solitude Panels | 1,11, 17 |
| Mineral fiber lay-in panels, needle perforated pattern. Fireshield | | | | | | | | | | | | | |
| 7 | 5/8 | .70 | .34 | .36 | .71 | .95 | .74 | .65 | - | G&H | 128 | Fireshield Solitude Panels | 1,11, 17 |
| Pin perforated facing | | | | | | | | | | | | | |
| 7 | 5/8 | .80 | .85 | .86 | .64 | .84 | .90 | .89 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| Fissured vinyl facing | | | | | | | | | | | | | |
| 7 | 5/8 | .85 | .61 | .88 | .69 | .90 | .96 | .82 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| Frescor facing | | | | | | | | | | | | | |
| 7 | 5/8 | .85 | .67 | .39 | .68 | .88 | .98 | .81 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |

TABLE 21E CEILINGS (Contd)
(Mineral fiber lay-in panels)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft3 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frescor vinyl facing | | | | | | | | | |
| 7 | 5/8 | .85 | .60 | .85 | .68 | .88 | .92 | .79 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| | | | | Pin Perforated facing | | | | | | | | | |
| 7 | 5/8 | .85 | .63 | .87 | .68 | .88 | .98 | .80 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| | | | | Textured facing | | | | | | | | | |
| 7 | 5/8 | .85 | .63 | .90 | .68 | .90 | .96 | .91 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| | | | | Vinyl, Fissured, 24" x 24" x 5/8" std. size | | | | | | | | | |
| 7 | 5/8 | .85 | .62 | .86 | .70 | .90 | .94 | .80 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| | | | | Vinyl, Textured | | | | | | | | | |
| 7 | 5/8 | .85 | .65 | .88 | .72 | .86 | .93 | .98 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27,28 |
| | | | | Film faced Sono-board, unperforated | | | | | | | | | |
| 7 | 3/4 | .30 | .36 | .31 | .21 | .26 | .46 | .33 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 17,18, 27 |
| | | | | Fissured ATN pattern panels | | | | | | | | | |
| 7 | 3/4 | .70 | .28 | .32 | .66 | .89 | .91 | .97 | - | G&H | 128 | Travacoustic C - Tonico Panels | 1,11, 17 |
| | | | | Mineral fibers blended with a cement like binder; fissured | | | | | | | | | |
| 7 | 3/4 | .70 | .46 | .59 | .54 | .76 | .92 | .93 | - | G&H | 128 | Travacoustic C - Tonico Panels | 1,11, 17 |
| | | | | Mineral fibers blended with a cement like binder; course fissured | | | | | | | | | |
| 7 | 3/4 | .70 | .28 | .30 | .64 | .91 | .90 | .89 | - | G&H | 128 | Travacoustic C - Tonico Panels | 1,11, 17 |
| | | | | Fissured facing. Size 48" x 48" | | | | | | | | | |
| 7 | 1 | .85 | .49 | .79 | .75 | .97 | .98 | .76 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Textured facing. Size 48" x 48" | | | | | | | | | |
| 7 | 1 | .85 | .72 | .70 | .82 | .98 | .94 | .84 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Frescor style facing. Size 48" x 48" | | | | | | | | | |
| 7 | 1 | .85 | .60 | .85 | .73 | .93 | .94 | .79 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Film faced Sonoboard, perforated, size 48" x 48" | | | | | | | | | |
| 7 | 1 | .85 | .69 | .84 | .73 | .92 | .83 | .67 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |

TABLE 21E CEILINGS (Concl)
(Mineral fiber lay-in panels)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Textured pattern glass cloth facing. Sizes 48" x 48" and 48" x 96" | | | | | | | | | |
| 7 | 1 | .90 | .68 | .91 | .75 | .97 | .99 | .96 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Nubby pattern glass cloth facing. Sizes 48" x 48" and 48" x 96" | | | | | | | | | |
| 7 | 1 | .90 | .69 | .95 | .74 | .98 | .99 | .99 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Linear pattern glass cloth facing. Sizes 48" x 48" and 48" x 96" | | | | | | | | | |
| 7 | 1 | .90 | .68 | .93 | .75 | .98 | .99 | .99 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Pin-perforated facing. Size 48" x 48" | | | | | | | | | |
| 7 | 1 | .90 | .61 | .84 | .76 | .97 | .99 | .98 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Unpainted Linear pattern glass cloth facing. Size 48" x 48" and 48" x 96" | | | | | | | | | |
| 7 | 1 | .90 | .69 | .94 | .75 | .98 | .99 | .99 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | White stucco embossed aluminum 0.024" thick and fiberglas pads | | | | | | | | | |
| 7 | 1-1/2 | .95 | .79 | .97 | .87 | 1.02 | 1.05 | .95 | - | - | 15 | Alpro Noise Control Panels | |

TABLE 21F CEILINGS
(Perforated metal panels with mineral fiber pads)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Perforated unpainted main-board with perforated metal face panel | | | | | | | | | |
| 7 | 5/8 | .65 | .44 | .47 | .50 | .77 | .76 | .71 | 1.44 | RAL | 53 | Donn Acoustic Ceiling Panels | 19 |
| | | | | Fireshield acoustic metal panels | | | | | | | | | |
| 7 | 1-9/16 | .85 | .85 | .76 | .82 | .96 | .79 | .69 | - | G&H | 128 | Acousti-metal Panels | 1,11, 17 |
| | | | | Fireshield acoustic metal panels, needlepoint pattern | | | | | | | | | |
| 7 | 1-9/16 | .85 | .91 | .79 | .88 | .99 | .79 | .60 | - | G&H | 128 | Fireshield Acousti-metal Panels | 1,11, 17 |
| | | | | Fireshield acoustic metal panels, square pattern | | | | | | | | | |
| 7 | 1-9/16 | .90 | .81 | .89 | .93 | .99 | .77 | .80 | - | G&H | 128 | Fireshield Acousti-metal Panels | 1,11, 17 |
| | | | | Acoustic metal panels, square pattern | | | | | | | | | |
| 7 | 1-9/16 | .90 | .70 | .97 | .83 | .99 | .91 | .70 | - | G&H | 128 | Acousti-metal panels | 1,11, 17 |
| | | | | Acoustic metal panels, needlepoint pattern | | | | | | | | | |
| 7 | 1-9/16 | .90 | .73 | .93 | .81 | .94 | .82 | .60 | - | G&H | 128 | Acousti-metal panels | 1,11, 17 |
| | | | | Acoustic metal panels, diagonal 1740 | | | | | | | | | |
| 7 | 1-9/16 | .95 | .66 | .95 | .83 | .99 | .99 | .89 | - | G&H | 128 | Acousti-metal panels | 1,11, 17 |
| | | | | Acoustic metal panels, diagonal 1105 | | | | | | | | | |
| 7 | 1-9/16 | .95 | .67 | .96 | .82 | .99 | .93 | .77 | - | G&H | 128 | Acousti-metal panels | 1,11, 17 |
| | | | | Acoustic metal panels, diagonal 1105 with 1/2" gypsum board backing | | | | | | | | | |
| 7 | 2-1/16 | .75 | .23 | .39 | .93 | .99 | .79 | .71 | - | G&H | 128 | Acousti-metal panels | 1,11, 17 |
| | | | | Main tees, paraline panels (.015 steel) rigidized and perforated. 1" fiberglass insulation | | | | | | | | | |
| 7 | 2-1/4 | .75 | .52 | .82 | .56 | .78 | .87 | .85 | 1.09 | RAL | 53 | Paraline Panels | 20 |
| | | | | Main tees, paraline panels (.015 steel) 2" fiberglass insulation | | | | | | | | | |
| 7 | 2-3/4 | .65 | .75 | .83 | .73 | .70 | .40 | .43 | 1.29 | RAL | 53 | Paraline Panels | 20 |
| | | | | Main tees, paraline panels (.015 steel) rigidized and perforated | | | | | | | | | |
| 7 | 2-3/4 | .90 | .67 | .94 | .76 | .94 | .96 | .90 | 1.27 | RAL | 53 | Paraline panels | 20 |

TABLE 21G CEILINGS
(Perforated asbestos cement board panels with mineral fiber pads)

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Absorption Coefficients | | | | | | | | | |
| 5 | 1 | .60 | .09 | Asbestos fiber cement binder with sound absorbent mineral fiber pads .31 | .56 | .93 | .68 | .23 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |
| 5 | 1-3/16 | .55 to .65 | .09 | Asbestos cement lay-in panels .31 | .56 | .93 | .68 | .23 | - | - | 128 | Perforated Transite Panels | 24 |
| 7 | 3/16 | .65 | .52 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Random pattern .80 | .59 | .61 | .55 | .39 | - | G&H | 128 | Asbestibel Panels | 1,11, 17 |
| 7 | 3/16 | .75 | .94 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Uniform pattern .89 | .66 | .72 | .65 | .51 | - | G&H | 128 | Asbestibel Panels | 1,11, 17 |
| 7 | 1 | .60 | .60 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Random pattern .69 | .49 | .64 | .54 | .32 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |
| 7 | 1 | .65 | .75 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Uniform pattern .66 | .67 | .75 | .65 | .44 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |
| 7 | 1-1/2 | .70 | .69 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Random pattern .78 | .65 | .75 | .56 | .35 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |
| 7 | 2 | .80 | .93 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Uniform pattern .81 | .86 | .96 | .65 | .45 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |
| 7 | 2-3/16 | .75 to .85 | .93 | Asbestos cement transite lay-in panels .81 | .86 | .96 | .65 | .45 | - | - | 109 | Perforated Transite Panels | 24 |
| 8 | 2 | .75 | .18 | Asbestos fiber cement binder with sound absorbent mineral fiber pads. Uniform pattern .55 | .98 | .98 | .58 | .44 | - | G&H | 128 | Perforated Asbestos Panels | 1,11, 17 |

TABLE 21H CEILINGS
(Ceiling systems)

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density $lb/ft^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Absorption Coefficients | | | | | | | | | |
| | | | | Reynolds aluminum linear acoustical systems, 6063-T5 alloy aluminum | | | | | | | | | |
| 7 | 1 | - | .41 | .59 | .63 | .65 | .74 | .71 | - | RAL | 146 | Reynolds Acoustical Systems | 21 |
| | | | | Nubby pattern glass cloth facing or Painted Linear glass cloth facing. Sizes 48" x 48" and 48" x 96" | | | | | | | | | |
| 7 | 1 | .90 | .69 | .95 | .74 | .98 | .99 | .99 | - | - | 132 | Mondrian Ceiling System | 2,27 |
| | | | | Reynolds aluminum linear acoustical systems, 6063-T5 alloy aluminum | | | | | | | | | |
| 7 | 1-1/2 | - | .59 | .75 | .74 | .80 | .81 | .80 | - | RAL | 146 | Reynolds Acoustical Systems | 21 |
| | | | | Luxalon with PF 336 glass wool and with a PVC covering on both sides | | | | | | | | | |
| 7 | 1-3/4 | .65 | .49 | .72 | .65 | .79 | .37 | .19 | - | RAL | 100 | Luxalon | 22 |
| | | | | Luxalon aluminum ceiling with 1" 703 duct liner board | | | | | | | | | |
| 7 | 1-3/4 | .70 | .72 | .82 | .72 | .75 | .41 | .29 | .65 | RAL | 100 | Luxalon | 22 |
| | | | | Reynolds aluminum linear acoustical systems 6063-T5 alloy aluminum | | | | | | | | | |
| 7 | 2 | - | .71 | .85 | .84 | .88 | .87 | .87 | - | RAL | 146 | Reynolds Acoustical Systems | 21 |
| | | | | Luxalon aluminum and mineral wool wrapped in 2 mil black PVC | | | | | | | | | |
| 7 | 2 | .70 | .65 | .84 | .76 | .73 | .37 | .20 | .66 | RAL | 100 | Luxalon | 20,22 |
| | | | | Luxalon aluminum and mineral wool insulation with 2 oz black non-woven fabric laminated to one side | | | | | | | | | |
| 7 | 2 | .70 | .64 | .83 | .71 | .77 | .40 | .33 | .66 | RAL | 100 | Luxalon | 20,22 |

TABLE 211 CEILINGS
(Special acoustical panels and units)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1-3/16 | .65 | .22 | .35 | .77 | .94 | .60 | .41 | 1.7 | CT | 109 | Marine Acoustic Unit | 23 |
| 7 | 1-3/16 | .70 | .67 | .72 | .64 | .75 | .63 | .45 | 1.7 | CT | 109 | Marine Acoustic Unit | 23 |
| | | | | Embossed vinyl-faced fiberglass lay-in panel | | | | | | | | | |
| 7 | 1-1/2 | .75 to .85 | .69 | .87 | .77 | .91 | .68 | .49 | - | - | 109 | Spanacoustic Panels | 24 |

TABLE 21J CEILINGS
(Ceiling boards)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Film faced perforated Sonoboard. Sizes 24" x 24", 24" x 48", 24" x 60" | | | | | | | | | |
| 7 | 3/4 | .80 | .94 | .75 | .78 | .89 | .80 | .70 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Frescor pattern facing | | | | | | | | | |
| 7 | 3/4 | .85 | .56 | .88 | .71 | .90 | .96 | .85 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Fissured pattern facing | | | | | | | | | |
| 7 | 3/4 | .85 | .83 | .79 | .75 | .97 | .87 | .58 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Linear pattern glass cloth facing. Sizes 24" x 24", 24" x 48" | | | | | | | | | |
| 7 | 3/4 | .85 | .85 | .84 | .79 | .91 | .93 | .87 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Textured pattern facing | | | | | | | | | |
| 7 | 3/4 | .85 | .76 | .73 | .78 | .92 | .92 | .83 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Nubby pattern glass cloth facing. Sizes 24" x 24" and 24" x 48" | | | | | | | | | |
| 7 | 3/4 | .90 | .89 | .78 | .83 | .97 | .99 | .91 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Pin Perforated pattern facing | | | | | | | | | |
| 7 | 3/4 | .90 | .68 | .89 | .76 | .93 | .99 | .97 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Textured pattern glass cloth facing. Sizes 24" x 24" and 24" x 48" | | | | | | | | | |
| 7 | 3/4 | .95 | .76 | .93 | .83 | .99 | .99 | .94 | - | - | 132 | Fiberglas Acoustical Ceiling Board | 18,27 |
| | | | | Embossed vinyl-faced fiberglas panels | | | | | | | | | |
| 7 | 3/4 | .70 to .80 | .69 | .80 | .71 | .68 | .68 | .43 | - | - | 109 | Spana Coustic Panels | 24 |
| | | | | Paraline main tees and unpainted 5/8" ceiling boards | | | | | | | | | |
| 7 | 1-1/2 | .65 | .36 | .30 | .53 | .83 | .84 | .82 | 1.24 | - | 53 | Paraline Grid System | |
| - | - | - | | 1" rigid polystyrene foam board | | | | | 0.1 to 1.25 | - | 29 | Syrolit | 25,26 |

FOOTNOTES FOR TABLE 21A, 21B, 21C, 21D, 21E, 21F, 21G, 21H, 21I, 21J
CEILINGS

1. Flame spread 20.
2. Flame spread 25.
3. Tenutone - pierced, have a random mixture of large and small perforations.
4. Tenutone - uniform drilled, regular rows of 3/10" diameter drilled holes on 1/2" centers.
5. Used in health and medical facilities, food preparation areas and educational facilities.
6. Used in suspended ceiling installation.
7. Tenutone Random Drilled - random mixture of 3/10" and 1/4" diameter drilled holes.
8. Spintone DCF with small directional controlled fissures and tiny perforations.
9. Spintone 360 with random sized and spaced nondirectional fissures with tiny perforations.
10. Spintone 720 with small uniformly dispersed nondirectional fissures.
11. Temperature range to 150°F, poor resistance to chemicals. Used in ceilings, roofs, partitions, spot acoustical treatment.
12. Tempertone 360 with larger random sized and spaced nondirectional fissures.
13. General purpose tiles.
14. Flame spread 0.
15. Test details available on request.
16. MR Fireshield.
17. Standard for testing: AIMA.
18. Not recommended for high humidity, or more than 140°F temperature or concentrated chemical fumes.
19. Standard for testing ASTM C423-65T.
20. Standard for testing ASTM C423-66.
21. Noncombustible, moisture resistant.
22. Temperature Range: -40° to 140°F, flame spread 5, class A, incombustible.
23. Standard for testing ASTM C-423.
24. Standard procedure for this manufacturer is to report NRC values as a range.
25. Temperature range: -150°F to 190°F, relative humidity 0-100%.
26. Flame spread - self-extinguishing, is attacked by chemical solvents.
27. The manufacturer uses the names or description of the facing pattern to identify his products. The terms Textured, Fissured, Frescor, Pin Perforated, Textured-film faced, Random Perforated, Nubby, Painted Linear, Unpainted Linear, Random Fissured, Stonebrook, Sonoflex, Sonoboard, etc. represent different facing styles. For further information about these facing styles contact the manufacturer.
28. Standard available sizes are 24" x 24", 24" x 48", and 24" x 60".

TABLE 22
PARTITIONS (ABSORPTION)

Sound absorption coefficients for the partitions used to divide a room either temporarily or semipermanently (demountable partitions made from panels and held in place by moldings are termed semipermanent type partitions) are listed. Partitions, as opposed to curtains, are rigid and are "less easily movable". They are available in a variety of sizes, shapes, and colors. The sound absorption of the screen type partitions can significantly improve the acoustic environment of an "open" office space where many people are working in a large room. Figure 22 shows one such partition which can be easily moved to a desired place to divide a work space, provide sound absorption, and reduce interference caused by noise. Partitions and curtains as sound barrier systems are listed in Tables 36, 37 and 38. The companies (by numbers shown in Section II) with products listed in Table 22 are: 53, 62, 116.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

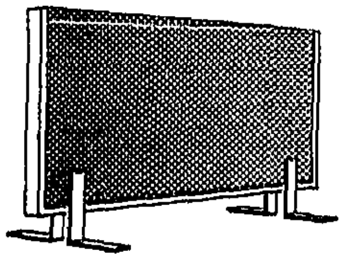



Figure 22 One of the Many Types of Decorative Partitions Used for Sound Control

GLOSSARY

**Facing:** The outside surface of the specimen. In general, the side facing the sound source

**Backing:** The other outside surface of the specimen. In general the side not facing the sound source

**Core:** The region between the facing and the backing

TABLE 22 PARTITIONS (ABSORPTION)

| Mounting | Thickness (inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Type B divider panels held in place with "H" or "U" type moldings, 2" rigid fiberglass core with 1/8" facing & backing of glass fiber | | | | | | | | | |
| 2 | 2-1/4 | .85 | .57 | .98 | .92 | .76 | .71 | .78 | 1.25 | OCRL 35261-2 | 116 | Vicracoustic "Alpha" Screens | 3 |
| | | | | Type B divider panels held in place with "H" or "U" type moldings, 2" rigid fiberglass core with 1/8" facing & backing of glass fiber | | | | | | | | | |
| 4 | 2-1/4 | .85 | .47 | .95 | .89 | .77 | .75 | .76 | 1.25 | - | 116 | Vicracoustic "Alpha" Screens | 3 |
| | | | | 20-gage galvanized steel backing, perforated type B panels, 18-gage facing, insulation bolt (1"x12"x96") core of glass fiber sealed in polyethylene bags | | | | | | | | | |
| 4 | 2-1/2 | .85 | .30 | .70 | 1.04 | 1.02 | .74 | .41 | 4.50 | RAL A72-72 | 62 | Channel Wall & B-Liner Wall System | 1 |
| | | | | Shadowall, backing of 20-gage galvanized steel, facing of galvanized perforated type "C" panel (each 12"x96"), and fiberglass insulation (4.2 lb/ft³) 1/2" thick core | | | | | | | | | |
| 4 | 3-1/4 | .90 | .37 | .67 | 1.08 | 1.03 | .91 | .71 | 6.1 | RAL A70-145 | 62 | Shado Wall & C-Liner Wall System | 1 |
| | | | | Perforated metal panels with glass fiber insulation & crusader studs | | | | | | | | | |
| 7 | 3 | .80 | .34 | .39 | .76 | 1.08 | .96 | .83 | 5.59 | RAL A68-191 | 53 | Acousta Wall | 2 |
| | | | | Channel wall, backing of .032" aluminum, facing of galvanized perforated type "C" panels - 18-gage insulation bolt (1/2"x12"x96") core of glass fiber sealed in polyethylene bags | | | | | | | | | |
| - | 3-1/4 | .90 | .32 | .81 | 1.03 | .97 | .80 | .44 | 3.7 | RAL A72-70 | 62 | Channel & C-Liner Wall System | 1 |

FOOTNOTES FOR TABLE 22
PARTITIONS (ABSORPTION)

1. Test specimen size: 8' x 9', tested and evaluated according to ASTM C 423-66.
2. Tested and evaluated according to ASTM C 423-66. Test specimen made from 3 panels 30" x 96" and 1 panel 18" x 96". Surface of each panel was perforated by 1/6" holes 7/16" on center.
3. For indoor use. Flame spread: Class B. Excellent resistance to stain. Tested and evaluated according to ASTM C 423-66. For further information, see Table 20.

## TABLE 23

## CURTAINS (ABSORPTION)

Sound absorption coefficients of various products manufactured as curtains, or which can be directly used as curtains with minor modifications necessary to drape the product are listed. Sound absorption of the curtain is dependent upon the curtain material, surface texture, the backing material or medium, and the manner in which the curtain is hung. Varying the distance of the curtain from the wall or changing the test angle can change the absorption coefficients as can be seen from the table. The curtain absorption coefficients are also changed considerably when the curtain covers a different percentage of its maximum possible coverage. This is also seen in the table. The companies (by numbers shown in Section II) with products listed in Table 23 are: 3, 95, 155, 188, 192.

> CAUTION
>
> 1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
> 2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

## GLOSSARY

**Facing:** The outside surface of the specimen. In general the side facing the sound source

**Backing:** The other outside surface of the specimen. In general the side not facing the sound source

**Core:** The region between the facing and the backing

TABLE 23 CURTAINS (ABSORPTION)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | single-layer fiber polyester supplied in 70" wide rolls, used as sound-absorbing curtains, room dividers, panels, or barriers; tested 30" from wall. | | | | | | | | | |
| - | .03 | .65 | .42 | .43 | .64 | .75 | .86 | .93 | .12 | RAL A73-26 | 188 | Westex FIL-44 | 1 |
| | | | | single-layer fiber polyester supplied in 70" wide rolls; tested 6" from wall. | | | | | | | | | |
| - | .03 | .70 | .17 | .46 | .63 | .80 | .76 | .78 | .12 | RAL A73-22 | 188 | Westex FIL-44 | 1 |
| | | | | single-layered polyester fiber used for sound damping; tested 30" from wall | | | | | | | | | |
| - | .04 | .39 | .28 | .22 | .34 | .45 | .55 | .71 | .04 | RAL A73-32 | 188 | Westex FIL-9.4 | |
| | | | | single-layered polyester fiber used for sound damping; tested 6" from wall | | | | | | | | | |
| - | .04 | .45 | .02 | .22 | .50 | .50 | .52 | .65 | .04 | RAL A73-33 | 188 | Westex FIL-9.4 | |
| | | | | double-layer fiber polyester supplied in 70" wide rolls; tested 6" off wall | | | | | | | | | |
| - | .06 | .95 | .29 | .64 | 1.06 | 1.03 | 1.10 | 1.12 | .22 | RAL A73-24 | 188 | Westex FIL-44 | 1 |
| | | | | double-layer fiber polyester supplied in 70" wide rolls; tested 30" off wall | | | | | | | | | |
| - | .06 | .95 | .63 | .62 | .86 | 1.09 | 1.28 | 1.38 | .22 | RAL A73-25 | 188 | Westex FIL-44 | 1 |
| | | | | double-layer fiber polyester supplied in 70" wide rolls; tested @ 60° to 70° | | | | | | | | | |
| - | .06 | .95 | .29 | .71 | 1.10 | 1.27 | 1.50 | 1.66 | .22 | RAL A73-23 | 188 | Westex FIL-44 | 1 |
| | | | | double-layered polyester fiber used for sound damping | | | | | | | | | |
| 4 | .08 | .15 | .02 | .05 | .07 | .17 | .36 | .62 | .08 | RAL A73-37 | 188 | Westex FIL-9.4 | |
| | | | | double-layered polyester fibre used for sound damping; tested @ 30° | | | | | | | | | |
| - | .08 | .65 | .45 | .41 | .59 | .72 | .89 | 1.02 | .08 | RAL A73-35 | 188 | Westex FIL-9.4 | |

TABLE 23 CURTAINS (ABSORPTION) (Contd)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | double-layered polyester fibre used for sound damping; tested 6" from wall | | | | | | | | | |
| - | .08 | .69 | .10 | .37 | .77 | .80 | .82 | .95 | .08 | RAL A73-34 | 188 | Westex FIL-9.4 | |
| | | | | single-layer nomex fiber supplied in 72" wide rolls used as a sound-absorbing curtain; tested 30" from wall | | | | | | | | | |
| - | .08 | .69 | .40 | .40 | .62 | .80 | .93 | 1.10 | .097 | RAL A73-27 | 188 | Westex FIL-95 | 2 |
| | | | | double-layered polyester fiber used for sound damping; tested @ 60" | | | | | | | | | |
| - | .08 | .73 | .36 | .49 | .67 | .79 | .97 | 1.13 | .08 | RAL A73-36 | 188 | Westex FIL-9.4 | |
| | | | | single-layer nomex fiber supplied in 72" wide rolls; tested 6" from wall | | | | | | | | | |
| - | .08 | .75 | .15 | .42 | .83 | .85 | .89 | .99 | .097 | RAL A73-28 | 188 | Westex FIL-95 | 2 |
| | | | | double-layer nomex fiber supplied in 72" wide rolls | | | | | | | | | |
| 4 | .16 | .32 | .04 | .05 | .14 | .37 | .73 | 1.03 | .194 | RAL A73-38 | 188 | Westex FIL-95 | 2 |
| | | | | double-layer nomex fiber supplied in 72" wide rolls; tested 6" from wall | | | | | | | | | |
| - | .16 | .95 | .23 | .62 | 1.01 | 1.02 | 1.12 | 1.26 | .194 | RAL A73-29 | 188 | Westex FIL-95 | 2 |
| | | | | double-layer nomex fiber supplied in 72" wide rolls; tested 30" from wall | | | | | | | | | |
| - | .16 | .95 | .53 | .57 | .82 | 1.05 | 1.30 | 1.53 | .194 | RAL A73-30 | 188 | Westex FIL-95 | 2 |
| | | | | double-layer nomex fiber supplied in 72" wide rolls; tested 60" from wall | | | | | | | | | |
| - | .16 | .95 | .26 | .65 | .97 | 1.21 | 1.50 | 1.80 | .194 | RAL A73-31 | 188 | Westex FIL-95 | 2 |

TABLE 23 CURTAINS (ABSORPTION) (Contd)

| Mounting | Thickness (Inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | single-layer fiber polyester supplied in 72" wide 12 yard long rolls. Used for sound damping. | | | | | | | | | |
| 4 | .75 | .64 | .03 | .13 | .44 | .86 | 1.12 | 1.18 | .71 | RAL A73-20 | 188 | Westex FIL-28 | 3 |
| | | | | single-layer fiber polyester used as sound damping | | | | | | | | | |
| 4 | 1 | .80 | .08 | .26 | .73 | 1.08 | 1.22 | 1.17 | .94 | RAL A73-18 | 188 | Westex FIL-281 | 3<br>4 |
| | | | | Sound Absorbing Draperies | | | | | | | | | |
| - | 1 | .85 | .11 | .48 | 1.04 | .90 | .89 | .97 | .15 | RAL A69-60 | 155 | Foam Curtain | 6,9 |
| | | | | double-layer fiber polyester supplied in 72" wide, 12 yd. long rolls used for sound damping | | | | | | | | | |
| - | 1.5 | .95 | .19 | .55 | 1.06 | 1.27 | 1.28 | 1.20 | .71 | RAL A73-21 | 188 | Westex FIL-28 | 3 |
| | | | | 48" wide by 60" high facing & backing of angus burlap with 1/2" incombustible mineral board fiber; core of fibrous glass acoustic blanket. Used as room dividers | | | | | | | | | |
| - | 2 | .65 | .31 | .59 | .83 | .83 | .73 | .57 | .49 | RAL A71-142 | 192 | Workwall Divider Screen | 5 |
| | | | | double-layer polyester fibre used for sound damping | | | | | | | | | |
| 4 | 2 | .95 | .36 | .83 | 1.21 | 1.29 | 1.28 | 1.23 | 1.86 | RAL A73-19 | 188 | Westex FIL-281 | 3<br>4 |
| | | | | 68" wide by 67" wide fabric facing & backing with 2 layers of fibrous glass acoustic blanket as core. Used as room dividers. | | | | | | | | | |
| - | 3 | .80 | .31 | .56 | .87 | .90 | .91 | .85 | 3.35 | RAL A72-218 | 192 | Workwall Acoustic Dividers | 5 |
| | | | | Sound Absorbing Draperies Stretched flat. | | | | | | | | | |
| - | - | .45 | .04 | .26 | .55 | .54 | .48 | .51 | - | G&H | 3 | Acoustidrape | 6,7 |
| | | | | Sound Absorbing Draperies fully draped. | | | | | | | | | |
| - | - | .65 | .10 | .49 | .69 | .73 | .68 | .71 | - | G&H | 3 | Acoustidrape | 6,8 |
| | | | | 72 sq ft facing of perforated fabric, foil-backed fiberglas insulation core, 24-gage steel slots & membrane backing | | | | | | | | | |
| - | - | - | .64 | .61 | .70 | .72 | .98 | 1.03 | 4.8 | RAL A71-37 | 95 | Foldoor X12-NRC | 5 |

FOOTNOTES FOR TABLE 23

CURTAINS (ABSORPTION)

1. Sticks at 455°F, can be flameproofed, disintegrated by 96% hydrochloric acid & boiling alkalies.
2. Decomposes at 700°F, does not melt.
3. Temperature Range to 300°F, melts at 482°F, can be flameproofed.
4. Excellent resistance to bleaches, oxidizing agents.
5. Meets ASTM C423-66.
6. Tested and evaluated according to ASTM C423-66. Flameproof.
7. Special mounting used to simulate a stretched flat hung curtain.
8. Special mounting used to simulate a draped 100% fullness curtain.
9. Hung on wall with 2 inch space between wall and specimen.

TABLE 24
FLOOR COVERINGS (ABSORPTION)

A few products which are used as floor coverings are listed. The small number of products listed may cause some surprise because a floor covering is usually a very important sound absorbing surface in a room. In residential applications floor coverings may play a dominant role in determining the acoustical characteristic of a room. In industrial applications, however, floors are seldom used as the primary sound absorbing surface. Ceilings are usually treated first and additional absorption is obtained through wall coverings and sound absorbing units of the types listed in Table 19. This may account for the fact that a very few floor covering products are listed in Table 24. Additional information of a generic nature about carpets and their acoustical properties is provided in Section I-5.1.4. Carpets are also very effective in reducing the sounds generated by objects dropped on floors, footsteps, etc. This aspect of their sound control potential can be verified by studying Tables 30 and 31. The companies (by numbers shown in Section II) with products listed in Table 24 are: 12, 30, 34.

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

TABLE 24 FLOOR COVERINGS (ABSORPTION)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Woven fiber surface, sizes as required; available in rolls or die-cut patterns. | | | | | | | | | |
| 4 | 1/2 | .35 | .04 | .10 | .23 | .43 | .59 | .70 | .22 | RAL A72-183 | 34 | Bonded "E-5" Fiber Padding | |
| | | | | Carpet for heavy traffic area on a 3/16" sponge rubber pad. | | | | | | | | | |
| 4 | - | .50 | .19 | .46 | .46 | .46 | .48 | .58 | - | KAL 1466-1-73 | 30 | Years Ahead | |
| - | - | - | | Supported vinyl bonded to 1/4" Polycor foam bonded to .10" thick dead rubber acoustic mass. | | | | | - | - | 12 | Floortite Acoustic Matting #122 | |
| - | - | - | | 2 layers of .10" thick dead rubber acoustic mass separated by 1/4" thick foam; one side is protected from wear by vinyl. | | | | | - | - | 12 | Floortite Acoustic Matting #125 | |

TABLE 25

ROOF DECKS (ABSORPTION)

Roof decks and their sound absorption properties are listed. Sound absorption is achieved by placing sound absorbing pads behind perforated metal channels or by using a sound absorbent panel. Figure 25A shows a roof deck panel made from wood fibers, and cement. Figure 25B shows another type of roof deck where the sound absorptive fiberglass batts are laid inside the perforated channels to provide sound absorption. Roof decks may be used in relatively large office rooms, churches, schools, etc., and the additional sound absorption provided by these special acoustical designs helps reduce the reverberation time of the rooms. Roof decks are also noise barriers, and the transmission losses of some of the roof decks are shown in Table 35. The companies (by numbers shown in Section II) with products listed in Table 25 are: 13, 43, 56, 106, 120, 144, 190.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11.

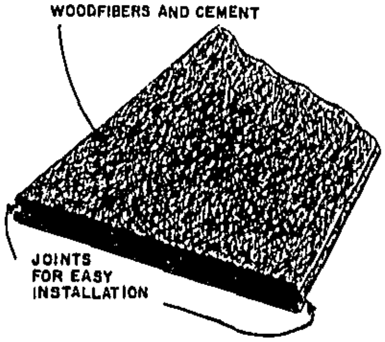



Figure 25A Roof Deck Panel for Sound Absorption

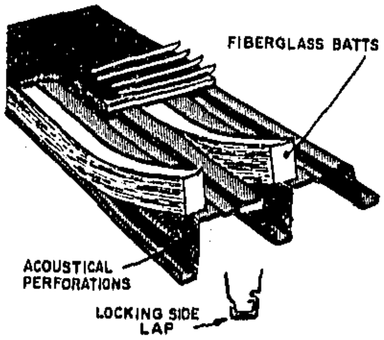



Figure 25B Acoustical Roof Deck Panel with Perforated Facing and Fiberglass Core

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Roof Deck: A platform or a surface covering the structural framework to form a roof

Reverberation Time: Defined as the time required for the sound pressure level of a room to decay 60 decibels, this quantity is an indirect measure of the total sound absorption provided by the room.

TABLE 25 ROOF DECKS (ABSORPTION)

| Mounting | Thickness (Inches) | NRC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Perlite concrete roof slabs with cement base paint. | | | | | | | | | | |
| 4 | 3 | .75 | .17 | .50 | .99 | .69 | .82 | .80 | 10.3 | RAL A59-70 | 56 | Perlite | 6,17 |
| | | | 3" thick porex panels with built-up roofing 32" wide panels. Thickness - 1-1/2", 2-1/2", and 3". NRC range .55 to .85; weight shown in the table is on porex only. | | | | | | | | | | |
| 4 | 3 | .80 | .34 | .40 | .99 | .91 | .92 | .87 | 7.46 | RAL A66-48 | 43 | Permadeck | 1,7,17 |
| | | | For steel roof decking sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 3 | .90 | .43 | .82 | 1.15 | .95 | .71 | .56 | 7.99 | RAL A70-83 | 106 | Inland Ryerson type 3" NF | 4,10 |
| | | | Type 4-1/2" H Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. Backed with 1-7/8" thick Owens Corning Fiberglass, rigid roof installation. | | | | | | | | | | |
| 4 | 4-1/2 | .80 | .69 | .97 | 1.00 | .73 | .40 | .32 | 5.9 | RAL A70-72 | 106 | 4-1/2" H Panel | 4,11 |
| | | | Type 3" H Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 5 | .90 | .73 | 1.13 | 1.06 | .89 | .52 | .31 | 3.97 | RAL A70-21 | 106 | 5" N Type Acoustideck | 4,12 |
| | | | Type 4-1/2" HF Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 5-1/2 | .95 | .65 | 1.08 | 1.14 | .99 | .79 | .61 | 6.5 | RAL A70-23 | 106 | Type HF Acoustideck | 4,13 |
| | | | Type 6" H Acoustideck. For steel roof decking, sizes 6' to 45. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 6 | .85 | .83 | 1.16 | 1.06 | .68 | .49 | .46 | 6.17 | RAL A70-22 | 106 | Type GH Acoustideck | 4,14 |
| | | | Type 6" HF Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 6 | .95 | .68 | 1.13 | 1.11 | .95 | .78 | .58 | 7.38 | RAL A70-81 | 106 | Type 6 HF Acoustideck | 4,13 |
| | | | Type 7-1/2" H Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | | |
| 4 | 7-1/2 | .80 | .79 | 1.02 | .82 | .66 | .61 | .61 | 6.33 | RAL A70-82 | 106 | Type 7.5 H Acoustideck | 4,15 |

TABLE 25 ROOF DECKS (ABSORPTION)(Contd)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Type 7-1/2" HF Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire entire installation. | | | | | | | | | |
| 4 | 7-1/2 | .95 | .91 | 1.23 | 1.07 | 1.00 | .79 | .64 | 7.55 | RAL A70-24 | 106 | Type 7.5 HF Acoustideck | 4,13 |
| | | | | Perforated on web side with 1-1/2" deep ribs. | | | | | | | | | |
| 4 | - | .75 | .26 | .64 | .93 | .88 | .51 | .29 | - | RAL A62-42 | 13 | Quiet Deck Bowman Type B | 6 |
| | | | | Steel roof decking 6' to 30'. | | | | | | | | | |
| - | 1-1/2 | .70 | .19 | .76 | 1.02 | .73 | .37 | .21 | 2.5 | RAL A70-105 | 106 | Type B Acoustideck | 4,9 |
| | | | | Manufactured in 30" width, furnished with die set ends. Rib openings accommodate 1" thick insulation. | | | | | | | | | |
| - | 1-1/2 | .75 | .26 | .64 | .93 | .88 | .51 | .29 | - | RAL A72-102 A72-105 | 144 | B Quiet Deck | 2,6 |
| | | | | 1" rigid insulation. Steel roof decking 6' to 30'. | | | | | | | | | |
| - | 1-1/2 | .80 | .19 | .69 | 1.12 | .88 | .52 | .27 | 2.5 | RAL A70-104 | 106 | Type S Acoustideck | 4,9 |
| | | | | 1-7/8" rigid insulation. Steel roof decking 6' to 30'. | | | | | | | | | |
| - | 1-1/2 | .85 | .47 | 1.01 | 1.01 | .90 | .53 | .24 | 2.5 | RAL A70-103 | 106 | Type S Acoustideck | 4,9 |
| | | | | For steel roof decking sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | |
| - | 1-5/8 | .70 | .37 | .49 | .68 | .98 | .58 | .39 | 5.9 | RAL A70-123 | 106 | Inland-Ryerson Type 1-5/8" NF | 4,9 |
| | | | | Insulating, acoustical roof deck. Thickness - 1-1/2", 2-1/2", and 3". NRC range .55 to .85 weight shown in the table is on porex only. | | | | | | | | | |
| - | 2 | .65 | .14 | .25 | .56 | .99 | .71 | .84 | 5.13 | RAL A66-114 | 43 | Permadeck | 1,7,17 |
| | | | | Type 3" H Acoustideck. For steel roof decking, sizes 6' to 45'. Weight shown is for the entire installation. | | | | | | | | | |
| - | 3 | .75 | .60 | .90 | .95 | .78 | .34 | .22 | 6.33 | - | 106 | 3" H Panel | 8 |
| - | 3 | | | Acoustically-treated ribs. | | | | | - | RAL A72-102 A72-105 | 144 | "N" Quiet deck | |

TABLE 25 ROOF DECKS (ABSORPTION) (Concl)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | 3 | - | Insulating, acoustical roof deck. Thickness - 1-1/2", 2-1/2", and 3". NRC range .55 to .85; weight shown in the table is on porex only. | | | | | | - | RAL A66-22 | 43 | Permadeck | 1,16 |
| - | 3-1/4 | .80 | Thickness - 1-1/2", 2-1/2", and 3". NRC range .55 to .85; weight shown in the table is on porex only. | | | | | | | | | | |
| | | | .37 | .50 | .94 | .85 | .92 | .85 | 7.46 | RAL A66-55 | 43 | Permadeck | 1,6,16 |
| - | - | .50 | Steel deck system with 12" cover width. | | | | | | - | RAL A69-47 | 13 | Acoustideck panels CA-3 | |
| - | - | .60 | Steel deck system with 12" cover width. | | | | | | - | RAL A69-61 | 13 | Acoustideck Panels CA-4.5 | |
| - | - | .70 | Sizes 30" wide, up to 42' long. Assembly backed with 1" thick rigid board insulation of 1.5 lb/ft². | | | | | | | | | | |
| | | | .41 | .57 | .82 | .95 | .39 | .24 | - | RAL A62-200 | 190 | Wheeling Painted Acoustic Metal Deck | 6,17 |
| - | - | .75 | BA - 24" cover width; B3A - 30" cover width. | | | | | | - | RAL A63-49 | 13 | Acoustideck BA and B3A | 3 |
| - | - | .75 | Steel deck system with 24" cover width. | | | | | | - | RAL A62-118 | 13 | Acoustideck Panel 2CFA-3 | |
| - | - | .75 | Sizes 30" wide, up to 42' long. Galvanized metal deck with 1" thick glass fiber roof insulation. | | | | | | | | | | |
| | | | .48 | .87 | .99 | .81 | .36 | .27 | 1 | RAL A62-197 | 190 | Wheeling Galvanized Acoustic Metal Deck | 6,17 |
| - | - | .85 | Steel deck system with 24" cover width | | | | | | - | RAL A68-175 | 13 | Acoustideck 2CFA | |
| - | - | - | Precast textured slabs of wood fibers pressure bonded with portland cement | | | | | | - | - | 120 | Fibroplank roof Deck panels | 8,16 |

## FOOTNOTES FOR TABLE 25

### ROOF DECKS (ABSORPTION)

1. Temperature range; below zero to 180°F. Flame spread: 20.
2. Sound absorbing elements are inert mineral fibered materials which fit in the spaces between vertical perforated webs of the deck.
3. BA and B3A decks feature a button punchable side lap joint.
4. Tested and evaluated according to ASTM C423-66.
5. Tested and evaluated according to ASTM C423-58T.(Tentative method preceding approval of ASTM C423-58).
6. Tested and evaluated according to ASTM C423-60T.
7. Extrapolated from Riverbank Acoustical Laboratory tests A70-72 and A70-22.
8. Thickness range 2" to 4". 32" wide with lengths upto 12'6" weight range from 6 to 10 lbs/sq.ft. Average NRC ranges from 0.60 for 2" thick plank to 0.90 for 4" thick plank.
9. Deck has cells 1-1/2" deep by 1-7/8" wide on 6" centers perforated with 5/32" holes on 3/8" staggered centers, filled with an insulation batt 2-1/4" by 1-1/2".
10. Deck has cells 8" on center perforated with 5/32" holes on 3/8" staggered centers, filled with an insulation batt 4-3/4" by 2-1/2".
11. Deck has ribs 12" on center perforated with 5/32" holes on 3/8" staggered centers, filled with an insulation batt 3-1/4" by 2-1/2".
12. Same as 11 but with batt 3" by 2-1/2".
13. Same as 12 but with batt 8" by 2-1/2".
14. Deck has ribs 3-1/8" wide by 6" deep on 12" centers perforated with 5/32" holes on 3/8" staggered centers, filled with an insulation batt 5" by 2-1/2".
15. Same as 12 but with ribs 3-1/8" wide by 7-1/2" deep, filled with an insulation batt 6-1/4" by 2-1/2".
16. Similar to Figure 25A but not necessarily with wood fibers.
17. Deck has 2-1/8" wide by 1-1/2" deep ribs spaced on 6" centers, perforated with 5/32" holes on 3/8" staggered centers, filled with rigid insulation 2-1/2" by 1-1/2".

## TABLE 26
## PREFABRICATED QUIET ROOMS

Quiet rooms and their noise reduction and sound absorption characteristics are listed. Quiet rooms are defined here as rooms where the undesired sound is outside the room and a desired quiet environment is maintained inside the room. This is opposite of enclosures in which case the undesired sound is inside the structure and a quiet environment outside the enclosure is the goal. Table 26 is subdivided according to the available information. Table 26A shows noise reduction. Table 26B shows sound absorption coefficients of the inside walls or panels of the quiet room, and Table 26C lists the room or booth for which the acoustic information was not available.

Quiet rooms are installed to fulfill various functions. They can provide a quieter environment for a worker in a noisy factory, they can provide suitable space for audiometric testing or music recording sessions, etc. and their simplest forms as booths, can provide adequate relief from noise to make telephone calls. Figures 26A and 26B show two types of quiet rooms. Figure 26A shows a room with good visibility and adequate sound isolation and Figure 26B shows an autiometric booth with good sound isolation and adequate visibility. The companies (by numbers shown in Section II) with products listed in Table 26 are: 4, 9, 59, 82, 92, 104, 111, 119, 139, 142, 157, 164, 168, 187.

**CAUTION**

1. VALUES PRESENTED IN TABLE 26A ARE NOISE REDUCTIONS AND NOT TRANSMISSION LOSSES. SEE SECTION I-3.6 FOR EXPLANATION OF DIFFERENCE.
2. NOISE REDUCTION DATA ARE SOMETIMES OBTAINED BY COMPUTATIONS BASED ON DATA FOR INDIVIDUAL PANELS WHICH ARE USED TO CONSTRUCT THE ROOM. ALSO, SPECIAL CUSTOMER OPTIONS (WINDOWS, VENTS, ETC.) MAY AFFECT THE PERFORMANCE OF A ROOM.
3. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN IN TABLE 26B REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED IN SECTION I-3.1.3 AND ILLUSTRATED IN FIGURE I-11. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE SECTION I-3.1.2.

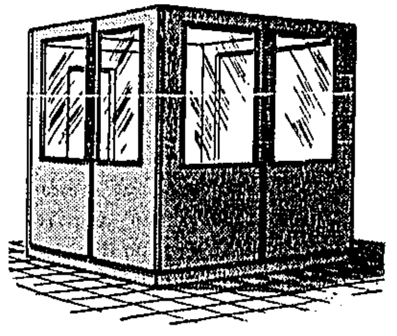



Figure 26A  Quiet Room with Good Visibility for In-Plant Use

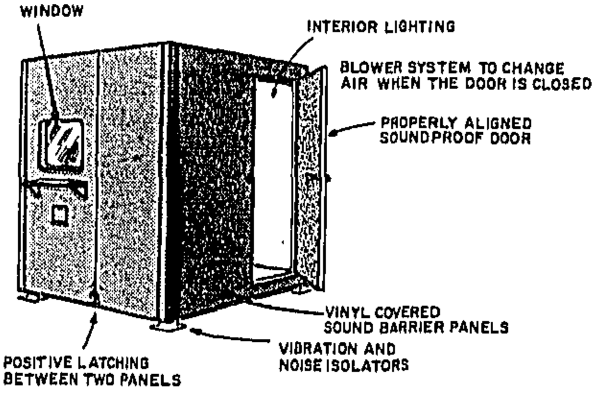



Figure 26B  Portable Audiometric Test Room

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Anechoic: Echo free

Anechoic Wedges: Wedge-shaped sound absorbing units commonly used to create a free-field type environment

## TABLE 26A PREFABRICATED QUIET ROOMS (NOISE REDUCTION)

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Noise Reduction (decibels) | | | | | | | | | | | | | | | | | | | | |
| | | | | | Portable building. Sizes from 4' x 3' to 12' x 24'. | | | | | | | | | | | | | | | | | |
| - | - | 12 | | | 18 | | | 22 | | | 27 | | | 28 | | | 30 | - | AN | 164 | Model 810 | 3 |
| | | | | | 2" thickness. Inside dimensions: 80" x 80" x 84"; Outside dimensions: 84" x 84" x 89". | | | | | | | | | | | | | | | | | |
| - | - | 16 | | | 24 | | | 25 | | | 29 | | | 34 | | | 37 | - | - | 111 | Noiseguard portable office enclosures | 9 |
| | | | | | 4" thickness. Inside dimensions: 76" x 76" x 84"; Outside dimensions: 84" x 84" x 91". | | | | | | | | | | | | | | | | | |
| - | - | 27 | | | 36 | | | 45 | | | 50 | | | 55 | | | 59 | - | - | 111 | Noiseguard portable office enclosures | 9 |
| | | | | | Size: 6'9" x 7'6" x 7'9". Other sizes available. | | | | | | | | | | | | | | | | | |
| - | - | 23 | | | 30 | | | 38 | | | 44 | | | 45 | | | 47 | - | KAL 1270-3-71 | 104 | Type R all purpose room | 4 |
| | | | | | Outside dimensions: 108" x 116" x 86"; Inside dimensions: 104" x 112" x 82". | | | | | | | | | | | | | | | | | |
| - | - | | 28 | | 35 | | 44 | | 50 | | 59 | | 62 | | 63 | | | - | RAL NR62-15 | 104 | 4" thick sound isolation room | 7 |
| | | | | | Four models available: AUD 1 (61.25 ft³) AUD 2 (85.75 ft³) AUD 3 (236.4 ft³) AUD 4 (376.4 ft³) | | | | | | | | | | | | | | | | | |
| - | - | | 30 | | 39 | | 48 | | 53 | | 57 | | 62 | | 55 | | 35 | - | - | 111 | Noiseguard Audiometric Rooms | 10 |
| | | | | | 2" thick panels are made up of 16 ga. cold rolled steel. Exterior dimensions: length, 52"; width, 48"; height, 99". Interior dimensions: length, 44"; width, 48"; height, 96". | | | | | | | | | | | | | | | | | |
| - | - | 36 | | | 42 | | | 45 | | | 57 | | | 67 | | | 70 | - | - | 157 | Audiometric Testing Booth | |
| | | | | | Outside: 83" x 113" x 94-1/2"; Inside: 75" x 105" x 87". | | | | | | | | | | | | | | | | | |
| - | - | 35 | 34 | 45 | 56 | 61 | 65 | 70 | 78 | 83 | 85 | 83 | 89 | 93 | 96 | 97 | 94 | - | RAL NR72-17 | 187 | Sound Module | 8 |
| | | | | | Hearing test booth Inside: 4'0" x 3'7" x 6'6"; Outside: 4'5" x 4'0" x 7'6". | | | | | | | | | | | | | | | | | |
| - | - | 22 | 19 | 25 | 29 | 32 | 36 | 40 | 45 | 47 | 50 | 54 | 57 | 58 | 58 | 60 | 60 | - | RAL | 142 | Sound shield rooms series 258, class 4 | 2 |
| | | | | | 32" x 40" x 62". 2" thick walls floor and ceiling | | | | | | | | | | | | | | | | | |
| - | - | 15 | 23 | 27 | 30 | 31 | 34 | 36 | 38 | 41 | 41 | 45 | 46 | 47 | 48 | 48 | 49 | - | RAL NR71-7 | 59 | Eckoustic Audiometric Booths | 1 |

TABLE 26A PREFABRICATED QUIET ROOMS (NOISE REDUCTION) (Contd)

| Thickness (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Music practice room: Inside: 6'3" x 8'9" x 7'2"; Outside: 6'11" x 9'5" x 7'10" Noise reduction inside to outside | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 20 | 24 | 28 | 30 | 34 | 37 | 41 | 43 | 45 | 48 | 50 | 50 | 51 | 50 | 51 | 51 | - | RAL NR72-26 | 142 | Sound Shield Rooms, series 800 Model 802, class 3 | 2 |
| Examination booth: Outside: 38" x 28" x 76", 4" thick; Inside: 34" x 24" x 66", 4" thick; Wall made of galvanized sheet steel with zinc alloy outer surface, 22 ga cold rolled steel inner surface. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 20 | | | 21 | | | 38 | | | 44 | | | 51 | | | 52 | - | RAL | 168 | RE-120 | 5 |
| Examination booth: Outside: 42" x 38" x 70", 4" thick Inside: 38" x 32" x 60", 4" thick Wall made of galvanized sheet steel with zinc alloy outer surface, 22 ga cold rolled steel inner surface. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 20 | | | 31 | | | 38 | | | 44 | | | 51 | | | 52 | - | RAL | 168 | RE-100 | 5 |
| Single wall room | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 28 | | | 31 | | | 38 | | | 44 | | | 46 | | | 47 | - | - | 9 | Sound Proof Rooms | |
| Sound shield panel system: Panels range from 24" x 48" to 48" x 144", 2-1/2" or 4" thick | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 22 | | | 33 | | | 45 | | | 56 | | | 60 | | | 62 | - | RAL | 142 | Sound Shield Rooms series 900H | 2 |
| Outside: 4'0" x 3'8" x 91"; Inside: 3'4" x 3'0" x 78" H | | | | | | | | | | | | | | | | | | | | | | |
| - | - | [28] | | | [35] | | | [44] | | | [50] | | | [59] | | | [62] | - | RAL NR62-9 | 104 | #4 Audiometric Test Room | 6,11 |
| Single-wall medical examination rooms. Galvanized sheet steel with zinc alloy outer surface and 22 ga cold rolled steel inner surface. Twenty-three standard sizes. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 24 | 23 | 28 | 31 | 34 | 39 | 44 | 46 | 48 | 52 | 55 | 57 | 58 | 60 | 59 | 59 | - | RAL | 168 | Series RE-140, RE-240, RS-240, RS-250: Single Wall | 5 |
| Single-wall rooms have outside dimensions from 3'0" x 3'8" x 7'4" to 10'0" x 10'0" x 7'4". | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 34 | 29 | 33 | 36 | 40 | 43 | 48 | 54 | 56 | 57 | 61 | 63 | 64 | 65 | 65 | 66 | - | RAL | 142 | Sound Shield Rooms Series 100 Class 2 | 2 |
| Sound Shield Panel System: panels range from 24" x 48" to 48" x 144", 2-1/2" or 4" thick. Includes special fasteners for interlocking panels. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 32 | | | 36 | | | 46 | | | 58 | | | 64 | | | 66 | - | RAL | 142 | Sound Shield Rooms Series 900C | 2 |

TABLE 26A PREFABRICATED QUIET ROOMS (NOISE REDUCTION) (Concl)

| Thickness (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Double-wall room | | | | | | | | | | | | | | | | | | | | |
| - | - | 38 | | | 52 | | | 60 | | | 62 | | | 62 | | | 62 | - | - | 9 | Sound Proof Rooms | |
| | | Music practice room: Inside: 6'3" x 8'9" x 7'2"; Outside: 4'11" x 9'5" x 7'10". Noise reduction inside to outside. | | | | | | | | | | | | | | | | | | | | |
| - | - | 37 | 42 | 49 | 57 | 64 | 69 | 76 | 86 | 90 | 96 | 98 | 97 | 98 | 98 | 101 | 101 | - | RAL NR72-27 | 142 | Sound Shield Rooms Series 800, Model 802, Class 3 | 2 |
| | | Double-wall rooms have outside dimentions from 6'0" x 5'4" x 8'0" to 12'0" x 11'4" x 8'0". | | | | | | | | | | | | | | | | | | | | |
| - | - | 52 | 45 | 52 | 59 | 70 | 72 | 82 | 90 | 97 | 101 | 104 | 106 | 109 | 107 | 107 | 111 | - | RAL | 142 | Sound Shield Rooms Series 200, Class 1 | 2 |
| | | Double-wall medical examination rooms. Galvanized sheet steel with zinc alloy outer surface and 22 ga cold rolled steel inner surface. Twenty-three standard sizes. | | | | | | | | | | | | | | | | | | | | |
| - | - | 49 | 46 | 55 | 61 | 71 | 74 | 74 | 82 | 84 | 87 | 90 | 90 | 92 | 92 | 98 | 98 | - | RAL | 168 | Series RE-140, RE-240, RS-240 RS-250: Double Wall | 5 |
| | | Size: Outer, 124" x 132" x 100"; Inner, 100" x 108" x 78". | | | | | | | | | | | | | | | | | | | | |
| - | | [48] | | | [64] | | | [79] | | | [81] | | | [79] | | | [80] | - | RAL NR62-10 | 104 | 1204A Audio-metric Test Room | 6,11 |
| | | Size: Outer, 124" x 132" x 100"; Inner, 100" x 108" x 78". | | | | | | | | | | | | | | | | | | | | |
| - | | [48] | | | [64] | | | [70] | | | [81] | | | [79] | | | [83] | - | RAL NR62-16 | 104 | Schedule Ø60 Sound Isolation Room | 7,11 |

TABLE 26B PREFABRICATED QUIET ROOMS (SOUND ABSORPTION)

| Mounting | Thickness (inches) | NRC | Absorption Coefficients 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sound shield panel system; panels range from 24" x 48" to 48" x 144", 2-1/2" or 4" thick. Includes special fasteners for interlocking panels. Unit size 96" x 108" x 4". | | | | | | | | | |
| 4 | 4 | .95 | .73 | .96 | 1.03 | 1.02 | 1.00 | .94 | 6.4 | RAL A71-2 | 142 | Sound Shield Panels | 2 |
| | | | | Hearing test booth: Inside: 4'0" x 3'7" x 6'6"; Outside: 4'5" x 4'0" x 7'6". Sound shield panel system: panels range from 24" x 48" to 48" x 144", 2-1/2 or 4" thick. Includes special fasteners for interlocking panels. Double-wall rooms have outside dimensions from 6'0" x 5'4" x 8'0" to 12'0" x 11'4" x 8'0". Single-wall rooms have outside dimensions from 3'0" x 3'8" x 7'4" to 10'8" x 10' 0" x 7'4". | | | | | | | | | |
| 4 | 4 | .95 | .73 | .96 | 1.03 | 1.02 | 1.00 | .94 | 6.4 | RAL | 142 | Sound Shield Rooms Series 100 through 700, 900 and 25B | 2 |
| | | | | Music practice room: Inside: 6'3" x 8'9" x 7'2"; Outside: 6'11" x 9'5" x 7'10". Music practice room: Inside: 6'3" x 8'9" x 7'2"; Outside: 6'11" x9'5" x 7'10". Noise reduction inside to outside | | | | | | | | | |
| 4 | 4 | .95 | .57 | .97 | 1.09 | 1.10 | 1.08 | 1.02 | 6.4 | RAL | 142 | Sound Shield Rooms Series 800 | 2 |
| | | | | Unit size 30" x 87" x 4". Perforated sheet metal face with back of solid sheet metal. | | | | | | | | | |
| - | 4 | .95 | .57 | .98 | 1.13 | 1.06 | 1.06 | 1.03 | 5.9 | RAL A72-124 | 187 | Sound Module | 8 |
| | | | | Walls made of galvanized sheet steel with zinc alloy outer surface, 22 ga. cold rolled steel inner surface. | | | | | | | | | |
| - | 4 | .95 | .40 | .99 | .99 | .99 | .98 | .05 | - | RAL | 168 | Medical Examination Rooms, Series RE-140, -240; RS-240, -250 | 5 |
| 4 | - | - | .70 | .98 | .99 | .99 | .94 | .83 | - | - | 9 | Sound Proof Rooms | |
| | | | | Unit size 48" x 120" Facing material, fiberglass. Incombustible. Not affected by oil. | | | | | | | | | |
| - | - | .85 | .30 | .61 | .71 | .96 | .89 | .85 | .75 | RAL | 83 | Nonois-2 | |

TABLE 26C PREFABRICATED QUIET ROOMS - NO DATA

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | Anechoic chambers in sizes ranging from small portable model to very large rooms. Can meet cutoff frequency requirements of from 50 to 400 Hz. The An-Eck-Oic wedges used are made from fibrous glass and are mounted to form modular units. | | | | | | | | | | | | | | | | - | - | 59 | An-Eck-Oic Chambers | |
| - | - | Steel and glass rooms for indoor or outdoors. Standard heights: 8' and 10'. Standard panel: 28" wide. | | | | | | | | | | | | | | | | - | - | 82 | Prefabricated Sound proof Rooms | |
| - | - | Custom built anechoic test facilities. Wedges 18" to 90" long. | | | | | | | | | | | | | | | | - | - | 82 | Anechoic rooms and wedges | |
| - | - | Designed for administering in-plant hearing test-Compact Attenuates external noise levels from 23 to 66 dB over 250 to 8000 Hz range. | | | | | | | | | | | | | | | | - | - | 92 | Audiometric "T" Booth | |
| - | - | Partial, telephone enclosures. Available in different sizes and shapes. | | | | | | | | | | | | | | | | - | - | 4 | Acousti-booth | |
| - | - | Audiometric booths and acoustic enclosures in industrial plants. Made using modular panels. | | | | | | | | | | | | | | | | - | - | 119 | Acoustical rooms and Fittings | |
| - | - | Exterior dimensions: Width, 48"; Length, 96"; Height, 108". Interior dimensions: Width, 44"; Length, 92"; Height, 92". | | | | | | | | | | | | | | | | - | - | 157 | Quiet Rooms | 10 |
| - | - | Exterior dimensions: Width, 96"; Length, 96"; Height, 100:. Interior dimensions: Width, 92"; Length, 92"; Height, 92". | | | | | | | | | | | | | | | | - | - | 157 | Quiet Rooms | 10 |
| - | - | Portable audiological testing booth, weight - 650 lbs. 2½ thick "Noishield" panels. Outside dimensions are 29" wide x 39" deep x 75" high | | | | | | | | | | | | | | | | - | - | 139 | Compact Sound booth | |

FOOTNOTES FOR TABLE 26A, 26B, 26C

PREFABRICATED QUIET ROOMS

1. For hearing evaluation by doctors, nurses, etc.
2. Audiometric rooms, music practice rooms, industrial sound controls, etc.
3. In-plant offices, audiometric booths, testing booths, clear rooms, etc.
4. Guard houses, power plant offices, control rooms, etc.
5. Industrial hearing consultation programs, testing programs in clinics, hospitals, and research facilities.
6. For testing, etc.
7. For sound isolation.
8. Music rooms, recording rooms, reading rooms, noise protection, etc.
9. Quiet office space for production supervisors in noisy factories, forging plants, field job sites, etc.
10. Audiometric examining rooms for conducting tests of employees hearing.
11. Bracketed data are for the octave bands 75-150, 150-300, 300-600, 600-1200, and 1200-2400 Hz.

## TABLE 27
## GYPSUM BOARD WALLS

The sound transmission losses of gypsum board walls are listed. Walls are the most commonly used sound barriers and their acoustic performance plays a very important part in establishing the acoustic environments in apartments and homes. Generic information about the acoustical characteristics of walls is given in Section I-5.2.3.

Gypsum is the most commonly used wall material; however, walls using gypsum boards of approximately the same thicknesses (say 1/2 inch) can be erected in a variety of ways with each wall construction providing a different sound transmission loss. Most common variables in such wall construction are the number of gypsum boards, thickness of the insulation added in the cavity, additional sound deadening boards, and different stud materials and construction. Figures 27A and 27B show two gypsum board walls and illustrate the possible complexities of internal construction.

Table 27 is subdivided according to the sound transmission class (STC) of the walls for convenience of presentation. The sound transmission class ranges are:

27A, 34 to 39;
27B, 40 to 44;
27C, 45 to 49;
27D, 50 to 54;
27E, 55 and higher.

It should be noted that the products listed in Table 27 may not be available from the listed manufacturer in the form that they are listed in the table. For example, a manufacturer of insulation may build and test walls with and without insulation. The results of such tests are also presented in the table because it is thought that the information may prove useful to the users. The companies (by numbers shown in Section II) with products listed in Table 27 are: 58, 97, 99, 122, 128, 132, 154, 189.

### GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Batt: Fiber wadded in sheets

Fiber glass bolt: Fiberglass roll of a given length

Furring: The creating of air spaces with thin strips of wood or metal before adding wall bonds or plaster

Gypsum: A hydrated sulfate of calcium. $CaSO_4 \cdot 2H_2O$. Used for making wallboards, plaster of Paris, etc.

Lath: Thin, lightweight structure used as groundwork for plastering, mounting tiles, etc. It may be in a form of gypsum board, perforated metal wire cloth, thin wood strips, etc.

Screw Stud: Studs on which the wall boards are attached by screws

Stud: An upright piece in a frame to which boards or laths are applied

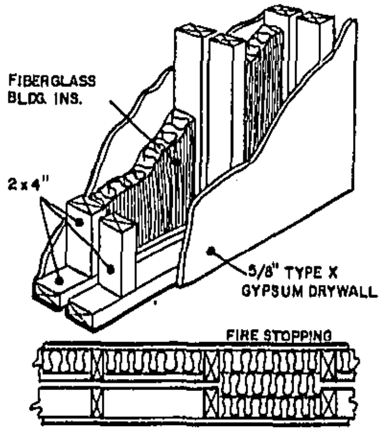



Figure 27A Gypsum Board Wall with Twin Stud Support and Insulation

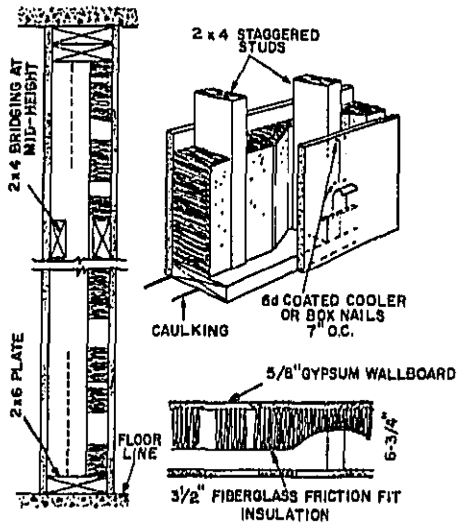



Figure 27B Gypsum Board Wall with Staggered Studs and Insulation

TABLE 27A GYPSUM BOARD WALLS; STC 34-39

| Thickness (inches) | STC | Construction | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 36 | Facing: 5/8" Gypsum board<br>Core: 1" Gypsum ribs, filler strips and closure plate<br>Backing: 5/8" Gypsum board | 22 | 21 | 19 | 23 | 30 | 34 | 38 | 37 | 39 | 41 | 42 | 40 | 37 | 37 | 39 | 42 | 7 | CT | 128 | Semi-solid core, studless, wall board | 5,6, 8,23 |
| 2-1/2 | 36 | Facing: 1/2" Gypsum board<br>Core: 2" metal edge corewall<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | 10.5 | CT | 128 | Metal edge core-wall, studless | 5,6, 14 |
| 3-1/2 | 35 | Facing: 1/2" Gypsum board<br>Core: 2-1/2" steel studs (no insulation)<br>Backing: 1,2" Gypsum board | 17 | 19 | 22 | 28 | 32 | 34 | 37 | 40 | 43 | 45 | 49 | 49 | 43 | 35 | 37 | 42 | | CT | 132 | 1/2" Gypsum board wall | 1,4, 19,20 |
| 3-1/2 | 37 | Facing: 1/2" Gypsum board<br>Core: Studs and cement pads<br>Backing: 1/2" Gypsum board | 17 | 21 | 25 | 27 | 28 | 35 | 36 | 37 | 42 | 43 | 43 | 45 | 46 | 42 | 36 | 39 | 4.22 | KAL 799-2-69R | 58 | Demountable wall system | 23 |
| 3-3/4 | 34 | Facing: 5/8; Gypsum board<br>Core: Wood studs<br>Backing: 5/8" Gypsum board | 19 | 19 | 22 | 24 | 26 | 29 | 31 | 36 | 38 | 41 | 42 | 42 | 34 | 32 | 39 | 44 | 5.14 | KAL 1421-1-72 | 58 | Demountable wall system | 19,20 |
| 3-3/4 | 38 | Facing: 5/8" Gypsum board<br>Core: Screw studs<br>Backing: 5/8" Gypsum board | 20 | 18 | 22 | 27 | 33 | 36 | 39 | 40 | 43 | 46 | 48 | 46 | 38 | 37 | 41 | 42 | 6 | CT | 128 | Gypsum wallboard, screw stud, con-tempo wall demountable | 5,8, 23 |
| 3-3/4 | 39 | Facing: 5/8" Gypsum board<br>Core: 2-1/2" steel studs (no insulation<br>Backing: 5/8" Gypsum board | 22 | 28 | 28 | 27 | 30 | 38 | 43 | 43 | 47 | 47 | 49 | 45 | 37 | 37 | 42 | 47 | | CT | 132 | 5/8" Gypsum board wall | 1,4, 19,20 |
| 4-1/4 | 39 | Facing: 7/16" gypsolite plaster and 1/16" finish coat<br>Core: 3/8" plain lath and hollow studs<br>Backing: 7/16" gypsolite plaster and 1/16" finish coat | 23 | 20 | 24 | 31 | 34 | 39 | 41 | 44 | 46 | 46 | 44 | 38 | 36 | 41 | 45 | 47 | 8 | CT | 128 | Gypsum lath and plaster, Holostud board | 5,17, 23 |
| 4-5/8 | 38 | Facing: 1/2" Gypsum board<br>Core: Screw studs<br>Backing: 1/2" Gypsum board | 20 | 23 | 23 | 30 | 33 | 36 | 38 | 42 | 44 | 47 | 51 | 51 | 49 | 36 | 36 | 40 | 4.5 | CT | 128 | Gypsum wallboard, Singlelayer, screw studs | 5,12, 23 |

TABLE 27A GYPSUM BOARD WALLS; STC 34-39 (Concl)

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| | | Facing: 1/2" Gypsum board<br>Core: 5 wood studs<br>Backing: 1'2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | (36) | 17 | [22] | | 29 | [35] | | 37 | [39] | | 42 | [46] | | 45 | [38] | | 38 | 5.3 | RAL TL-65-186 | 99 | Standard stud, dry wall | 2,21, 22 |
| | | Facing: 5/8" Gypsum board<br>Core: 3-5/8" steel studs (no insulation)<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 39 | 25 | 26 | 29 | 28 | 29 | 35 | 41 | 45 | 48 | 49 | 52 | 52 | 50 | 37 | 36 | 40 | - | OCRL | 132 | Noise isolation #W-S10 without insulation | 1,14 |
| | | Facing: 5/8" Gypsum board<br>Core: Wood studs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-7/8 | (37) | 19 | [35] | | 31 | [31] | | 34 | [37] | | 40 | [43] | | 39 | [40] | | 43 | 8 | CT | 128 | Drywall, wood stud, 5/8" fire shield wall board | 2,21 |
| | | Facing: 5/8" Gypsum board<br>Core: 3-5/8" steel studs (no insulation)<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-7/8 | 39 | 25 | 31 | 36 | 34 | 30 | 39 | 44 | 44 | 47 | 48 | 49 | 46 | 36 | 35 | 41 | 47 | - | CT | 132 | 5/8" Gypsum board wall | 1,4, 19,20 |
| | | Facing: 5/8" Gypsum board with sound deadening board lining<br>Core: Wood studs (nailed to facing and backing)<br>Backing: 5/8" Gypsum board with sound deadening board lining | | | | | | | | | | | | | | | | | | | | |
| 6 | 37 | 17 | 18 | 19 | 29 | 33 | 35 | 40 | 42 | 43 | 49 | 51 | 53 | 48 | 41 | 45 | 51 | 8 | CT | 154 | 5/8" Gypsum board wall with lining board | 24 |
| | | Facing: 1/2" Gypsum board<br>Core: 7 wood studs<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 6-5/8 | (39) | 19 | [25] | | 30 | [36] | | 41 | [43] | | 48 | [49] | | 47 | [37] | | 42 | 6.3 | RAL TL65-185 | 99 | Staggered stud dry wall | 2,21, 23 |

TABLE 27B GYPSUM BOARD WALLS; STC 40-44

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facing: 1/2" or 5/8" Gypsum board<br>Core: Extruded aluminum stud and 1" glass fiber<br>Backing: 1/2" or 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 2-3/4 | 40 | 17 | 20 | 27 | 31 | 34 | 38 | 41 | 42 | 43 | 45 | 47 | 49 | 50 | 49 | 42 | 46 | - | RAL TL68-61 | 122 | Marlite Partition System #275 | 23 |
| Facing: Two layers of 5/8" Gypsum board<br>Core: Two layers Metaledge core-wall panel with angle, runner, etc.<br>Backing: Two layers of 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 40 | 29 | 28 | 29 | 31 | 32 | 33 | 35 | 38 | 39 | 40 | 43 | 45 | 46 | 45 | 43 | 44 | 13.5 | CT | 128 | Metal edge core-wall, studless board | 5,14, 23 |
| Facing: 1/2" Gypsum board<br>Core: 2-1/2" steel studs<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/2 | 43 | 20 | 24 | 27 | 34 | 38 | 44 | 48 | 48 | 51 | 53 | 56 | 57 | 58 | 46 | 42 | 43 | - | CT | 132 | 1/2" Gypsum board wall | 1,4, 19,20 |
| Facing: 1/2" Gypsum board<br>Core: 2-1/2" steel studs and 2" insulation<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/2 | 44 | 25 | 27 | 30 | 35 | 43 | 47 | 50 | 51 | 53 | 55 | 57 | 58 | 59 | 50 | 44 | 46 | - | CT | 132 | 1/2" Gypsum board wall with insulation | 1,4, 19,20 |
| Facing: 1/2" Kalkore (fireshield) with minimum 3/32" veneer plaster<br>Core: Screw studs<br>Backing: 1/2" Kalkore (fireshield) board | | | | | | | | | | | | | | | | | | | | | | |
| 3-3/4 | 40 | 19 | 21 | 28 | 34 | 38 | 40 | 42 | 45 | 47 | 47 | 46 | 40 | 36 | 39 | 42 | 44 | - | CT | 128 | Veneer plaster, screw stud | 5,9, 23 |
| Facing: 5/8" Gypsum board<br>Core: Studs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 3-3/4 | 43 | 23 | 26 | 32 | 35 | 35 | 39 | 42 | 46 | 48 | 49 | 49 | 47 | 44 | 42 | 46 | 52 | 5.59 | KAL 1421-2-72 | 58 | Demountable wall system | 19,20 |
| Facing: 7/16" Gypsum sand plaster and 1/16" coat finish<br>Core: 3/8" Gypsum lath and holostud<br>Backing: 7/16" Gypsum sand plaster and 1/16" coat finish | | | | | | | | | | | | | | | | | | | | | | |
| 4-1/4 | 41 | 23 | 26 | 30 | 36 | 40 | 43 | 44 | 48 | 49 | 50 | 50 | 46 | 37 | 42 | 47 | 51 | 14 | CT | 128 | Gypsum lath plaster, screw stud | 5,17, 23 |
| Facing: Two layers of 1/2" Gypsum board<br>Core: 2-1/2" steel studs<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 4-3/8 | 44 | 28 | 29 | 31 | 31 | 33 | 42 | 46 | 45 | 49 | 51 | 52 | 54 | 52 | 43 | 44 | 47 | - | CT | 132 | Noise isolation W-S15 No insulation | 1,8 |

TABLE 27B GYPSUM BOARD WALLS; STC 40-44 (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Facing: 1/2" Gypsum board<br>Core: Screw studs<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 40 | 21 | 26 | 24 | 31 | 34 | 37 | 39 | 42 | 46 | 48 | 50 | 50 | 47 | 37 | 38 | 42 | 4.5 | CT | 128 | Gypsum wallboard, single layer, screw studs | 5,13, 23 |
| | | Facing: 5/8" Gypsum board<br>Core: Metaledge corewall panel with angles, runner, etc.<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 43 | 29 | 28 | 28 | 32 | 34 | 37 | 39 | 41 | 43 | 45 | 48 | 52 | 54 | 55 | 57 | 57 | 19.5 | CT | 128 | Metaledge corewall, studless board | 5,6, 14,19 |
| | | Facing: 1/2" Gypsum board<br>Core: 3-5/8" studs and 2-1/2" insulation<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 44 | 29 | 30 | 35 | 49 | 41 | 47 | 52 | 54 | 56 | 58 | 60 | 59 | 60 | 57 | 40 | 45 | - | CT | 132 | - | 1,4, 19,20 |
| | | Facing: 5/8" Gypsum board<br>Core: 3-5/8" steel stud and 3-1/2" insulation<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 4-7/8 | 44 | 29 | 35 | 40 | 42 | 43 | 47 | 52 | 55 | 57 | 57 | 57 | 54 | 45 | 40 | 44 | 50 | - | CT | 132 | 5/8" Gypsum board wall with insulation | 1,4, 19,20 |
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: Screw studs<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-1/8 | 43 | 25 | 30 | 27 | 34 | 38 | 42 | 42 | 47 | 50 | 51 | 53 | 54 | 50 | 40 | 41 | 46 | 7 | CT | 128 | Gypsum wallboard, unbalanced, screw studs | 5,13, 23 |
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: Screw studs<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-1/8 | 44 | 26 | 30 | 28 | 35 | 37 | 41 | 43 | 47 | 50 | 51 | 53 | 54 | 53 | 42 | 42 | 46 | 7 | CT | 128 | Gypsum wallboard, unbalanced, screw stud | 5,12, 23 |
| | | Facing: 5/8" Gypsum board with resilient channel<br>Core: Wood studs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-3/8 | 40 | 27 | 27 | 29 | 25 | 30 | 42 | 42 | 46 | 49 | 51 | 53 | 51 | 42 | 40 | 44 | 54 | 6.4 | CT | 132 | Noise isolation, ØW-W3 without insulation | 1,15 |
| | | Facing: 5/8" Gypsum board<br>Core: Wood studs and furring channel<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-3/8 | 43 | 24 | 24 | 30 | 36 | 38 | 40 | 41 | 44 | 48 | 48 | 51 | 50 | 45 | 42 | 43 | 49 | - | CT | 128 | Drywall wood studs, fireshield, wall board, insulation, resilient furring channel | 7,23 |

TABLE 27B GYPSUM BOARD WALLS; STC 40-44 (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facing: 5/8" Gypsum with sound deadening board strips (adhesive between these two)<br>Core: Wood stud (nailed to facing and backing)<br>Backing: 5/8" Gypsum with sound deadening board strips (adhesive between these two) | | | | | | | | | | | | | | | | | | | | | | |
| 5-3/4 | 42 | 21 | 23 | 26 | 33 | 35 | 39 | 44 | 47 | 49 | 51 | 54 | 55 | 48 | 41 | 46 | 51 | 8 | CT | 154 | 5/8" Gypsum board wall with board strips | 24 |
| Facing: 5/8" Gypsum board with 1/4" sound deadening board<br>Core: Wood studs (nailed to facing and backing)<br>Backing: 5/8" Gypsum board with 1/4" sound deadening board | | | | | | | | | | | | | | | | | | | | | | |
| 5-3/4 | 43 | 25 | 22 | 28 | 37 | 38 | 37 | 42 | 45 | 47 | 49 | 53 | 56 | 54 | 51 | 54 | 58 | 8 | CT | 154 | 5/8" Gypsum board wall with board lining | 24 |
| Facing: Two layers of 5/8" Gypsum board<br>Core: Wood stud<br>Backing: Two layers of 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 6-1/8 | 40 | 25 | 23 | 23 | 34 | 38 | 33 | 34 | 37 | 41 | 46 | 48 | 48 | 45 | 43 | 47 | 51 | - | CT | 128 | Drywall, wood stud, double layer fireshield wall board | 23 |
| Facing: Two layers of 5/8" Gypsum board<br>Core: Wood stud and fiberglas<br>Backing: Two layers of 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 6-1/8 | 41 | 25 | 23 | 24 | 36 | 39 | 34 | 35 | 38 | 42 | 47 | 48 | 49 | 46 | 44 | 47 | 51 | - | CT | 128 | Drywall, wood stud, double layer fire-shield wallboard, insulation | 23 |
| Facing: Two layers of 5/8" Gypsum board separated by furring channel<br>Core: Metaledge corewall<br>Backing: Two layers of 5/8" Gypsum board separated by furring channel | | | | | | | | | | | | | | | | | | | | | | |
| 6-1/4 | 44 | 22 | 23 | 29 | 34 | 39 | 44 | 51 | 57 | 61 | 64 | 66 | 68 | 63 | 59 | 62 | 66 | 18.5 | CT | 128 | Metaledge core-wall, studless board | 5,6, 14,20 |
| Facing: 5/8" Gypsum board<br>Core: Wood studs and horizontal wood ribs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 6-3/4 | 42 | 24 | 26 | 29 | 35 | 37 | 37 | 38 | 43 | 45 | 45 | 47 | 47 | 42 | 39 | 43 | 47 | - | CT | 128 | Drywall, wood studs staggered, fireshield wallboard | 23 |
| Facing: 5/8" Gypsum board<br>Core: Wood studs and no in-sulation<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 6-7/8 | 42 | 29 | 28 | 31 | 29 | 35 | 40 | 42 | 44 | 46 | 46 | 48 | 46 | 39 | 39 | 46 | 52 | 7.2 | CT | 132 | Noise Isolation W-W5 (no insulation) | 1,15 |

TABLE 27B GYPSUM BOARD WALLS; STC 40-44 (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Facing: 5/8" Gypsum board<br>Core: Double row of wood studs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 9-1/4 | 43 | 34 | 33 | 38 | 35 | 37 | 49 | 47 | 51 | 53 | 54 | 56 | 54 | 45 | 39 | 45 | 54 | - | CT | 132 | Noise isolation W-W7 (no insulation) | 1,15 |
| | | Facing: 1/2" Gypsum board<br>Core: Chase wall with 12" core space - 1-5/8" two studs, 3-1/2" stud brace at 1/3 height<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 13 | 42 | 27 | 30 | 33 | 36 | 36 | 45 | 48 | 47 | 49 | 51 | 53 | 55 | 50 | 40 | 39 | 45 | - | CT | 132 | Noise isolation W-S17 (no insulation) | 1,9 |
| | | Facing: 1/2" Gypsum board<br>Core: Chase wall with 12" core space - 1-5/8" two studs, stud brace at midheight<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 13 | 43 | 30 | 31 | 37 | 40 | 40 | 45 | 47 | 46 | 49 | 51 | 53 | 56 | 50 | 39 | 40 | 47 | - | CT | 132 | 1/2" Gypsum board wall | 19,20 |

TABLE 27C GYPSUM BOARD WALLS; STC 45-49

| Thickness (inches) | STC | Construction | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| 3-1/2 | 45 | Facing: 1/2" Gypsum board<br>Core: 2-1/2" stud with 2-1/2" insulation<br>Backing: 1/2" Gypsum board | 23 | 29 | 31 | 41 | 40 | 45 | 52 | 53 | 55 | 58 | 59 | 58 | 58 | 48 | 43 | 49 | - | CT | 132 | 1/2" Gypsum board wall with insulation | 1,19, 20 |
| 3-1/2 | 46 | Facing: 1/2" Gypsum board<br>Core: 2-1/2" steel stud with 3" insulation<br>Backing: 1/2" Gypsum board | 23 | 29 | 34 | 38 | 45 | 50 | 53 | 54 | 55 | 57 | 58 | 59 | 61 | 50 | 44 | 46 | - | CT | 132 | 1/2" Gypsum board wall with insulation | 1,4 |
| 3-1/2 | 47 | Facing: 1/2" Gypsum wallboard<br>Core: Screw studs and 2" mineral wool<br>Backing: 1/2" Gypsum wallboard | 24 | 29 | 30 | 37 | 43 | 47 | 51 | 53 | 54 | 55 | 56 | 57 | 58 | 53 | 46 | 47 | 5 | CT | 128 | Gypsum wallboard, screw stud - contempo wall demountable | 5,8, 23 |
| 3-3/4 | 45 | Facing: 5/8" Gypsum board<br>Core: 2-1/2" stud with 2-1/2" insulation<br>Backing: 5/8" Gypsum board | 26 | 35 | 34 | 40 | 44 | 49 | 52 | 53 | 55 | 59 | 54 | 50 | 44 | 41 | 45 | 51 | - | CT | 132 | 5/8" Gypsum board wall with insulation | 1,4, 19,20 |
| 3-3/4 | 46 | Facing: 1/2" Kal-Kore with minimum 3/32" Kal-Kote plaster<br>Core: 2-1/2" screw studs with 2" fiberglas<br>Backing: 1/2" Kal-Kore with minimum 3/32" Kal-Kote plaster | 25 | 32 | 35 | 39 | 43 | 46 | 49 | 51 | 51 | 51 | 53 | 50 | 42 | 42 | 44 | 47 | 6 | CT | 128 | Veneer plaster, screw stud | 5,9, 23 |
| 4 | 45 | Facing: 1/2" Gypsum board with 1/4" gypsum board lining<br>Core: 2-1/2" screw studs<br>Backing: 1/2" Gypsum board with 1/4" gypsumboard lining | 22 | 24 | 27 | 37 | 40 | 43 | 44 | 48 | 50 | 51 | 52 | 53 | 50 | 47 | 47 | 52 | - | CT | 128 | Drywall, screw stud, 1/4" Gypsum wallboard | 4,23 |
| 4-1/4 | 45 | Facing: 1/2" sand plaster and 3/8" gypsum lath<br>Core: 2-1/2" screw studs<br>Backing: 1/2" sand plaster and 3/8" gypsum lath | 34 | 31 | 35 | 40 | 44 | 48 | 52 | 53 | 55 | 55 | 48 | 41 | 47 | 52 | 55 | 59 | 12 | CT | 128 | Lath and plaster, screw stud, board | 5,10, 18,23 |
| 4-1/4 | 46 | Facing: 1/2" sand plaster and 3/8" gypsum lath<br>Core: 2-1/2" screw studs<br>Backing: 1/2" sand plaster and 3/8" gypsum lath | 34 | 33 | 38 | 43 | 46 | 48 | 52 | 53 | 52 | 52 | 49 | 43 | 42 | 48 | 50 | 54 | 12 | CT | 128 | 3/8" Gypsum lath wall with sand plaster | 5,11, 18,23 |

TABLE 27C GYPSUM BOARD WALLS; STC 45-49 (Contd)

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| Facing: 1/2" Gypsum board<br>Core: 3-5/8" screw studs<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 46 | 25 | 31 | 34 | 38 | 43 | 47 | 49 | 52 | 53 | 56 | 59 | 59 | 61 | 47 | 42 | 46 | 5 | CT | 128 | Gypsum wall board, single layer, screw studs | 5,12, 23 |
| Facing: 1/2" Gypsum board<br>Core: 3-5/8" screw studs with fiberglas bolts<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 46 | 27 | 32 | 32 | 37 | 40 | 43 | 46 | 49 | 53 | 54 | 55 | 55 | 55 | 44 | 42 | 47 | 5 | CT | 128 | Gypsum wall board, single layer, screw studs | 5,13, 23 |
| Facing: Gypsum board<br>Core: 3-5/8" steel stud<br>Backing: Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 4-5/8 | 46 | 28 | 32 | 35 | 39 | 44 | 48 | 52 | 54 | 56 | 56 | 58 | 58 | 58 | 48 | 43 | 46 | - | CT | 132 | Noise isolation, W-S10, 3-1/2" insulation | 1,14 |
| Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" screw stud and 3" fiberglas bolts<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 5-1/8 | 49 | 27 | 34 | 36 | 41 | 44 | 47 | 48 | 53 | 55 | 56 | 56 | 58 | 58 | 47 | 46 | 52 | 7 | CT | 128 | Gypsum wallboard, unbalanced, screw studs | 5,13, 23 |
| Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" screw stud and 2" fiberglas bolts<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 5-1/8 | 49 | 29 | 34 | 36 | 40 | 43 | 47 | 50 | 53 | 55 | 55 | 56 | 56 | 57 | 50 | 46 | 50 | 7 | CT | 128 | Gypsum wallboard, Unbalanced, screw studs | 5,12, 23 |
| Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" steel studs with 3-1/2" insulation<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 5-1/8 | 49 | 34 | 37 | 40 | 43 | 46 | 49 | 52 | 54 | 56 | 56 | 58 | 60 | 59 | 52 | 46 | 49 | - | CT | 132 | Gypsum board wall with insulation | 4,19, 20 |
| Facing: 5/8" Gypsum board with resilient channel<br>Core: Wood studs and 3-1/2" fiberglas<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 5-3/8 | 46 | 29 | 33 | 37 | 40 | 44 | 50 | 51 | 54 | 54 | 55 | 55 | 54 | 48 | 42 | 50 | 58 | 6.4 | CT | 132 | Noise isolation, W-W3, 3-1/2" insulation | 1,15 |
| Facing: 1/2" Gypsum board with 1/4" Gypsum board lining<br>Core: Wood studs<br>Backing: 1/2" Gypsum board with 1/4" Gypsum board lining | | | | | | | | | | | | | | | | | | | | | | |
| 5-1/2 | 45 | 21 | 25 | 32 | 36 | 39 | 43 | 44 | 48 | 52 | 53 | 56 | 57 | 55 | 51 | 50 | 53 | - | CT | 128 | Drywall, wood stud, 1/4" Gypsum wall-board | 4,23 |

TABLE 27C GYPSUM BOARD WALLS; STC 45-49 (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Facing: Two layers of 1/2" Gypsum board; Core: 3-5/8" Steel stud; Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-1/2 | 45 | 29 | 31 | 35 | 35 | 35 | 41 | 48 | 47 | 49 | 51 | 53 | 56 | 53 | 43 | 41 | 46 | - | CT | 154 | Gypsum board wall with board lining | 1,19, 20 |
| | | Facing: Two layers of 1/2" Gypsum board; Core: 3-5/8" screw studs; Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-5/8 | 46 | 28 | 31 | 33 | 35 | 41 | 43 | 44 | 49 | 52 | 55 | 55 | 56 | 53 | 44 | 45 | 50 | 9 | CT | 189 | Gypsum wallboard, double layer, screw studs | 5,13, 23 |
| | | Facing: Two layers of 1/2" Gypsum board; Core: 3-5/8" screw studs; Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5-5/8 | 48 | 34 | 35 | 34 | 38 | 41 | 45 | 47 | 51 | 53 | 54 | 57 | 57 | 57 | 46 | 46 | 50 | 9 | CT | 128 | Gypsum wallboard, double layers screw studs | 5,12, 23 |
| | | Facing: 5/8" Gypsum board with 1/2" sound deadening board lining; Core: Wood studs; Backing: 5/8" Gypsum board with 1/2" sound deadening board lining | | | | | | | | | | | | | | | | | | | | |
| 5-3/4 | 48 | 28 | 27 | 37 | 41 | 43 | 44 | 48 | 50 | 51 | 53 | 55 | 59 | 57 | 55 | 57 | 60 | 8 | CT | 154 | Gypsum board wall with board lining | 24 |
| | | Facing: 5/8" Gypsum board with 1/2" sound deadening board lining; Core: Wood studs; Backing: 5/8" Gypsum board with 1/2" deadening board lining | | | | | | | | | | | | | | | | | | | | |
| 5-7/8 | 48 | 24 | 28 | 34 | 37 | 42 | 47 | 51 | 55 | 58 | 61 | 62 | 64 | 63 | 60 | 61 | 64 | 7.7 | RAL TL70-3 | 189 | Partition wall system | 21,22 |
| | | Facing: 5/8" Gypsum board with 1/2" sound deadening board lining; Core: Wood studs (all nailed together); Backing: 5/8" Gypsum board with 1/2" sound deadening board lining | | | | | | | | | | | | | | | | | | | | |
| 6 | 46 | 22 | 31 | 36 | 38 | 42 | 46 | 47 | 50 | 53 | 55 | 57 | 56 | 53 | 51 | 54 | 55 | 8 | CT | 154 | 5/8" Gypsum board wall with board lining | 24 |
| | | Facing: 5/8" Gypsum board with 1/2" sound deadening board lining; Core: Wood studs (adhesive application); Backing: 5/8" Gypsum board with 1/2" sound deadening board lining | | | | | | | | | | | | | | | | | | | | |
| 6 | 48 | 24 | 35 | 38 | 39 | 43 | 47 | 48 | 50 | 54 | 56 | 57 | 54 | 52 | 50 | 53 | 52 | 8 | CT | 154 | 5/8" Gypsum board wall with board lining | 24 |

TABLE 27C GYPSUM BOARD WALLS; STC 45-49 (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facing: Two layers of 5/8" Gypsum board separated by furring channel<br>Core: Metaledge corewall<br>Backing: Two layers of 5/8" Gypsum board separated by furring channel | | | | | | | | | | | | | | | | | | | | | | |
| 6-1/4 | 46 | 22 | 29 | 38 | 44 | 48 | 53 | 57 | 61 | 64 | 66 | 68 | 69 | 69 | 61 | 63 | 66 | 18.5 | CT | 128 | Metaledge corewall, Stud-less board | 5,6, 14,19 |
| Facing: 5/8" Gypsum board<br>Core: Wood studs with fiberglas<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 6-7/8 | 49 | 25 | 31 | 35 | 40 | 40 | 42 | 45 | 46 | 48 | 50 | 53 | 54 | 50 | 49 | 51 | 59 | 7.2 | G&H | 132 | Noise isolation W-W5 with insulation | 1,3 |
| Facing: 5/8" Gypsum board<br>Core: Wood stud with fiberglas<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 7-1/4 | 45 | 32 | 34 | 38 | 42 | 42 | 43 | 42 | 45 | 47 | 48 | 50 | 50 | 45 | 41 | 45 | 49 | - | CT | 128 | Drywall, wood studs staggered, fireshield wallboard, insulation | 4,23 |
| Facing: 1/2" Gypsum board<br>Core: Double rows of wood studs with 1/2" sound deadening board in 1" space between two rows<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 9-1/2 | 48 | 27 | 30 | 35 | 34 | 39 | 43 | 47 | 55 | 53 | 56 | 59 | 61 | 62 | 57 | 61 | 67 | 10 | CT | 154 | Gypsum board wall | 24 |
| Facing: 5/8" Gypsum board<br>Core: Double row of wood studs and 6 mil polytheylene film between two rows<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 10-1/4 | 45 | 26 | 28 | 33 | 33 | 37 | 41 | 46 | 49 | 51 | 55 | 57 | 59 | 54 | 56 | 49 | | - | OCRL | 154 | 5/8" Gypsum board wall | 4,24 |

TABLE 27D GYPSUM BOARD WALLS; STC 50-54

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Facing: Two layers of 1/2" Gypsum board<br>Core: 1" Fiberglas and furring channel<br>Backing: 2" Metaledge corewall panel | | | | | | | | | | | | | | | | | | |
| 4 (nom.) | 53 | 29 | 33 | 37 | 43 | 47 | 51 | 55 | 56 | 57 | 58 | 59 | 60 | 60 | 60 | 62 | 64 | 12.5 | CT | 128 | Metaledge Core-wall studless | 5,6, 14,19 |
| | | | | Facing: 1/2" Gypsum board with 1/4" Gypsum board lining<br>Core: 2-1/2" screw stud with 2" glass fiber<br>Backing: 1/2" Gypsum board with 1/4" Gypsum board lining | | | | | | | | | | | | | | | | | | |
| 4 | 53 | 32 | 33 | 36 | 43 | 48 | 52 | 55 | 55 | 55 | 54 | 57 | 60 | 62 | 62 | 59 | 66 | - | CT | 128 | Drywall, screw stud, 1/4" Gypsum wallboard | 4,23 |
| | | | | Facing: Two layers of 1/2" Gypsum board<br>Core: Screw studs (2-1/2" and glass fiber)<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | |
| 4-1/8 | [52] | 34 | [38] | | 40 | [46] | | 50 | [54] | | 54 | [56] | | 56 | [51] | | 51 | 7 | RAL TL66-66 | 128 | Gypsum wallboard, unbalanced, screw studs | 2,5, 8,22, 23 |
| | | | | Facing: Two layers of 1/2" Gypsum board<br>Core: 2-1/2" steel stud with fiberglas insulation<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | |
| 4-3/8 | 51 | 32 | 34 | 35 | 43 | 47 | 52 | 55 | 56 | 58 | 58 | 60 | 61 | 61 | 54 | 47 | 51 | - | CT | 132 | Noise isolation W-S15 with 2-1/2" insulation | 1,8 |
| | | | | Facing: 1/2" Gypsum board with 1/2" Gypsum board lining<br>Core: Screw studs and glass fiber<br>Backing: 1/2" Gypsum board with 1/2" Gypsum lining | | | | | | | | | | | | | | | | | | |
| 4-1/2 | 53 | 38 | 41 | 44 | 43 | 47 | 49 | 51 | 54 | 55 | 55 | 58 | 58 | 58 | 53 | 51 | 52 | 9 | RAL TL66-65 | 128 | Gypsum board wall, double layer, screw studs | 5,8, 22,23 |
| | | | | Facing: Two layers of 5/8" Gypsum board<br>Core: Screw studs<br>Backing: Two layers of 5/8" Gypsum board | | | | | | | | | | | | | | | | | | |
| 5 | [50] | 28 | [35] | | 41 | [44] | | 48 | [51] | | 53 | [55] | | 53 | [54] | | 55 | 11 | G&H | 128 | Gypsum wallboard double layer, screw studs | 2,5, 8,21 |
| | | | | Facing: Two layers of 1/2" Gypsum board<br>Core: 2-1/2" steel studs<br>Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | |
| 5 | 50 | 32 | 36 | 36 | 40 | 39 | 46 | 52 | 52 | 53 | 55 | 56 | 57 | 57 | 54 | 50 | 54 | - | CT | 132 | Noise isolation W-S16 (no insulation) | 1,8, 19,20 |

TABLE 27D GYPSUM BOARD WALLS; STC 50-54 (Contd)

| Thickness (Inches) | STC | Construction | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Transmission Loss (decibels)** | | | | | | | | | | | | | | | | | | | | | |
| 5-3/8 | [52] | Facing: 5/8" Gypsum board<br>Core: Wood studs, fiberglas and furring channels<br>Backing: 5/8" Gypsum board | 32 | [35] | | 44 | [48] | | 51 | [52] | | 56 | [59] | | 56 | [58] | | 59 | - | CT | 128 | Drywall, wood studs, fireshield, wall-board, resilient furring channel | 2,21 |
| 5-1/2 | [53] | Facing: Two layers of 5/8" Gypsum board<br>Core: Screw studs and mineral wool<br>Backing: One layer of 5/8" Gypsum board | 31 | [37] | | 48 | [48] | | 56 | [56] | | 56 | [57] | | 56 | [53] | | 55 | 9 | G&H | 128 | Unbalanced, screw studs, Gypsum wallboard | 2,5 14,21 |
| 5-5/8 | 50 | Facing: Two layers of 1/2" Gypsum board<br>Core: Screw studs and fiberglas bolts<br>Backing: Two layers of 1/2" Gypsum board | 30 | 36 | 36 | 38 | 46 | 48 | 50 | 53 | 56 | 56 | 57 | 59 | 59 | 48 | 48 | 54 | 9 | CT | 128 | Gypsum wallboard, double layer, screw studs | 5,13, 23 |
| 5-5/8 | 53 | Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" screw studs, 3" fiberglas bolts<br>Backing: One layer of 1/2" Gypsum board | 34 | 38 | 38 | 43 | 46 | 50 | 53 | 56 | 59 | 59 | 61 | 61 | 62 | 55 | 51 | 55 | 9 | CT | 128 | Gypsum wallboard, double layer, screw studs | 5,12, 23 |
| 5-7/8 | 50 | Facing: 5/8" Gypsum board with 1/2" Homosole sound deadening board<br>Core: Wood studs<br>Backing: 5/8" Gypsum board with 1/2" Homosole sound deadening board | 27 | 29 | 37 | 39 | 43 | 46 | 47 | 51 | 53 | 59 | 62 | 62 | 60 | 57 | 57 | 55 | - | KAL 506-2-67 | 97 | 5/8" Gypsum board wall with sound deadening boards | 23 |
| 5-7/8 | 52 | Facing: 5/8" Gypsum board with 1/2" sound deadening board<br>Core: Wood stud and glass fiber insulation<br>Backing: 5/8" Gypsum board with 1/2" sound deadening board | 28 | 32 | 39 | 43 | 46 | 56 | 55 | 57 | 59 | 62 | 63 | 65 | 64 | 61 | 62 | 63 | 7.8 | RAL TL70-2 | 189 | Partition wall system | 22,23 |
| 6-1/8 | 50 | Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" screw studs<br>Backing: Two layers of 1/2" Gypsum board | 34 | 34 | 40 | 42 | 40 | 47 | 53 | 52 | 54 | 55 | 57 | 59 | 58 | 48 | 48 | 52 | - | CT | 132 | Gypsum board wall | 1,14, 19,20 |
| 6-1/8 | [51] | Facing: Two layers of 5/8" Gypsum board<br>Core: 3-5/8" screw studs<br>Backing: Two layers of 5/8" Gypsum board | 29 | [39] | | 41 | [45] | | 48 | [54] | | 53 | [54] | | 53 | [54] | | 57 | 11 | G&H | 128 | Gypsum wallboard, double layer, screw studs | 2,5, 14,21 |

TABLE 27D GYPSUM BOARD WALLS; STC 50-54 (Contd)

| Thickness (inches) | STC | Construction | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-3/16 | 51 | Facing: 1/2" plaster with finish coat and 3/8" lath<br>Core: Holo studs and 3" fiberglas<br>Backing: 1/2" plaster with finish coat and 3/8" lath | 39 | 41 | 43 | 46 | 47 | 51 | 53 | 55 | 58 | 57 | 56 | 51 | 47 | 51 | 53 | 56 | 12 | CT | 128 | Resilient one side, Gypsum lath and plaster holostud | 5,16, 23 |
| 6-5/8 | 50 | Facing: Two layers of 5/8" Gypsum board<br>Core: Wood studs and furring channel<br>Backing: Two layers of 5/8" Gypsum board | 27 | 34 | 36 | 42 | 44 | 46 | 49 | 51 | 54 | 55 | 57 | 57 | 54 | 51 | 53 | 57 | - | CT | 128 | Drywall, wood stud, double layer fireshield wallboard, insulation, resilient furring channel | 23 |
| 6-5/8 | 54 | Facing: Two layers of 5/8" Gypsum board<br>Core: Wood studs, 3-1/2" fiberglas and furring channels (one side)<br>Backing: Two layers of 5/8" Gypsum board | 32 | 37 | 39 | 44 | 48 | 50 | 52 | 55 | 57 | 58 | 60 | 60 | 59 | 55 | 56 | 59 | - | CT | 132 | Drywall, wood stud, double layer fireshield wallboard, insulation, resilient furring channel | 23 |
| 6-7/8 | 52 | Facing: 5/8" Gypsum board<br>Core: Wood studs and fiberglas insulation<br>Backing: 5/8" Gypsum board | 30 | 38 | 43 | 43 | 45 | 47 | 50 | 52 | 54 | 54 | 57 | 55 | 52 | 54 | 56 | 58 | 7.2 | G&H | 132 | Noise isolation W-W5 with insulation | 1,15 |
| 7-3/4 | [50] | Facing: 1/2" Gypsum board with 1/2" sound deadening board<br>Core: Wood studs<br>Backing: 1/2" Gypsum board with 1/2" sound deadening board | 29 | [34] | | 40 | | [45] | 47 | [52] | | 58 | [61] | | 62 | [59] | | 57 | 8 | RAL TL65-200 | 99 | Staggered stud/dry wall with sound deadening board | 2,21, 22 |
| 7-7/8 | 50 | Facing: 5/8" Gypsum board with 1/2" sound deadening board<br>Core: Wood studs<br>Backing: 5/8" Gypsum board with 1/2" sound deadening board | 27 | 30 | 34 | 39 | 42 | 47 | 52 | 56 | 59 | 59 | 60 | 60 | 61 | 61 | 60 | 60 | 8.5 | RAL TL70-4 | 189 | 5/8" Gypsum board wall with sound deadening boards | 22,23 |
| 8 | 51 | Facing: Two layers of 5/8" Gypsum board<br>Core: Wood studs<br>Backing: Two layers of 5/8" Gypsum board | 31 | 35 | 36 | 42 | 45 | 47 | 49 | 51 | 54 | 54 | 56 | 56 | 53 | 51 | 55 | 59 | - | CT | 128 | Dry wall, wood studs, staggered double layer fire shield wallboard | 23 |
| 8 | 53 | Facing: Two layers of 5/8" Gypsum board<br>Core: Wood studs and 3-1/2" fiberglas<br>Backing: Two layers of 5/8" Gypsum board | 35 | 39 | 45 | 45 | 49 | 49 | 52 | 53 | 54 | 55 | 56 | 57 | 54 | 50 | 53 | 57 | - | CT | 128 | Dry wall, wood studs staggered, double layer fire shield wallboard insulation | 23 |

TABLE 27D GYPSUM BOARD WALLS; STC 50-54 (Concl)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facing: 5/8" Gypsum board with 1/2" Deciban lining<br>Core: Double row of wood studs<br>Backing: 5/8" Gypsum board with 1/2" Deciban lining | | | | | | | | | | | | | | | | | | | | | | |
| 8-1·2 | [53] | 31 | [37] | | 43 | [49] | | 43 | [58] | | 61 | [61] | | 64 | [64] | | 65 | - | G&H | 128 | Dry wall, wood studs, Deciban board | 2,8, 21 |
| Facing: 5'8" Gypsum board<br>Core: Double row of wood studs (1" apart), 1'2" sound deadening board in that cavity and 2" insulation<br>Backing: 5'8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 9-1/2 | 50 | 27 | 33 | 38 | 40 | 41 | 45 | 48 | 52 | 53 | 57 | 59 | 61 | 61 | 57 | 60 | | 10 | CT | 154 | 5/8" Gypsum board wall with insulation | 24 |
| Facing: 5/8" Gypsum board, resilient channel and 1/2" sound deadening board<br>Core: Double row of wood studs<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 9-3/4 | 50 | 32 | 31 | 36 | 38 | 46 | 48 | 53 | 57 | 57 | 61 | 64 | 65 | 60 | 49 | 51 | 56 | 10 | CT | 154 | 5/8" Gypsum board wall | 24 |
| Facing: 5'8" Gypsum board, resilient channel and 1'2" sound deadening board<br>Core: Double row of wood studs<br>Backing: 5'8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 10-1/4 | 53 | 31 | 33 | 39 | 41 | 45 | 49 | 54 | 57 | 60 | 64 | 67 | 68 | 68 | 65 | 69 | 73 | 10 | CT | 128 | 5/8" Gypsum board wall | 24 |
| Facing: Two layers of 1/2" Gypsum board<br>Core: Double row of wood studs<br>Backing Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 10-1/4 | 54 | 31 | 36 | 41 | 41 | 45 | 50 | 52 | 55 | 58 | 57 | 62 | 63 | 64 | 59 | 57 | 62 | - | CT | 128 | Drywall, wood studs, double layer (1/2") fire shield wallboard | 23 |
| Facing: 1/2" Gypsum board<br>Core: Chase wall with 12" core space, 1-5/8" two studs, 3-1/2" one layer insulation, stud brace at 1/3 points<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 52 | 33 | 37 | 39 | 42 | 46 | 50 | 53 | 55 | 57 | 59 | 60 | 62 | 61 | 50 | 48 | 54 | - | OCRL | 154 | Noise insulation W-S17 with 3-1/2" insulation | 1, 9, 19,20 |
| Facing: 1/2" Gypsum board<br>Core: Chase wall with 12" core space, 1-5/8" two studs, 3-1/2" one layer insulation (Stud brace at midheight)<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 53 | 34 | 40 | 41 | 43 | 47 | 51 | 52 | 53 | 57 | 59 | 61 | 63 | 62 | 51 | 50 | 55 | - | OCRL | 154 | 1/2" Gypsum board wall | 1,19, 20 |

TABLE 27E GYPSUM BOARD WALLS; STC 55 and HIGHER

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: 2-1/2" steel stud with 2-1/2" insulation .<br>Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 5 | 58 | 35 | 39 | 44 | 49 | 53 | 57 | 60 | 59 | 61 | 62 | 63 | 64 | 64 | 59 | 55 | 57 | - | CT | 132 | Noise isolation, W-S16 with 2-1/2" insulation | 1,8, 19,20 |
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: 3-5/8" steel stud with 3" insulation<br>Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 6-1/8 | 56 | 40 | 44 | 46 | 48 | 52 | 56 | 59 | 58 | 60 | 60 | 61 | 63 | 62 | 55 | 52 | 57 | - | CT | 132 | 1/2" Gypsum board wall | 1,14, 19,20 |
| | | Facing: 5/8" Gypsum board<br>Core: Double row of wood studs and 3-1/2" fiberglas insulation<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 9-1/4 | 55 | 34 | 39 | 44 | 44 | 48 | 53 | 51 | 55 | 57 | 59 | 61 | 63 | 58 | 54 | 60 | 65 | - | CT | 132. | Noise isolation, W-W7 with 3-1/2" insulation | |
| | | Facing: 5/8" Gypsum board<br>Core: Double row of wood studs and 9" fiberglas insulation<br>Backing: 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 9-1/4 | 58 | 41 | 43 | 45 | 48 | 51 | 55 | 54 | 57 | 59 | 60 | 62 | 64 | 62 | 59 | 63 | 55 | 7.1 | CT | 132 | Noise isolation W-W7 with 9" insulation | 1,15 |
| | | Facing: Two layers of 5/8" Gypsum board<br>Core: Double row of wood studs and 3-1/2" fiberglas<br>Backing: Two layers of 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 10-3/4 | 57 | 37 | 39 | 45 | 47 | 49 | 52 | 55 | 57 | 60 | 63 | 66 | 67 | 67 | 65 | 66 | 67 | - | CT | 128 | Dry wall, wood studs, double layer fire shield wallboard | 23 |
| | | Facing: 1/2" Gypsum board<br>Core: Chase wall with 12" core space, 1-5/8" two studs, 9-1/2" insulation, stud braces at midheight<br>Backing: 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 13 | 55 | 38 | 42 | 44 | 45 | 47 | 54 | 54 | 56 | 59 | 61 | 63 | 65 | 62 | 53 | 51 | 57 | - | CT | 132 | Noise isolation W-S17 with 9-1/2" insulation | 9,19, 20 |
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: Chase wall with 12" core space, 1-5/8" two studs, three layers of 3-1/2" insulation, stud braces at midheight<br>Backing: One layer of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 13-1/2 | 59 | 42 | 45 | 47 | 59 | 52 | 55 | 57 | 59 | 62 | 62 | 64 | 66 | 66 | 57 | 56 | 61 | - | CT | 132 | 1/2" Gypsum board wall | 1,19, 20 |
| | | Facing: Two layers of 1/2" Gypsum board<br>Core: Chase wall with 12" core space, 1-5/8" two studs, three layers of 3-1/2" insulation, stud braces at midheight<br>Backing: Two layers of 1/2" Gypsum board | | | | | | | | | | | | | | | | | | | | |
| 14 | 60 | 43 | 48 | 48 | 50 | 52 | 55 | 57 | 58 | 61 | 62 | 65 | 66 | 67 | 59 | 59 | 67 | - | CT | 132 | 1/2" Gypsum board wall | 1,19 20 |

FOOTNOTES FOR TABLE 27A, 27B, 27C, 27D, 27E

GYPSUM BOARD WALLS

1. Data were provided in a graphical form.
2. Bracketed data are for 175, 350, 700, 1400, 2800 Hz respectively. The bracketed [STC], given for these data, is an average of frequencies rather than an actual STC.
3. STC range.
4. Approximate thickness as computed from the sketches of the product.
5. Nonloadbearing wall.
6. Not to be used in humid environment.
7. Resilient furring channels on both sides do not increase transmission loss.
8. Recommended maximum height: 12'0"
9. Recommended maximum height: 10'0"
10. Recommended maximum height: 8'6"
11. Recommended maximum height: 13'6"
12. Recommended maximum height: 17'3"
13. Recommended maximum height: 20'5"
14. Recommended maximum height: 16'0"
15. Recommended maximum height: 14'0"
16. Recommended maximum height: 22'0"
17. Recommended maximum height: 15'0"
18. Plaster must set within a maximum of 3 hrs.
19. Tested and evaluated according to ASTM E90-70.
20. Tested and evaluated according to ASTM E413-70T.
21. Tested and evaluated according to ASTM E90-61T.
22. Tested and evaluated according to ASARP Z-24.19-1957.
23. Tested and evaluated according to ASTM E90-66T.
24. Tested and evaluated according to AMA 1-II-1967.

TABLE 28

STEEL WALLS

The sound transmission losses of wall constructions where sheet steel is a major component of the wall system are listed. These walls are available with insulation placed inside the cavities to reduce sound transmission. Figure 28 shows the internal details of one specific steel wall partition. The classification between semipermanent partition and wall is not always clear and therefore Table 38 should also be referred to for additional products which can be compared directly with the products listed in Table 28. The companies (by numbers shown in Section II) with products listed in Table 28 are: 62, 182.

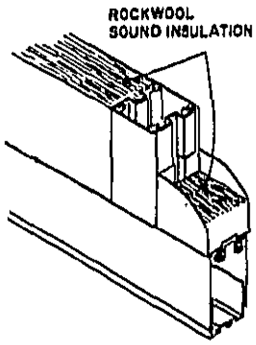



Figure 28 A Section through a Steel Partition

GLOSSARY

Gypsum: A hydrated sulphate of Calcium. $CaSO_4 \cdot 2H_2O$. Used for making wallboards, plaster of Paris, etc.

## TABLE 28 STEEL WALLS

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel Stiffners and rock wool insulation between 20 ga. steel sheets. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 39 | 15 | 23 | 30 | 33 | 38 | 40 | 41 | 42 | 43 | 44 | 46 | 48 | 48 | 46 | 46 | 49 | 4.46 | RAL TL73-104 | 182 | Monoline wall Partition | 1, 2 |
| Welded steel ribs, vertical stiffners of 14 ga. steel and rock wool insulation between 20 ga. steel sheets. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 40 | 18 | | | 34 | | | 37 | | | 39 | | | 45 | | | 44 | 5.0 | G&H VMP 76-ST | 182 | Twinline DF-410 Partition | 2 |
| Welded Steel Ribs, vertical stiffners of 14 ga. steel and rockwool insulation between 20 ga. steel sheets | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 41 | 17 | | | 34 | | | 39 | | | 42 | | | 46 | | | 43 | 5.13 | G&H VMP 54-ST | 182 | Corporate MS-454 | 3, 4 |
| Perforated 18 ga. Galvanized steel B-liner with glass fibers sealed in polyethylene bags and channel wall 20 ga. Galvanized steel. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/2 | 29 | 16 | 14 | 16 | 19 | 20 | 23 | 25 | 27 | 29 | 31 | 34 | 36 | 35 | 34 | 36 | 34 | 4.5 | RAL TL72-68 | 62 | Channel Wall and B-Liner Wall System | 1, 2, 6 |
| Perforated 18 ga. Galvanized steel C-liner with glass fibers sealed in polyethylene bags and channel wall 20 ga. Galvanized steel. | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 33 | 18 | 16 | 18 | 20 | 23 | 26 | 29 | 33 | 36 | 38 | 41 | 42 | 40 | 40 | 43 | 45 | 4.7 | RAL TL72-66 | 62 | Channel wall and C-liner Wall System | 1, 2, 6 |
| Perforated 18 ga. Galvanized steel C-liner with glass mineral fibers and and 1" thick glass fiber insulation both sealed in polyethylene bags. Channel wall 20 ga. Galvanized steel | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 40 | 22 | 23 | 25 | 27 | 30 | 33 | 37 | 42 | 44 | 47 | 49 | 51 | 53 | 52 | 55 | 57 | 5.6 | RAL TL72-81 | 62 | Channel wall and C-liner Wall System | 1, 2, 6 |
| Perforated 18 ga. Galvanized steel C-liner with glass fibers sealed in polyethylene bags, shadowall 20 ga. Galvanized steel. | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 44 | 20 | 23 | 30 | 35 | 39 | 44 | 48 | 50 | 53 | 54 | 55 | 54 | 52 | 51 | 51 | 53 | 6.1 | RAL TL70-231 | 62 | Shadowall and C-liner Wall System | 3, 5, 6 |
| 18 ga. Galvanized steel C-liner with 5/8" gypsum board and glass fibers. 20 ga. Galvanized steel Shadowall. | | | | | | | | | | | | | | | | | | | | | | |
| 4-3/4 | 46 | 24 | 25 | 31 | 36 | 39 | 44 | 49 | 53 | 54 | 55 | 55 | 56 | 57 | 57 | 57 | 58 | 11 | RAL | 62 | Shadowall and C-liner Wall System | 3, 5, 6 |

### FOOTNOTES FOR TABLE 28

### STEEL WALLS

1. Tested and evaluated according to ASTM E 90-70
2. Tested and evaluated according to ASTM E 413-70T
3. Tested and evaluated according to ASTM E 90-66T
4. Tested and evaluated according to ASTM RM-14-4
5. Tested and evaluated according to ASARP-Z24.19-1957
6. "B-liner" - "C-liner" Manufacturer's description

TABLE 29

MASONRY WALLS

The sound transmission losses of masonry walls are listed. These are load-carrying walls made from blocks or structural tiles, and consequently they are heavier than those shown in Tables 27 and 28. Figure 29 shows a masonry wall made from concrete blocks. Masonry walls provide good sound attenuation and poor sound absorption. The sound absorption can, however, be increased by using blocks with cavities open to the sound field. Sound absorption provided by some block designs is shown in Table 5. The companies (by numbers shown in Section II) with products listed in Table 29 are: 25, 31, 89, 102, 141, 162, 186.

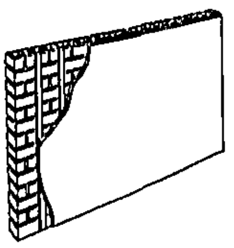


Figure 29 A Masonry Wall with Plaster

TABLE 29 MASONRY WALLS

| Thickness (inches) | STC | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | | | | | |
| 3.75 | 43 | 15-3/4" x 7-3/4", core of fiberglass with perforated glazed tile facing. | 35 | [35] | | 37 | [38] | | 41 | [45] | | 47 | [51] | | 53 | [54] | | 55 | 23.75 | RAL TL59-112 | 25 | Sound bar | 1,4,5,6,8 |
| 3.75 | 46 | 7/16" plaster and 1/16" lime putty coat facing with core of 4" x 8" x 16" ceramic structural clay tile. No plaster on back of wall used as a masonry wall product. | | | | | | | | | | | | | | | | | 31 | RAL TL63-24 | 162 | Starkustic sound absorbing glazed tile | 2,4,9 |
| 3.75 | 46 | Acoustic ceramic glazed structural facing tile (3-3/4" x 5-1/16" x 11-3/4") Used as a masonry wall product. | 40 | [40] | | 42 | [40] | | 41 | [45] | | 51 | [51] | | 54 | [56] | | 58 | 35 | RAL TL60-83 | 162 | SCR acoustile | 1,4,5,6,10 |
| – 6.0 | 43 | Two coats of bondex cement base paint facing; core of masonry wall (8"x16"x6") lightweight concrete blocks (50% Waylite & sand aggregate, 1:1); no plaster or paint on back | 38 | [37] | | 36 | [37] | | 40 | [45] | | 45 | [53] | | 50 | [50] | | 56 | 26 | KAL 365-3-66 | 141 | Soundblox Type "A" | 2,5,6,7 |
| – 6.0 | 47 | Two coats of bondex cement base paint facing; core of masonry wall (8"x16"x6") Proudfoot Soundblox Type A blocks with Waylite sand aggregate (1:1) no plaster or paint on back. | 38 | [41] | | 38 | [43] | | 44 | [48] | | 51 | [56] | | 58 | [53] | | 58 | 28 | KAL 365-3-66 | 141 | Soundblox Type "A" | 2,5,6,7 |
| – 6.0 | 48 | Two coats of bondex cement base paint facing core of masonry wall (8"x16"x6") proudfoot soundblox type B blocks with Waylite sand (1:1) aggregate. No plaster or paint on back. | 39 | [42] | | 38 | [41] | | 49 | [51] | | 53 | [55] | | 60 | [56] | | 58 | 30 | KAL 365-2-66 | 141 | Soundblox Type "B" | 2,5,6 |
| - | - | Concrete blocks and concrete bricks. | | | | | | | | | | | | | | | | | - | - | 31 | | 3 |
| - | - | Concrete mason units of various sizes and shapes. | | | | | | | | | | | | | | | | | - | - | 89 | | |
| - | - | Masonry units of all sizes. | | | | | | | | | | | | | | | | | - | - | 186 | Weblite | |
| - | - | Masonry bricks and blocks. | | | | | | | | | | | | | | | | | - | - | 102 | Auto claved Waylite concrete masonry unit | 11 |

FOOTNOTES FOR TABLE 29

MASONRY WALLS

1. Tested and evaluated according to ASTM E90-55.
2. Tested and evaluated according to ASTM E90-61T.
3. Tested and evaluated according to ASTM E90-66T.
4. Tested and evaluated according to ASA Z.24.19-1957.
5. "STC" number is a nine frequency average, not a true STC.
6. Data in brackets obtained in the one-third octave bands centered at 175, 350, 700, 1400 and 2800 Hz.
7. Temperature range: to 400°F, zero flame spread, resistance same as concrete. Surface density is actually total weight of face block unit.
8. Resistant to all chemicals except hydrofluoric acid. Temperature range: -50° to 2000°F.
9. 280 random holes.
10. 322 random holes in face.
11. Various shapes of block with thicknesses of 2", 4", 6", 8", 10", 12". Volume density range 80 to 150 lb/cu ft. Temperature range to 2000°F.

TABLE 30

CONCRETE FLOORS

Sound transmission losses of concrete floors and sound pressure levels generated in the rooms below when the floors were tapped by standard tapping machines are listed. These sound pressure levels are indicative of the floors effectiveness in reducing annoyance caused in a room by movement of people and furniture on the floor above the room. The test procedure to measure sound pressure level and the impact insulation class are explained fully in Section I-3.4. Concrete floors are typically heavy and provide a good transmission barrier but they are efficient transmitters of tapping sounds. The tapping sound transmission can be reduced significantly by using carpets, pads, and insulation filled cavities. The table shows two sets of data for each product. The upper data set shows sound transmission class and transmission losses, and the lower data set shows the impact insulation class and the impact sound pressure level generated by a tapping device.

Figure 30 shows a floor assembly of concrete slab covered with various layers to create a "finish floor". It should be noted that the product listed in the table may not be a floor assembly itself but the floor was tested with the product as a part of the assembly and the data are therefore presented in this table. The companies (by numbers shown in Section II) with products listed in Table 30 are: 74, 78, 121, 132, 159.

CAUTION

1. TWO SETS OF DATA ARE PRESENTED FOR EACH PRODUCT. LOWER SET OF DATA REPRESENTS SOUND PRESSURE LEVEL GENERATED BY A TAPPING MACHINE AND THE IMPACT INSULATION CLASS OF THE FLOOR. SEE SECTION I-3.4 FOR EXPLANATION.
2. THE PRODUCT LISTED IN THE TABLE MAY ONLY BE A FLOOR ACCESSORY BUT IT WAS TESTED IN A FLOOR SYSTEM AND HENCE IS LISTED IN THIS TABLE.

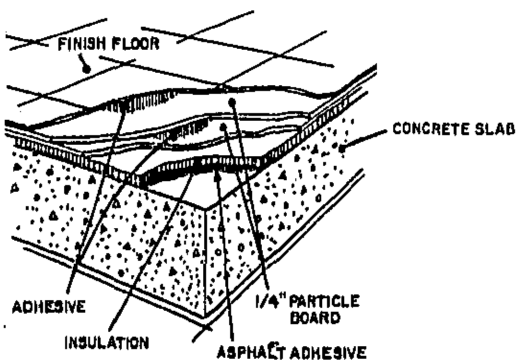



Figure 30 Concrete Subfloor with a Finish Floor Cover

GLOSSARY

Wood Joists: Parallel timbers that support the planks of a floor

Standard Carpet and Pad: 44 oz per square yard Gro-Point carpet with 40 oz per square yard hair felt pad (see discussion in Subsection I-4.1.4)

TABLE 30 CONCRETE FLOORS

| Thickness (inches) | IIC/STC | Transmission Loss (decibels): Sound Pressure Level from Tapping Machine | | | | | | | | | | | | | | | | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | | | | | |
| | | Seven Hi-stress flexicore slabs 6" x 24" x 9'6". | | | | | | | | | | | | | | | | | | | | |
| | 45 | 33 | 35 | 33 | 37 | 37 | 41 | 43 | 45 | 49 | 51 | 53 | 56 | 57 | 58 | 60 | 60 | | | | | |
| 6 | 23 | 63 | 67 | 70 | 70 | 70 | 72 | 74 | 75 | 75 | 77 | 77 | 78 | 78 | 78 | 77 | 74 | - | CKAL 6612-1 | 74 | Hi-stress Flexicore slabs | 1,2, 3,4, 5,7 |
| | | Seven Hi-stress flexicore slabs 6" x 24" x 9'6" formed a horizontal partition, standard 44 oz. Carpet and 40 oz. felt pad covered surface. | | | | | | | | | | | | | | | | | | | | |
| | 45 | 30 | 32 | 33 | 36 | 37 | 41 | 46 | 48 | 52 | 54 | 56 | 59 | 60 | 63 | 65 | 62 | | | | | |
| 6 | 69 | 47 | 47 | 46 | 42 | 40 | 36 | 35 | 31 | 26 | 24 | 23 | 18 | .17 | 15 | 15 | 14 | - | CKAL 6612-2 | 74 | Hi-stress Flexicore slabs with Carpet and pad | 1, 2,3, 4,5, 6,7 |
| | | Seven Hi-stress flexicore slabs 6" x 24" x 9'6" long formed a horizontal partition. 1/2" x 9" x 9" laminated Oak blocks applied to slabs with recommend adhesive. | | | | | | | | | | | | | | | | | | | | |
| | 46 | 35 | 35 | 36 | 38 | 38 | 42 | 43 | 46 | 48 | 51 | 54 | 56 | 58 | 61 | 64 | 55 | | | | | |
| 6-1/2 | 48 | 60 | 63 | 67 | 66 | 67 | 66 | 66 | 64 | 60 | 58 | 55 | 53 | 51 | 49 | 45 | 41 | - | CKAL 6612-4 | 74 | Hi-stress Flexicore slabs with Parquet blocks | 1,2, 3,4, 5,7 |
| | | Seven Hi-stress flexicore slabs 6" x 24" x 9'6" long formed a horizontal partition. Wood fiber board panels 1/2" x 4' x 8' were laid on floor. Laminated Oak blocks 1/2" x 9" x 9" were applied to fiber board with adhesive. | | | | | | | | | | | | | | | | | | | | |
| | 45 | 37 | 36 | 36 | 38 | 37 | 41 | 43 | 47 | 52 | 54 | 56 | 60 | 61 | 65 | 68 | 68 | | | | | |
| 7 | 49 | 60 | 64 | 68 | 68 | 70 | 69 | 66 | 64 | 60 | 54 | 47 | 42 | 37 | 33 | 30 | 28 | - | CKAL 6612-3 | 74 | Hi-stress Flexicore slabs Surfaced with wood fiber board and Oak Parquet floors | 1,2, 3,4, 5,7 |
| | | 6" reinforced concrete slab hard surface floor. Two layers 1/4" particle board on fiber glass noise stopboard. Vinyl tile surface. | | | | | | | | | | | | | | | | | | | | |
| | 50-52 | | | | | | | | | | | | | | | | | | | | | |
| 7-1/4 | 52 | 71 | 71 | 69 | 67 | 63 | 58 | 55 | 50 | 47 | 44 | 41 | 37 | 34 | | | | - | CT OCF No. FIT-13 | 132 | Noise Isolation F-C5 With Vinyl Tile Surface | 5, 8,9 |
| | | 6" reinforced concrete slab hard surface floor on two layers 1/4" particle board on fiberglass noise stop board. Parquet finish surface. | | | | | | | | | | | | | | | | | | | | |
| | 50-52 | | | | | | | | | | | | | | | | | | | | | |
| 7-1/4 | 55 | 66 | 70 | 68 | 64 | 65 | 61 | 55 | 51 | 47 | 43 | 40 | 36 | 32 | | | | - | CT OCF No. FIT-14 | 132 | Noise Isolation F-C5 with Parquet surface | 5, 8,9 |

TABLE 30 CONCRETE FLOORS (Contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) Sound Pressure Level from Tapping Machine 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Five slabs each 8" thick, 48" wide and 166" long laid adjacent to each other to form a continuous floor. Joints were filled to slab depth with cement grout for rigid bonding. The bottom (ceiling side) was textured and painted with latex base paint. Impact measured on standard carpet and pad. | | | | | | | | | | | | | | | | | | | | |
| 8 | 70 | 50 | 44 | 41 | 42 | 39 | 40 | 36 | 25 | 33 | 29 | 23 | 19 | 10 | 8 | 9 | | 45 | RAL IN-68-5 | 159 | Prestressed Acoustical Spandeck (No topping) with standard Carpet and pad | 2,4,5,6,14 |
| | | Seven Hi-stress flexicore slabs 8" x 24" x 9'6" long, formed a horizontal partition. Surface was covered with 44 oz. carpet and 40 oz. hair felt pad. | | | | | | | | | | | | | | | | | | | | |
| | 46 | 34 | 32 | 37 | 36 | 37 | 43 | 46 | 49 | 53 | 55 | 59 | 62 | 66 | 68 | 70 | | | | | Hi-stress Flexicore Slabs with Carpet and pad | 1,2,3,4,5,6,7 |
| 8 | 73 | 46 | 47 | 40 | 40 | 38 | 36 | 24 | 28 | 25 | 23 | 23 | 17 | 10 | | | | 51.8 | CKAL 6612-11 | 74 | | |
| | | Seven Hi-stress flexicore slabs 8" x 24" x 9'6" long formed a horizontal partition. | | | | | | | | | | | | | | | | | | | | |
| | 47 | 34 | 33 | 39 | 39 | 39 | 44 | 46 | 48 | 51 | 53 | 55 | 57 | 59 | 63 | 65 | 64 | | | | 8" Hi-stress Flexicore slabs | 1,2,3,4,5,6,7 |
| 8 | 28 | 64 | 66 | 65 | 67 | 68 | 69 | 71 | 70 | 71 | 73 | 75 | 76 | 75 | 74 | 72 | 72 | 57 | CKAL 6612-12 | 74 | | |
| | | Sample was 8" x 4' x 8' standard Spandeck hollow core concrete slab, with a wet bottom layer of 2" slump concrete. | | | | | | | | | | | | | | | | | | | | |
| 8 | 50 | 32 | 35 | 39 | 38 | 41 | 43 | 47 | 49 | 52 | 52 | 53 | 52 | 57 | 60 | 62 | 63 | 50 | IATL 5-346-1 | 159 | Pre stressed Concrete Plank | 10,11,15 |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 1/2" laminated Oak blocks. | | | | | | | | | | | | | | | | | | | | |
| | 49 | 34 | 34 | 40 | 41 | 42 | 44 | 46 | 48 | 52 | 55 | 57 | 60 | 64 | 67 | 70 | 70 | | | | 8" Hi-stress Flexicore slabs with Oak surface | 1,2,3,4,5,7 |
| 8-1/2 | 47 | 66 | 67 | 67 | 67 | 68 | 67 | 69 | 66 | 64 | 61 | 59 | 55 | 50 | 45 | 42 | 42 | 57.6 | CKAL 6612-19 | 74 | | |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 7/16" fiberglass noise stop board and 1/2" plywood. | | | | | | | | | | | | | | | | | | | | |
| | 47 | 32 | 30 | 37 | 37 | 39 | 44 | 46 | 49 | 52 | 55 | 57 | 61 | 64 | 67 | 69 | 70 | | | | 8" Hi-stress Flexicore slabs with fiberglass board and Plywood surface | 1,2,3,4,5,7 |
| 8-15/16 | 53 | 62 | 65 | 65 | 65 | 66 | 62 | 60 | 56 | 52 | 48 | 42 | 36 | 32 | 26 | 20 | 16 | 58.9 | CKAL 6612-13 | 74 | | |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 7/16" fiberglass noise stop board, two layers of 1/8" Masonite board, and 80 ga. solid vinyl tile. | | | | | | | | | | | | | | | | | | | | |
| | 51 | 34 | 32 | 41 | 43 | 44 | 47 | 49 | 51 | 59 | 57 | 59 | 63 | 66 | 69 | 73 | 73 | | | | 8" Hi-stress Flexicore slabs with fiberglass board, Masonite board, and tile | 1,2,3,4,5,7 |
| 9-1/4 | 55 | 63 | 65 | 65 | 61 | 59 | 52 | 48 | 43 | 38 | 34 | 30 | 27 | 24 | 19 | 14 | 13 | 59.7 | CKAL 6612-18 | 74 | | |

TABLE 30 CONCRETE FLOORS (contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) / Sound Pressure Level from Tapping Machine 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 1 1/2" of concrete topping. Standard carpet and pad. | | | | | | | | | | | | | | | | | | | | |
| | 45 | 33 | 30 | 34 | 37 | 38 | 40 | 44 | 48 | 51 | 53 | 56 | 59 | 63 | 66 | 69 | 69 | | | | | |
| 9-1/2 | 76 | 42 | 44 | 36 | 35 | 33 | 31 | 27 | 24 | 19 | 17 | 16 | 9 | - | - | - | - | 75.3 | CKAL 6612-20 | 74 | 8" Hi-stress Flexicore slabs with concrete topping. Standard carpet and pad | 1,2, 3,4, 5,6, 7 |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 1/2" wood fiber board, 3/8" plywood and 80 ga. solid vinyl tile. | | | | | | | | | | | | | | | | | | | | |
| | 47 | 35 | 31 | 38 | 36 | 39 | 43 | 46 | 49 | 52 | 54 | 57 | 61 | 64 | 68 | 70 | 70 | | | | | |
| 9-1/2 | 54 | 62 | 64 | 65 | 64 | 63 | 60 | 56 | 52 | 48 | 45 | 40 | 36 | 30 | 26 | 20 | 18 | 59.6 | CKAL 6612-17 | 74 | 8" Hi-stress Flexicore slabs with wood fiber board, plywood, & tile | 1,2, 3,4, 5,7 |
| | | Seven slabs 8" x 24" x 9'6" formed the horizontal partition. Surfaced with 1/2" wood fiber board, asphalt felt building paper and laminated oak blocks. | | | | | | | | | | | | | | | | | | | | |
| | 50 | 32 | 34 | 40 | 41 | 42 | 47 | 50 | 51 | 54 | 57 | 60 | 64 | 67 | 67 | 73 | 72 | | | | | |
| 9-1/2 | 54 | 61 | 63 | 64 | 64 | 65 | 62 | 59 | 56 | 52 | 47 | 44 | 40 | 37 | 31 | 24 | 21 | 58.5 | CKAL 6612-16 | 74 | 8" high stress Flexicore slabs with wood fiber-board, asphalt felt, and oak blocks | 1,2, 3,4, 5,7 |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 7/16" fiberglass noise stop board, 1/2" plywood asphalt saturated felt building paper, and 80 ga. vinyl tile. | | | | | | | | | | | | | | | | | | | | |
| | 49 | 28 | 31 | 38 | 40 | 41 | 45 | 47 | 49 | 52 | 54 | 57 | 60 | 64 | 67 | 69 | 70 | | | | | |
| 10 | 55 | 63 | 65 | 63 | 62 | 61 | 54 | 51 | 47 | 41 | 33 | 27 | 23 | 18 | 12 | - | - | 59.7 | CKAL 6612-14 | 74 | 8" Hi-stress Flexicore slabs with fiberglass board, plywood, asphalt felt and tile. | 1,2, 3,4, 5,7 |
| | | 10" prestressed, hollow core, concrete plank. | | | | | | | | | | | | | | | | | | | | |
| | 50 | 37 | 34 | 36 | 40 | 41 | 42 | 47 | 49 | 53 | 55 | 56 | 59 | 62 | 65 | 66 | 66 | | | | | |
| 10 | 29 | 63 | 65 | 65 | 66 | 70 | 68 | 69 | 69 | 71 | 70 | 72 | 74 | 71 | 72 | 71 | 70 | 64 | CKAL 7312-03 | 78 | 10" Stresscore | 2,3, 4,10 |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 7/16" fiberglass noise stop board, 1/2" plywood, asphalt saturated felt building paper, and 1/2" laminated Oak block. | | | | | | | | | | | | | | | | | | | | |
| | 51 | 33 | 35 | 40 | 43 | 44 | 46 | 49 | 50 | 53 | 56 | 59 | 62 | 65 | 68 | 71 | 70 | | | | | |
| 10 | 55 | 63 | 64 | 63 | 62 | 62 | 56 | 52 | 48 | 45 | 40 | 37 | 32 | 29 | 23 | 18 | 15 | 59.6 | CKAL 6612-15 | 74 | 8" Hi-stress Flexicore slabs with fiberglass board, asphalt felt, and Oak blocks | 1,2, 3,4, 5,7 |
| | | 10" pre-stressed, hollow core, concrete plank surfaced with 1/8" underlayment and 1/8" vinyl asphalt tile. | | | | | | | | | | | | | | | | | | | | |
| | 50 | 37 | 34 | 36 | 39 | 42 | 43 | 47 | 49 | 52 | 55 | 57 | 59 | 62 | 64 | 66 | 66 | | | | | |
| 10-1/4 | 35 | 60 | 63 | 65 | 64 | 65 | 68 | 67 | 68 | 69 | 67 | 68 | 71 | 70 | 68 | 65 | 65 | 60 | CKAL 7312-04 | 78 | 10" Stresscore with underlay-ment and tile | 2,3, 4,5, 10 |

## TABLE 30 CONCRETE FLOORS (Contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) Sound Pressure Level from Tapping Machine 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 1 1/2" concrete topping, 1/2" wood fiber board, and 1/2" laminated Oak blocks. | | | | | | | | | | | | | | | | | | | | |
| | 49 | 38 | 35 | 38 | 41 | 41 | 45 | 47 | 49 | 52 | 56 | 58 | 61 | 65 | 69 | 71 | 71 | | | | 8" Hi-stress Flexicore slabs with concrete topping, wood fiber board and Oak blocks | 1,2, 3,4, 5,7, |
| 10-1/2 | 53 | 60 | 64 | 61 | 63 | 64 | 64 | 61 | 58 | 52 | 47 | 42 | 38 | 32 | 27 | 23 | 19 | 75.9 | CKAL 6612-22 | 74 | | |
| | | Seven slabs 8" x 24" x 9'6" formed a horizontal partition. Surfaced with 1-1/2" concrete topping, 1/2" wood fiber board, 3/8" plywood, and 80 ga vinyl tile. | | | | | | | | | | | | | | | | | | | | |
| | 49 | 38 | 36 | 40 | 42 | 42 | 45 | 48 | 51 | 53 | 57 | 54 | 63 | 66 | 69 | 72 | 72 | | | | 8" Hi-stress Flexicore slabs with concrete topping, wood fiber board plywood, & tile | 1,2, 3,4, 5,7 |
| 11 | 55 | 59 | 63 | 62 | 64 | 64 | 61 | 58 | 54 | 49 | 44 | 38 | 31 | 26 | 19 | 12 | 9 | 77.1 | CKAL 6612-21 | 74 | | |
| | | 14" T-section concrete joists with 2" concrete topping. This was the reference floor for all succeeding data. | | | | | | | | | | | | | | | | | | | | |
| 16 | 54 | 39 | 40 | 42 | 45 | 49 | 47 | 50 | 52 | 51 | 52 | 55 | 58 | 60 | 62 | 65 | 68 | 75 | RAL | 121 | Reference floor | 4,10, 12,15 |
| | | 14" T-section concrete joists with 2" concrete topping. Surface was 4" floating concrete floor. | | | | | | | | | | | | | | | | | | | | |
| | 57 | 47 | 46 | 49 | 51 | 52 | 50 | 55 | 54 | 52 | 55 | 58 | 61 | 63 | 65 | 67 | 71 | | | | | |
| 20 | 24 | | | | | | | | | | | | | | | | | 125 | RAL | 121 | Floating floor mounts | 4,5, 10,12 |
| | | 14" T-section concrete joists with 2" concrete topping, 1" air space, surface was 4" floating concrete floor without flanking protection. | | | | | | | | | | | | | | | | | | | | |
| | 61 | 44 | 45 | 46 | 47 | 54 | 56 | 58 | 61 | 63 | 68 | 72 | 74 | 75 | 80 | 82 | 87 | | | | | |
| 21 | 68 | | | | | | | | | | | | | | | | | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12 |
| | | 14" T-section concrete joists with 2" concrete topping. 1" air space. Surface was 4" floating concrete floor with flanking protection. | | | | | | | | | | | | | | | | | | | | |
| | 76 | 57 | 55 | 63 | 67 | 73 | 73 | 78 | 83 | 85 | 88 | 93 | 97 | 97 | 101 | 104 | 105 | | | | | |
| 21 | 68 | | | | | | | | | | | | | | | | | 125 | RAL | 121 | Floating Floor Mounts | 4, 5,10, 12,13 |
| | | 14" T-section concrete joists with 2" concrete topping, 2" air space, surface was 4" floating concrete floor. | | | | | | | | | | | | | | | | | | | | |
| | 61 | 44 | 45 | 45 | 48 | 54 | 56 | 59 | 62 | 63 | 68 | 72 | 73 | 75 | 79 | 84 | 90 | | | | | |
| 22 | 68 | | | | | | | | | | | | | | | | | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12 |

TABLE 30 CONCRETE FLOORS (Contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) Sound Pressure Level from Tapping Machine 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 14" T-section concrete joists with 2" concrete topping, 2" air space, surface was 4" floating concrete floor (with flanking protection). | | | | | | | | | | | | | | | | | | | | |
| 22 | 79<br>68 | 60 | 58 | 65 | 69 | 75 | 74 | 80 | 85 | 86 | 88 | 93 | 96 | 101 | 104 | 105 | 106 | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12, 13 |
| | | 14" T-section concrete joists with 2" concrete topping, 2" air space filled with 75% glass fiber fill. Surface was 4" floating concrete floor (with flanking protection) | | | | | | | | | | | | | | | | | | | | |
| 22 | 82 | 59 | 61 | 68 | 73 | 79 | 78 | 83 | 86 | 88 | 89 | 95 | 97 | 97 | 100 | 104 | 106 | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12, 13,15 |
| | | 14" T-section concrete joists with 2" concrete topping. 3" air space. Surface was 4" floating concrete floor floating on the floor mounts. Flanking noise problem was encountered during the test | | | | | | | | | | | | | | | | | | | | |
| 23 | 63<br>68 | 47 | 47 | 46 | 50 | 55 | 57 | 60 | 62 | 64 | 69 | 72 | 74 | 76 | 79 | 85 | 92 | 125 | RAL TL71-152 | 121 | Floating floor mounts. Mason type FSN-1336 with type EAPM-7640 neoprene elements. | 4,5, 10,12 |
| | | 14" T-section concrete joists with 2" concrete topping, 3" air space, surface was 4" floating concrete floor. Flanking protection increased STC by 17 decibels compared to the data shown above for test No. TL71-152. | | | | | | | | | | | | | | | | | | | | |
| 23 | 80<br>68 | 62 | 59 | 67 | 72 | 77 | 74 | 80 | 86 | 87 | 88 | 92 | 95 | 99 | 101 | 107 | 105 | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12, 13 |
| | | 14" T-section concrete joists with 2" concrete topping, 4" air space, surface was 4" floating concrete floor no flanking protection. | | | | | | | | | | | | | | | | | | | | |
| 24 | 63<br>69 | 47 | 47 | 46 | 50 | 54 | 57 | 60 | 62 | 65 | 69 | 73 | 75 | 77 | 80 | 86 | 91 | 125 | RAL | 121 | Floating Floor Mounts | 4,5, 10,12 |
| | | 14" T-section concrete joists with 2" concrete topping, 4" air space, surface was 4" floating concrete floor with flanking protection | | | | | | | | | | | | | | | | | | | | |
| 24 | 82<br>69 | 63 | 61 | 66 | 72 | 78 | 77 | 82 | 87 | 86 | 87 | 91 | 93 | 97 | 101 | 103 | 104 | 125 | RAL | 121 | Floating Floor mounts | 4,5, 10,12, 13 |

FOOTNOTES FOR TABLE 30

CONCRETE FLOORS

1. Tested and evaluated according to ASTM E90-61T, specifications.
2. Tested and evaluated according to ISO R140 specifications (see Section V-3: ASTM E492-73T).
3. First row of numbers designates sound transmission loss, second row designates impact sound pressure levels.
4. IIC computed using: IIC = INR + 51.
5. Approximate thickness computed from sketches of the product.
6. Carpet and pad thicknesses not included in overall thickness.
7. Joints between sections were granted from top and caulked on underside.
8. STC estimated.
9. Data were provided in graphical form.
10. Tested and evaluated according to ASTM E90-70 specifications.
11. Tested and evaluated according to ASTM RM-14-4 specifications.
12. Tested and evaluated according to ASTM E413-70T specifications.
13. Flanking protection was provided by building a complete secondary room within the source room.
14. Specimen tested for impact insulation only.
15. Specimen tested for sound transmission loss only.

TABLE 31
WOOD FLOORS

Wood floors or the floor materials when they were tested in wood floor assemblies are listed. The word "wood floor" is loosely interpreted here to include floors which have wood as their basic structural material. The description supplied with each listing gives more accurate information about the floor assemblies. The table shows sound transmission losses of the assemblies tested and the sound pressure levels generated in the rooms below when the floors were tapped by standard tapping machines. These sound pressure levels are indicative of the effectiveness of the floors in reducing the annoyance caused in a room by movement of people and furniture on the floor above the room. The test procedure to measure the sound pressure level and the impact insulation class are explained fully in Section I-3.4.

The floors listed in this table are, in general, lighter than those listed in Table 30. The table shows two sets of data for each product. The upper data set shows the sound transmission class and the sound transmission losses, and the lower data set shows the impact insulation class and the sound pressure levels generated by a tapping device.

It should be noted that the product listed in the table may not be a floor assembly itself but the floor was tested with the product as a part of the assembly and the data are therefore presented in this table. The companies (by numbers shown in Section II) with products listed in Table 31 are: 132, 171, 189.

CAUTION

1. TWO SETS OF DATA ARE PRESENTED FOR EACH PRODUCT. LOWER SET OF DATA REPRESENTS SOUND PRESSURE LEVEL GENERATED BY A TAPPING MACHINE AND THE IMPACT INSULATION CLASS OF THE FLOOR. SEE SECTION I-3.4 FOR EXPLANATION.

2. THE PRODUCT LISTED IN THE TABLE MAY ONLY BE A FLOOR ACCESSORY BUT IT WAS TESTED IN A FLOOR SYSTEM AND, HENCE IS LISTED IN THIS TABLE.

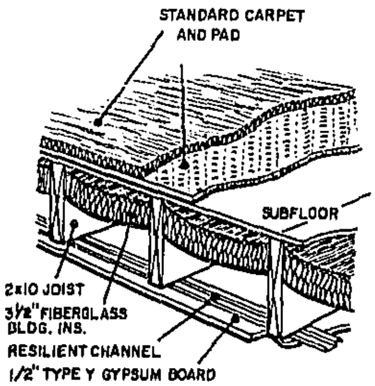



Figure 31 A Floor with Wood Support Structure and a Carpet Cover

GLOSSARY

Joists: Parallel structural members that support the floor.

Standard Carpet and Pad: 44 oz per square yard Gro-Point carpet with 40 oz per square yard hair felt pad. (see discussion in Subsection I-4.1.4).

TABLE 31 WOOD FLOORS

| Thickness (inches) | IIC/STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) — Sound Pressure Level from Tapping Machine | | | | | | | | | | | | | | | | | | | | |
| 2" x 10" wood floor joist with 3½" fiberglass building insulation. 5/8" plywood with lightweight carpet (22 oz) and pad on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | | | |
| | 51 | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| 12 | 58 | 63 | 62 | 57 | 52 | 48 | 43 | 38 | | | | | | | | | | - | CT OCF. No. F1-19-68 | 132 | Noise isolation F-W24 (with lightweight carpet and pad) | 3,5,6,9 |
| 2" x 10" wood floor joist with 3½" fiberglass building insulation. 5/8" plywood with standard carpet (44 oz) and pad on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | | | |
| | 51 | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| 12 | 70 | 48 | 46 | 43 | 39 | 39 | 38 | 35 | | | | | | | | | | - | CT OCF No. F1-18-68 | 132 | Noise isolation F-W24 (with lightweight carpet and pad) | 3,5,6,9 |
| 2" x 10" wood floor joist with glass fiber insulation. 3/8" plywood, ½" sound deadening board, ¼" plywood underlayment, and vinyl floor covering on top. Resilient channel with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | | | |
| | 58 | 36 | 42 | 43 | 47 | 49 | 52 | 55 | 58 | 61 | 66 | 70 | 71 | 71 | 70 | 74 | 78 | | | | | |
| 12¼ | 55 | 61 | 59 | 62 | 61 | 59 | 58 | 55 | 50 | 47 | 44 | 39 | 36 | 37 | 37 | 32 | 25 | 10.8 | RAL TL70-72 IN70-11 | 189 | Vinyl finish floor | 2,3,4,5,7 |
| 2" x 10" wood floor joist with glass fiber insulation. ½"plywood, ½" sound deadening board, 1" x 3" wood sleeper, 5/8" plywood underlayment and vinyl floor covering on top. Resilient channel and 5/8" gypsum board on bottom | | | | | | | | | | | | | | | | | | | | | | |
| | 57 | 37 | 40 | 43 | 46 | 49 | 52 | 55 | 57 | 61 | 65 | 68 | 70 | 68 | 66 | 69 | 75 | | | | | |
| 13¼ | 56 | 60 | 61 | 60 | 60 | 59 | 57 | 54 | 50 | 46 | 44 | 40 | 37 | 38 | 39 | 32 | 35 | 11.6 | RAL TL70-61 IN70-9 | 189 | Vinyl finish floor with wood sleeper | 2,3,4,5,7,8 |
| 2" x 10" wood floor joist with 3½" fiberglass insulation. 5/8" plywood, 7/16" fiberglass board, 2 layers of ¼" particle board and vinyl asbestos tile on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | | | |
| | 51 | - | | | - | | | - | | | - | | | - | | | - | | | | | |
| 14 | 52 | 72 | | | 71 | | | 65 | | | 57 | | | 43 | | | 38 | - | CT OCF No. F1-12-68 | 132 | Noise isolation F-W26 (vinyl tile surface) | 5,9 |

TABLE 31 WOOD FLOORS (Contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) | | | | | | | | | | | | | | | | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sound Pressure Level from Tapping Machine | | | | | | | | | | | | | | | | | | | | |
| | | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | | | | | |
| | | | | | 2" x 10" wood floor joist with 3½" fiberglass insulation. 5/8" plywood, 7/16" fiberglass board, 2 layers of ¼" particle board and parquet finish on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | |
| | 51 | - | | | - | | | - | | | - | | | - | | - | | | | | | |
| 14 | 53 | 70 | | | 68 | | | 63 | | | 57 | | | 43 | | 38 | | - | CT OCF No. F1-13-68 | 132 | Noise isolation F-W26 (parquet surface) | 5,9 |
| | | | | | 14" Trus Joist cavity with 3/4" plywood, ¼" underlayment and 1/8" vinyl tile on top. Resilient channel with 5/8" gypsum board. | | | | | | | | | | | | | | | | | |
| | 47 | 30 | 32 | 35 | 36 | 39 | 42 | 45 | 47 | 50 | 52 | 52 | 51 | 47 | 50 | 59 | 65 | | | | | |
| 16½ | 45 | 74 | 75 | 73 | 71 | 69 | 63 | 57 | 52 | 47 | 45 | 45 | 48 | 52 | 49 | 44 | 40 | - | CKAL 7212-04 | 171 | Trus Joist | 2,3, 4,5, 10 |
| | | | | | 14" Trus Joist cavity with 2 layers of 1½" sound attenuation blankets. 3/4" plywood with mastic layers, ¼" underlayment and 1/8" vinyl tile on top. Resilient channels with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | |
| | 52 | 24 | 38 | 38 | 42 | 43 | 46 | 49 | 50 | 53 | 56 | 58 | 62 | 61 | 63 | 67 | 68 | | | | | |
| 16½ | 51 | 68 | 67 | 68 | 65 | 63 | 58 | 51 | 44 | 39 | 37 | 35 | 33 | 37 | 37 | 39 | 28 | - | CKAL 7212-03 | 171. | Trus Joist | 2,3, 4,5, 10 |
| | | | | | 14" Trus Joist cavity with 3/4" plywood, rosin paper, and 3/8" plywood on top. Resilient channel with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | |
| | 48 | 26 | 31 | 34 | 37 | 41 | 45 | 49 | 51 | 52 | 53 | 53 | 52 | 48 | 47 | 52 | 56 | | | | | |
| 16½ | 62 | 50 | 42 | 36 | 34 | 30 | 26 | 24 | 18 | 17 | 14 | 11 | 12 | | | | | 7.5 | RAL TL70-48 IN70-7 | 171 | Trus Joist | 2,3, 4,5, 7,8, 12 |
| | | | | | 14" Trus Joist cavity with 1-3/4" floor decking and standard carpet and pad on top. ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | |
| | 42 | 22 | 21 | 30 | 35 | 35 | 38 | 45 | 47 | 52 | 56 | 61 | 65 | 66 | 69 | 70 | 71 | | | | | |
| 16½ | 58 | 56 | 51 | 48 | 40 | 40 | 39 | 32 | 32 | 27 | 23 | 19 | 18 | 16 | 15 | 15 | | 8.8 | KAL 858-1-70 | 171 | Trus Joist | 2,3, 4,7 |
| | | | | | 14" Trus Joist cavity with 1-3/4" floor decking and standard carpet and pad on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | |
| | 48 | 28 | 28 | 36 | 38 | 40 | 41 | 47 | 51 | 55 | 60 | 63 | 66 | 72 | 71 | 71 | 72 | | | | | |
| 16½ | 65 | 45 | 39 | 35 | 31 | 32 | 26 | 26 | 22 | 15 | 15 | | | | | | | 8.9 | KAL 858-3-70 | 171 | Trus Joist | 2,3, 4,7 |

TABLE 31 WOOD FLOORS (Contd)

| Thickness (inches) | IIC/STC | Transmission Loss (decibels) — Sound Pressure Level from Tapping Machine: 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 14" Trus Joist with rockwool butts. 1-3/4" floor decking with standard carpet and pad on top. Resilient channel with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 50 | 32 | 30 | 38 | 42 | 38 | 43 | 48 | 51 | 55 | 61 | 65 | 68 | 72 | 75 | 75 | 75 | | | | | |
| 16½ | 65 | 45 | 38 | 33 | 27 | 28 | 15 | 19 | 18 | 15 | | | | | | | | 9.7 | KAL<br>858-5-70 | 171 | Trus Joist | 2,3,<br>4,5,<br>7 |
| | | 14" Trus Joist cavity with 3/4" plywood, 15 lb asphalted felt, and 5/8" mastical gypsum concrete on top. Resilient channel and 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 53 | 33 | 37 | 37 | 43 | 46 | 50 | 54 | 57 | 59 | 60 | 60 | 58 | 52 | 52 | 59 | 65 | | | | | |
| | 69 | 47 | 39 | 32 | 28 | 25 | 23 | 18 | 11 | 10 | | | | | | | | | | | | |
| 16½ | 33 | 70 | 69 | 67 | 66 | 67 | 65 | 62 | 62 | 61 | 62 | 61 | 64 | 69 | 70 | 63 | 56 | 11.9 | RAL<br>TL70-1<br>IN70-3<br>IN70-2 | 171 | Trus Joist | 2,3,<br>4,7,<br>8,12,<br>13. |
| | | 14" Trus Joist with 2" therma-fiber insulation. 3/4" plywood, 15 lb asphalted felt, and 5/7" mastical gypsum concrete on top. Resilient channel and 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 60 | 39 | 45 | 45 | 49 | 52 | 54 | 57 | 60 | 63 | 67 | 70 | 70 | 65 | 63 | 69 | 77 | | | | | |
| 16½ | 72 | 41 | 34 | 27 | 23 | 22 | 18 | 14 | 10 | 7 | 7 | | | | | | | 12.3 | RAL<br>TL70-9<br>IN70-4 | 171 | Trus Joist | 2,3,<br>4,7,<br>8,12 |
| | | 14" Trus Joist cavity with 3/4" plywood, ½" sound board, and ½" parquet flooring on top. Resilient channel and 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 48 | 30 | 34 | 34 | 37 | 39 | 43 | 45 | 47 | 50 | 51 | 52 | 52 | 49 | 51 | 57 | 64 | | | | | |
| 16⅝ | 41 | 77 | 74 | 73 | 72 | 72 | 68 | 66 | 62 | 58 | 57 | 56 | 58 | 62 | 61 | 52 | 45 | - | CKAL<br>7212-01 | 171 | Trus Joist | 2,3,<br>4,10,<br>11 |
| | | 14" Trus Joist cavity with 3/4" plywood, rosin paper, and 3/8" plywood on top. Resilient channel with ½" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 49 | 28 | 28 | 30 | 33 | 36 | 41 | 45 | 48 | 52 | 55 | 57 | 58 | 58 | 54 | 56 | 62 | | | | | |
| 16⅝ | 66 | 49 | 45 | 42 | 44 | 39 | 33 | 29 | 22 | 16 | 11 | | | | | | | 9.0 | RAL<br>TL70-53<br>IN70-8 | 171 | Trus Joist | 2,3<br>4,7<br>8,12 |
| | | 14" Trus Joist cavity with two layers of 1½" sound attenuation blankets. 3/4" plywood with mastic layers, ½" underlayment and ½" parquet flooring on top. Resilient channels and 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 52 | 34 | 37 | 39 | 40 | 44 | 45 | 48 | 50 | 53 | 56 | 59 | 63 | 62 | 65 | 67 | 69 | | | | | |
| 16⅝ | 51 | 68 | 67 | 68 | 65 | 64 | 60 | 58 | 52 | 47 | 45 | 42 | 41 | 45 | 42 | 41 | 33 | - | CKAL<br>7212-02 | 171 | Trus Joist | 2,3,<br>4,10,<br>11 |

TABLE 31 WOOD FLOORS (Concl)

| Thickness (Inches) | IIC/STC | Transmission Loss (decibels) / Sound Pressure Level from Tapping Machine 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 14" Trus Joist with 3/4" plywood and 1-5/8" light-weight concrete on top. Resilient channel with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 58 | 39 | 40 | 43 | 47 | 51 | 54 | 57 | 57 | 57 | 59 | 64 | 66 | 65 | 64 | 69 | 74 | | RAL TL70-44 | | | 2,3, 4,7, |
| 17½ | 80 | 40 | 33 | 27 | 25 | 22 | 19 | 17 | 12 | 12 | 12 | 11 | 9 | | | | | - | IN70-6 | 171 | Trus Joist | 8,12 |
| | | 18" Trus Joist cavity with 3" fiberglass insulation. 1-1/8" plywood plus standard carpet and pad on top. Resilient channel with 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 47 | 28 | [35] | | 38 | [41] | | 47 | [49] | | 53 | [57] | | 64 | [63] | | 64 | | KAL 224-36-65 | | | 1,2, 3,4, |
| 19¾ | 69 | | [56] | | | [46] | | | [43] | | | [34] | | | [30] | | | - | 224-35-65 | 171 | Trus Joist | 14,15 |
| | | 18" Trus Joist cavity with 5/8" plywood, 1-5/8" concrete, and standard carpet and pad on top. 5/8" gypsum board on bottom. | | | | | | | | | | | | | | | | | | | | |
| | 46 | | - | | | - | | | - | | | - | | | - | | | | KAL 224-38-65 | | | |
| 20½ | 62 | | [63] | | | [48] | | | [39] | | | [33] | | | [25] | | | - | 224-37-65 | 171 | Trus Joist | 1,2, 4,15 |

FOOTNOTES FOR TABLE 31

WOOD FLOORS

1. Tested and evaluated according to ASTM E90-61T specifications.
2. Tested and evaluated according to ISO R140 specifications.
3. First row of numbers designate sound transmission loss, second row designates impact sound pressures in receiving room.
4. IIC computed using: IIC = INR + 51.
5. Approximate thickness computed from sketches of the product.
6. Carpet and pad thicknesses not included in overall thickness.
7. Tested and evaluated according to ASTM E90-66T.
8. Tested and evaluated according to ASARP-Z24.19-1957.
9. Data were provided in graphical form.
10. Tested and evaluated according to ASTM E90-70 specifications.
11. Tested and evaluated according to ASTM E413-70T specifications.
12. Impact noise rating performed with standard carpet and pad.
13. Bottom row of numbers for impact test using floor loaded with additional 10 lb/ft$^2$ without carpet and pad.
14. Transmission loss numbers in brackets are for one-third octave bands with center frequencies of 175, 350, 700, 1400, and 2800 Hz, respectively.
15. Impact sound pressure levels in brackets are at 150, 300, 600, 1200, 2400, and 4800 Hz, respectively.

TABLE 32

DOORS

Doors and their sound transmission losses are listed. The table illustrates the ranges of thicknesses and sound transmission classes available in doors. The thicknesses range from 1-3/8 inch to 11 inches and the sound transmission classes range from 13 to 65 for the doors listed in the table. Steel and wood are the most commonly used door materials. Acoustical insulation in the door cavities and good acoustical seal around the edges are essential for better performance. Improper seal around the edges of even the thickest door will result in very low sound transmission loss and therefore extreme care should be taken to ensure that a positive seal exists between the door frame and the door. Many sealing arrangements are possible. Most common is the gasket type seal. Figure 32, however, shows an "active" seal which is inflated by 15 psi air. This figure shows only one of the many other types of door, frame, and seal designs.

The table is subdivided in two parts for convenience. Table 32A lists doors with thicknesses less than 2 inches. Table 32B lists doors with thicknesses greater than 2 inches, and the doors for which the thickness was not given. The companies (by numbers shown in Section II) with products listed in Table 32 are: 23, 55, 59, 63, 70, 96, 101, 104, 108, 112, 114, 117, 123, 124, 126, 131, 136, 145, 156, 157, 176, 189.

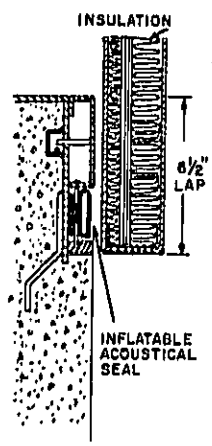



Figure 32 A Cross Section of a Door and Its Frame

## GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other side surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |

TABLE 32A DOORS
(Less than 2" thick)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 18 Ga. Steel - 7'2" x 3' weighing 84 lbs and having flat surface structure. | | | | | | | | | | | | | | | | | | |
| 1-3/8 | 13 | 13 | [10] | | 15 | [15] | | 16 | [16] | | 16 | [16] | | 13 | [12] | | 13 | 3.9 | G&H DSP-4ST | 70 | R 3072-M Fenestra | 1,8 |
| | | | | 18 Ga. Steel - 7'2" x 3' weighing 84 lbs | | | | | | | | | | | | | | | | | | |
| 1-3/8 | 25 | 19 | [15] | | 20 | [24] | | 28 | [30] | | 29 | [27] | | 22 | [25] | | 25 | 3.9 | G&H DSP-3ST | 70 | R 3072-M Fenestra | 1,8 |
| | | | | Metal door - 35-3/4" x 79-1/8" | | | | | | | | | | | | | | | | | | |
| 1-3/8 | 32 | 26 | 24 | 27 | 26 | 27 | 27 | 28 | 30 | 31 | 32 | 32 | 21 | 32 | 35 | 38 | 40 | 3.4 | RAL TL69-249 | 23 | Amweld 1500 series | 4,24 |
| | | | | Door - 7'2" x 3' | | | | | | | | | | | | | | | | | | |
| 1-3/8 | 33 | 22 | [17] | | 21 | [31] | | 36 | [37] | | 38 | [34] | | 32 | [35] | | 33 | 4.6 | G&H DSP-2ST | 70 | R 3072-M Fenestra | 1,8 |
| | | | | Facing of 16 Ga. steel - 7'2" x 4' and masonry as core | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 14 | 18 | [13] | | 14 | [15] | | 16 | [16] | | 16 | [15] | | 13 | [13] | | 13 | 5.4 | G&H DSP-9ST | 70 | F6C 4072-M Fenestra | 1,8 |
| | | | | Flush wood door - 35 3/4" x 83 3/4" | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 19 | 14 | 15 | 18 | 18 | 18 | 19 | 17 | 22 | 23 | 23 | 23 | 21 | 18 | 16 | 16 | 19 | 4.1 | RAL TL71-136 | 123 | Perma strait doors Plastic laminated | 5,9 |
| | | | | Facing of 20 Ga. steel 7'2" x 4' fiberglass as core | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 24 | 15 | [17] | | 20 | [26] | | 29 | [31] | | 30 | [26] | | 23 | [26] | | 23 | 3.9 | G&H DSP-6ST | 70 | Fenestra | 1,8 |
| | | | | Facing of steel, backing of steel - 35 3/4" x 83 1/8" and sound attenuation core. | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 24 | 25 | [26] | | 28 | [29] | | 28 | [28] | | 23 | [30] | | 42 | [43] | | 44 | - | RAL TL66-139 | 145 | Republic steel doors - series 634 | 2,10 |
| | | | | Polyurethane foam as core and steel surfaces - 6'7-1/4" x 2'8" | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 27 | 22 | 22 | 25 | 26 | 25 | 28 | 28 | 29 | 29 | 28 | 28 | 24 | 23 | 32 | 37 | 37 | - | RAL TL71-312 | 114 | Therma-Tru entry system | 5,11 |
| | | | | Wood door - 7' x 3' | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 28 | 23 | 25 | 24 | 28 | 28 | 29 | 27 | 27 | 26 | 25 | 26 | 28 | 30 | 32 | 24 | 32 | 4.8 | RAL TL69-364 | 176 | STC 28 Door System | 3,12 |
| | | | | Flush wood door - 3' x 7' | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 28 | 22 | 22 | 24 | 26 | 28 | 30 | 29 | 30 | 29 | 26 | 26 | 28 | 26 | 28 | 30 | 32 | 5.1 | RAL TL71-182 | 123 | Perma Strait doors wood veneered | 5,9 |
| | | | | Facing of 18 Ga. steel 7'2" x 4' | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 29 | 21 | [23] | | 22 | [26] | | 32 | [24] | | 32 | [29] | | 28 | [31] | | 27 | 4.65 | G&H DSP-5ST | 70 | F 6 C4072-M Fenestra | 1,8 |

## TABLE 32A DOORS (Contd) (Less than 2" thick)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Facing of 16 Ga. steel 7'2" x 4' | | | | | | | | | | | | | | | | | |
| 1-3/4 | 30 | 25 | [26] | | 27 | [30] | | 32 | [37] | | 35 | [30] | | 28 | [32] | | 30 | 6.8 | G&H DSP-7ST | 70 | F 6 C4072-M Fenestra | 1,8 |
| | | | | | Facing of 16 Ga. steel 7'2" x 4' | | | | | | | | | | | | | | | | | |
| 1 3/4 | 30 | 21 | [25] | | 25 | [28] | | 30 | [36] | | 34 | [30] | | 33 | [36] | | 31 | 5.4 | G&H DSP-8ST | 70 | F 6 C4072-M Fenestra | 1,8 |
| | | | | | Sound attenuation core with steel surfaces 35-3/4" x 83-1/8" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 30 | 26 | [25] | | 27 | [26] | | 26 | [30] | | 30 | [30] | | 29 | [30] | | 33 | - | RAL TL63-136 | 145 | Republic steel doors - series 634 | 1,10 |
| | | | | | Sound attenuation core with steel surfaces | | | | | | | | | | | | | | | | | |
| 1-3/4 | 31 | 26 | [25] | | 28 | [26] | | 27 | [30] | | 31 | [34] | | 31 | [31] | | 36 | - | RAL TL63-137 | 145 | Republic steel doors - series 634 | 2,10 |
| | | | | | Sound attenuation core with steel surfaces 35-3/4" x 83-1/8" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 32 | 22 | [22] | | 27 | [27] | | 28 | [31] | | 34 | [36] | | 32 | [32] | | 38 | - | RAL TL66-140 | 145 | Republic steel doors - series 634 | 2,10 |
| | | | | | Sound attenuation core with steel surfaces 35-3/4" x 83-1/8" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 33 | 20 | [24] | | 27 | [28] | | 30 | [32] | | 33 | [34] | | 33 | [30] | | 38 | 3.9 | RAL TL66-140 | 145 | Republic steel doors - series 634 | 2,10 |
| | | | | | Metal door - 35-3/4" x 79-1/8" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 33 | 28 | 28 | 29 | 30 | 30 | 30 | 29 | 30 | 31 | 33 | 33 | 31 | 34 | 37 | 38 | 35 | 4.6 | RAL TL69-290 | 23 | Amweld 1-3/4" 1500 series door | 4,13 |
| | | | | | 18 Ga. steel - 6'11-3/4" x 2'11-3/4" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 35 | 32 | [31] | | 29 | [29] | | 40 | [42] | | 43 | [42] | | 41 | [43] | | 48 | 6.8 | RAL TL63-160 | 131 | Overly acoustical door - 1-3/4" single glazed | 1 |
| | | | | | Sound attenuation core with steel surfaces 35-3/4" x 83-1/2" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 35 | 20 | [29] | | 26 | [29] | | 36 | [40] | | 41 | [43] | | 45 | [45] | | 46 | - | RAL TL66-138 | 145 | Republic steel doors - series 634 | 2,10 |
| | | | | | Plywood door - 7' x 3' | | | | | | | | | | | | | | | | | |
| 1-3/4 | 36 | 28 | 28 | 29 | 30 | 31 | 33 | 33 | 34 | 35 | 35 | 37 | 37 | 36 | 38 | 38 | 38 | 6.7 | RAL TL69-226 | 145 | STC 36 door system | 3,12 |
| | | | | | Weyerhauser, Timeblend high density core with hardwood surfaces 35-7/8" x 83-3/4" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 36 | 34 | [31] | | 34 | [36] | | 35 | [37] | | 36 | [-] | | 38 | [-] | | 40 | 6.7 | RAL TL64-182 | 189 | Sound retardant door Weyerhauser | 14 |
| | | | | | Metal door - 35-3/4" x 79-1/8" | | | | | | | | | | | | | | | | | |
| 1-3/4 | 36 | 29 | 29 | 30 | 32 | 32 | 34 | 34 | 35 | 36 | 37 | 36 | 33 | 35 | 37 | 39 | 39 | 6.7 | RAL TL69-293 | 23 | Amweld 1-3/4" 3500 series door | 4,15 |

TABLE 32A DOORS (Contd)
(Less than 2" thick)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Flush wood door - Face wood veneer or plastic laminated 3' x 7' | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 37 | 26 | 24 | 27 | 30 | 32 | 34 | 33 | 35 | 36 | 39 | 40 | 39 | 40 | 40 | 40 | 42 | 5.1 | RAL TL71-183 | 123 | Perma strait doors | 5,9 |
| | | Hollow metal kraft E11-99-1AS honey comb paper core with 18 Ga. or 16 Ga. CRS surfaces 6'11-3/4" x 2'11" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 37 | 29 | 28 | 30 | 31 | 30 | 33 | 34 | 36 | 37 | 38 | 38 | 35 | 35 | 39 | 42 | 45 | 21 | RAL TL69-168 | 63 | Sound Sentry door | 3 |
| | | Flush wood door 35-3/4" x 83-3/4" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 38 | 25 | 26 | 31 | 33 | 35 | 37 | 34 | 34 | 35 | 35 | 39 | 40 | 42 | 45 | 44 | 46 | 8.1 | RAL TL71-66 | 145 | 38 STC Sound door | 4 |
| 1-3/4 | 40 | 20 | 25 | 33 | 36 | 38 | 39 | 39 | 40 | 42 | 43 | 41 | 40 | 41 | 42 | 42 | 49 | 6 | RAL TL73-41 | 63 | 3' x 7' Door | 5 |
| | | Plywood door - 7' x 3' | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 40 | 33<br>30 | 30<br>30 | 32<br>32 | 33<br>34 | 34<br>34 | 36<br>36 | 38<br>36 | 39<br>38 | 41<br>39 | 42<br>40 | 43<br>41 | 44<br>42 | 44<br>43 | 43<br>43 | 43<br>42 | 44<br>43 | 6.7 | RAL TL69-258 | 176 | STC 40 Door system | 3, 16 |
| | | Louver flush hollow metal construction having 18 Ga. steel facing 6'11-3/4" x 2'11-3/4" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 41 | 31. | | [30] | 28 | [36] | | 42 | [44] | 47 | | 47] | 49 | | [50] | 55 | | 7.4 | RAL TL63-155 | 131 | Overly Acoustical Door | 1,25 |
| | | Single glazed door (300 sq. in. glazing) flush hollow metal construction. Internally reinforced and having 16 Ga. steel facing 6'11-1/2" x 2'11-3/4" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 41 | 24 | | [29] | 37 | [36] | | 37 | [38] | 40 | | [42] | 45 | | [48] | 50 | | 11.3 | RAL TL66-287 | 131 | Overly Acoustical Door | 1,25 |
| | | 16 Ga. steel facing 4' x 8' | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 42 | 26 | 26 | 29 | 32 | 38 | 42 | 41 | 42 | 43 | 41 | 41 | 41 | 43 | 45 | 46 | 47 | 7.9 | CKAL 704-7 | 131 | *Overly Acoustical* Door | 3,17 |
| | | Hollow metal door 35-3/4" x 83-3/4" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 42 | 25 | 25 | 32 | 35 | 37 | 39 | 49 | 39 | 39 | 41 | 44 | 48 | 51 | 53 | 53 | 53 | 8.1 | RAL TL70-98 | 117 | Sound Door | 4,18 |
| | | Hollow metal door 83-5/8" x 35-3/4" | | | | | | | | | | | | | | | | | | | | |
| 1-3/4 | 43 | 24 | 29 | 36 | 41 | 43 | 45 | 45 | 44 | 44 | 44 | 43 | 41 | 42 | 44 | 48 | 49 | 9.3 | RAL TL68-282 | 96 | Hollow metal doors | 4 |

TABLE 32A DOORS (concl)
(Less than 2" thick)

| Thickness (inches) | STC | Description | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-3/4 | 43 | Single glazed door with 16 Ga. steel facing 6'11-1/2" x 2'11-3/4" | 25 | [29] | | 38 | [37] | | 39 | [40] | | 42 | [45] | | 48 | [50] | | 52 | 11.3 | RAL TL66-286 | 131 | Overly Acoustical Door | 1 |
| 1-3/4 | 44 | Double glazed door (up to 300 sq.in. glazing) with 16 Ga. steel facing | 25 | [27] | | 37 | [38] | | 40 | [41] | | 44 | [46] | | 51 | [54] | | 57 | 11.3 | RAL TL66-281 | 131 | Overly Acoustical Door | 1 |
| 1-3/4 | 45 | Acoustical fire door with 16 Ga. Steel facing 6'11 3/4" x 2'11 3/4" | 35 | [38] | | 42 | [42] | | 45 | [46] | | 47 | [46] | | 45 | [48] | | 50 | 9.5 | RAL TL63-188 | 131 | Overly Acoustical Door | 1 |
| 1-3/4 | 45 | Single glazed door with 16 Ga. steel surface 6'11-1/2" x 2'11-3/4" | 25 | [31] | | 38 | [40] | | 41 | [43] | | 45 | [47] | | 49 | [50] | | 52 | 11.3 | RAL TL66-285 | 131 | Overly Acoustical Door | 1 |
| 1-3/4 | 46 | Double glazed door with 16 Ga. steel facing 6'11-1/2" x 2'11-3/4" | 25 | [29] | | 38 | [40] | | 41 | [44] | | 47 | [50] | | 53 | [54] | | 56 | 11.3 | RAL TL66-284 | 131 | Overly Acoustical Door | 1 |
| 1-3/4 | 47 | Masonry core with metal facing - 80-1/4" x 33-3/4" | 33 | [36] | | 44 | [43] | | 44 | [47] | | 50 | [53] | | 55 | [55] | | 54 | 7.7 | RAL TL61-227 | 104 | Industrial door | 1,19 |
| 1-3/4 | 49 | Plywood door - 7' x 3' | 33 | 35 | 38 | 41 | 44 | 45 | 47 | 48 | 48 | 50 | 51 | 52 | 53 | 53 | 54 | 53 | 9.2 | RAL TL68-243 | 176 | STC 49 Door system | 3,12 |
| 1-3/4 | 51 | Timeblend high density core with hardwood surfaces 35-7/8" x 83-3/4" | 36 | [39] | | 44 | [48] | | 49 | [52] | | 51 | [-] | | 55 | [-] | | 62 | - | RAL TL64-183 | 189 | Sound Retardant Door Weyerhauser | 14 |
| 1-3/4 | - | 16 Ga. steel facing 4' x 8' | 35 | 38 | 35 | 39 | 44 | 46 | 50 | 50 | 52 | 52 | 50 | 52 | 56 | 57 | 56 | 56 | 8.6 | RAL TL66-188 | 131 | Overly Acoustical Door | 1,7 |
| 1-3/4 | - | 16 Ga. steel core with rust inhibiting paint surfaces - 3'6" x 7'6" | | | | | | | | | | | | | | | | | - | - | 136 | Acousta Door | - |
| 1-3/4 | - | Door Size - 7' x 3' | | | | | | | | | | | | | | | | | - | RAL | 112 | Kriegersonic | - |
| 1-7/8 | 27 | 3' x 7' | 20 | 23 | 26 | 23 | 26 | 24 | 24 | 22 | 22 | 26 | 26 | 29 | 30 | 32 | 33 | 34 | 4 | - | 126 | Munchhausen Acoustical wood door | 3 |

TABLE 32B DOORS
(Greater than 2" thick)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hard wood door - 7' x 3' | | | | | | | | | | | | | | | | | |
| 2-1/8 | 27 | 20 | 24 | 26 | 25 | 26 | 23 | 22 | 23 | 25 | 27 | 27 | 29 | 31 | 32 | 34 | 35 | 4 | - | 126 | Munchhauser Acoustical wood door | 3 |
| | | | | | Timblend high density core with hardwood surfaces 36" x 84" | | | | | | | | | | | | | | | | | |
| 2-1/4 | 42 | 37 | [37] | | 39 | [38] | | 39 | [41] | | 41 | [-] | | 45 | [-] | | 40 | - | RAL TL61-194 | 189 | Weyerhauser Sound Retardent Door | 14 |
| | | | | | 12 Ga. steel facing 6'11-1/8" x 2'11-11/16" | | | | | | | | | | | | | | | | | |
| 2-1/2 | 51 | 43 | [45] | | 49 | [52] | | 48 | [51] | | 55 | [56] | | 57 | [55] | | 44 | 21.9 | RAL TL63-212 | 131 | Overly Acoustical Door | 1 |
| | | | | | Masonry core with steel facing - 86-3/8" x 40-3/8" | | | | | | | | | | | | | | | | | |
| 2-1/2 | - | 26 | 32 | 39 | 42 | 42 | 43 | 43 | 45 | 46 | 47 | 49 | 50 | 52 | 54 | 55 | 56 | 7.5 | RAL TL70-188 | 104 | Cam-Seal door | 4,19 |
| | | | | | Hardwood door - 3' x 7' | | | | | | | | | | | | | | | | | |
| 2-5/8 | 37 | 24 | 28 | 27 | 26 | 28 | 39 | 33 | 35 | 37 | 38 | 38 | 38 | 41 | 43 | 46 | 46 | 9 | - | 126 | "Shermlore" Dual Panel Door | 3 |
| | | | | | Core of Concrete block 6'10" x 9'5" | | | | | | | | | | | | | | | | | |
| 2-5/8 | 40 | 28 | 28 | 32 | 32 | 33 | 34 | 35 | 36 | 39 | 42 | 43 | 43 | 44 | 43 | 42 | 44 | - | RAL TL67-34 | 101 | #873 Acoustical Door | 4,20 |
| | | | | | Hard wood door - 7' x 3' | | | | | | | | | | | | | | | | | |
| 2-5/8 | 43 | 26 | 35 | 35 | 33 | 35 | 36 | 40 | 41 | 44 | 43 | 44 | 46 | 48 | 52 | 53 | 51 | 9 | - | 126 | "Shermlore" Dual Panel Door | 3 |
| | | | | | 18 Ga. Steel core 7' x 3' | | | | | | | | | | | | | | | | | |
| 3 | 50 | 34 | [41] | | 49 | [45] | | 47 | [49] | | 52 | [56] | | 56 | [56] | | 55 | 14.9 | RAL TL61-226 | 104 | Industrial door | 1,19 |
| | | | | | Door size - 33" x 82 7/8" | | | | | | | | | | | | | | | | | |
| 3 | 55 | 39 | 42 | 44 | 45 | 49 | 53 | 55 | 55 | 54 | 54 | 55 | 59 | 60 | 60 | 57 | 58 | 25.8 | RAL TL68-317 | 108 | Jamisonic | 3 |
| | | | | | 3/16" Thick steel facing 7'4-3/4" x 7'11-1/4" | | | | | | | | | | | | | | | | | |
| 4 | 43 | 35 | [36] | | 36 | [37] | | 38 | [42] | | 44 | [44] | | 47 | [45] | | 45 | 34 | RAL TL65-181 | 131 | Overly Acoustical Blast Door | 1,22 |
| | | | | | Damped metal absorbing insulation, hardware and gasketing as core 84-1/4" x 32-7/8" | | | | | | | | | | | | | | | | | |
| 4 | 52 | 43 | 45 | 45 | 47 | 49 | 51 | 51 | 50 | 51 | 54 | 55 | 54 | 52 | 52 | 52 | 50 | 19.1 | RAL TL71-294 | 108 | Jamisonic | |
| | | | | | 16 Ga. steel plate facing internally reinforced 7'3-9/16" x 3'8-1/8" | | | | | | | | | | | | | | | | | |
| 4 | 53 | 32 | 40 | 44 | 46 | 47 | 47 | 48 | 50 | 51 | 53 | 55 | 56 | 61 | 62 | 62 | 63 | 23 | RAL TL67-3 | 131 | Overly Acoustical Door | 3 |

TABLE 32B DOORS (Concl)
(Greater than 2" thick)

| Thickness (inches) | STC | | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | - | Concrete core with metal facing 84" x 44" | 38 [39] | | | 40 [39] | | | 45 [-] | | | 49 [52] | | | 52 [34] | | | 55 | 14.8 | RAL TL59-57 | 104 | Industrial door | 21 |
| 6 | 49 | Solid wood frame, septum sheet, mineral wool and feltliner as core with 18 Ga. metal sheet surfaces on each side 45-1/2" x 84-1/2" | 36 [37] | | | 43 [44] | | | 50 [48] | | | 46 [52] | | | 57 [61] | | | 61 | 23 | NBS 654 | 59 | TEC Sound Doors | 6 |
| 7 | 61 | Damped metal absorbing insulation, hardware and gasketing as core 84-7/8" x 37" | 46 | 48 | 50 | 51 | 52 | 57 | 59 | 60 | 61 | 62 | 64 | 65 | 65 | 66 | 65 | 62 | 28.9 | RAL TL70-123 | 108 | Jamisonic | 3,23 |
| 8 | 60 | 16 Ga. steel facing 8'1/4" x 4'3-1/2" | 38 | 43 | 48 | 50 | 54 | 56 | 56 | 58 | 60 | 61 | 64 | 68 | 68 | 71 | 71 | 74 | 45 | CKAL 704-4 | 131 | Overly Acoustical Door | 3,17 |
| 10 | 63 | Damped metal absorbing insulation, hardware and gasketing as core 84-7/8" x 37" | 47 | 50 | 52 | 53 | 56 | 59 | 61 | 63 | 63 | 64 | 66 | 65 | 64 | 65 | 65 | 65 | 36 | RAL TL70-122 | 108 | Jamisonic | 3,23 |
| 10 | 65 | Damped metal absorbing insulation, hardware and gasketing as core 84-7/8" x 31-3/4" | 48 | 50 | 53 | 54 | 55 | 59 | 62 | 64 | 65 | 68 | 68 | 69 | 66 | 68 | 73 | 74 | 37 | RAL TL70-121 | 108 | Jamisonic | 3,23 |
| 10-1/2 | 62 | Two doors separated by 7" air space, 16 Ga. steel facing - 6'11-3/4" x 2'11-3/4" | 50 [52] | | | 56 [58] | | | 59 [63] | | | 67 [63] | | | 60 [66] | | | 70 | 17.6 | RAL TL63-182 | 131 | Overly Acoustical Door | 1 |
| 11 1/4 | 63 | Door Size - 11'6" x 15'5" | 50 [45] | | | 54 [58] | | | 62 [67] | | | 69 [70] | | | 70 [72] | | | 74 | - | G&H DSP-1ST | 70 | Fenestra | 1,8 |
| - | 48 | Sliding glass door 66-1/2" x 81" | 34 [37] | | | 41 [45] | | | 46 [46] | | | 51 [52] | | | 48 [51] | | | 54 | 8 | RAL TL63-34 | 124 | Miller Sliding Glass Doors | 1 |
| - | - | Wood particle board, door sizes - 30" x 74" 33" x 74" | | | | | | | | | | | | | | | | | 45 | - | 55 | Duraflake Door Core | - |
| - | - | - | | | | | | | | | | | | | | | | | - | - | 156 | Ventilation System Door Panel | |
| - | - | Flush Surface | | | | | | | | | | | | | | | | | - | - | 157 | Single leaf Acoustical doors | 26 |
| - | - | Door with right out swing only | | | | | | | | | | | | | | | | | - | - | 157 | Double leaf acoustical doors | 27 |

FOOTNOTES FOR TABLE 32A, 32B

DOORS

1. Tested according to ASTM E90-61T and data in brackets refer to the frequencies centered at 175, 350 700, 1400, 2800 Hz.

2. Special nonstandard test used for comparison with specimen measured by the standard method. Transmission loss values of the modified specimen are estimated. Data in brackets refer to the frequencies 125, 175, 250, 350, 500, 700, 1000, 1400, 2000, 2800, and 4000 Hz. The void between the door panel and its frame were sealed on both sides with Duxseal, a caulking type material.

3. Tested and evaluated according to ASTM E90-66T.

4. Tested and evaluated according to ASTM E90-66T and ASA Z24.19-1957.

5. Tested and evaluated according to ASTM E90-70 and E413-70T.

6. Data in brackets correspond to half-octave frequency bands centered at 175, 350, 700, 1400, 2800 Hz respectively. ASARP Z24.19-1957 was the standard used.

7. Flush acoustical fire door with UL labels B, C, D & E.

8. Can be designed to fit any door opening.

9. Maximum size - 5' wide x 12' high. Temperature range: 300°F to 1500°F. Flame spread 25 to 200.

10. Different sizes and types are available. For interior use.

11. Exterior entry system. Temperature range: -40°F to 125°F.

12. Resistance to chemicals depends upon face finish. Interior use.

13. Interior or exterior door. Temperature range: -60° to 150°F. Flame spread 5.

14. Tested according to ASTM E90-61T and data in brackets refers to frequency bands centered at 175, 350, 700, and 1400 Hz. Interior doors, made to order.

15. For use in UL stairwell doors where codes require a minimum 450° temperature rise label. Temperature range: -50° to 250°F. Flame spread 10. Resistant to chemicals.

16. For interior use. Resistance to chemicals depends on face finish. Numbers in upper row indicate transmission loss obtained when door bottom is sealed with sloped threshold instead of automatic drop seal.

17. Fire resistant.

18. Temperature range: 20° to 150°F. Standard sizes up to 4' x 8'.

19. Maximum temperature 450°F. Flame Spread ≤ 25.

20. Available for single and part of swing, single and center parting, horizontal slide applications.

21. Data in brackets correspond to frequency bands centered at 175, 350, 700, 1400, and 2800 Hz. ASTM E80-55 and ASA Z24.19-1957 were the standards used. Maximum temperature 450°F. Flame spread ≤ 25.

22. Blast resistance of 72 $lb/in^2$.

23. Temperature range: 0° to 150°F. Relative humidity: 0 to 100%.

24. Temperature range: -60° to 150°F.

25. Door and louver size varies.

26. Single leaf acoustical door dimensions:

Flush surface; 36" x 60"; weight 165 lbs
Flush surface; 36" x 72"; weight 195 lbs
Flush surface; 36" x 84"; weight 205 lbs
Flush surface; 36" x 96"; weight 225 lbs
Flush surface; 48" x 60"; weight 195 lbs
Flush surface; 48" x 72"; weight 225 lbs
Flush surface; 48" x 84"; weight 245 lbs
Flush surface; 48" x 96"; weight 275 lbs

27. Double leaf acoustical door dimensions:

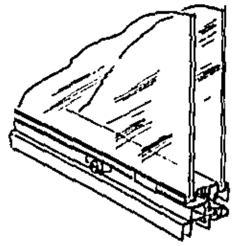
With right out swing only: Flush surface; 72" x 60"; weight 330 lbs
With right out swing only: Flush surface; 72" x 72"; weight 390 lbs
With right out swing only: Flush surface; 72" x 84"; weight 410 lbs
With right out swing only: Flush surface; 72" x 96"; weight 450 lbs
With right out swing only: Flush surface; 96" x 60"; weight 390 lbs
With right out swing only: Flush surface; 96" x 72"; weight 450 lbs
With right out swing only: Flush surface; 96" x 84"; weight 490 lbs
With right out swing only: Flush surface; 96" x 96"; weight 550 lbs

TABLE 33

WINDOWS

Sound transmission losses of window assemblies ranging in overall thicknesses from 1/4 inch to more than 5 inches are listed. Various types of windows, e.g., pivoted, dual glazed, laminated glass, venetian blind, and plastic windows, etc., are presented in the table. Figure 33 illustrates a dual glazed window. Simple windows are usually the "weak links" in the sound isolation of rooms and buildings, but it is possible to select windows with high sound transmission losses to make the interiors of the buildings reasonably quiet. In the buildings at airports the selection of windows will determine to a large extent the interior noise levels. In such instances entirely sealed, dual glazed windows with a large airspace between the plates provide acceptable sound attenuation as can be seen from the table. The companies (by numbers shown in Section II) with products listed in Table 33 are: 1, 14, 17, 42, 49, 66, 71, 110, 124, 163, 185.

DUAL GLAZING



TWO PANELS OF GLASS ENCLOSING A 2⅝" AIR SPACE REDUCE TRANSMISSION OF SOUND, HEAT AND COLD.

Figure 33 Dual Glazed Window

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Glazed Window: A window furnished with glass

Dual Glazed Window: A window furnished with two glass panes

TABLE 33 WINDOWS

| Thickness (inches) | STC | Description | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| 1/4 | 29 | Vertical pivoted window 1/4" plate | 25 | | | 29 | | | 33 | | | 36 | | | 26 | | | 35 | 4.5 | RAL TL62-254 | 17 | Single plate window | 1,4 |
| 1/4 | 31 | Single hung window, 1/4" plate glass, 52" wide x 62" high test specimen | 19 | 22 | 24 | 26 | 26 | 28 | 30 | 31 | 32 | 33 | 34 | 32 | 29 | 28 | 31 | 34 | 4.0 | RAL TL 71-333 | 1 | Series 375 DH-A3 | 3,5 |
| 0.49 | 35 | Laminated system with plastic between two plates. 14' x 9' test specimen | 27 | 23 | 27 | 28 | 30 | 32 | 33 | 34 | 35 | 34 | 33 | 35 | 38 | 42 | 45 | 48 | 6.7 | RAL TL68-59 | 110 | Core system with laminated glass | 2 |
| 1/2 | 40 | 1/2" laminated glass. 8' x 12' test specimen | 23 | 26 | 29 | 31 | 35 | 37 | 38 | 39 | 40 | 40 | 41 | 40 | 47 | 47 | 49 | 52 | 6.0 | RAL TL71-129 | 163 | Starline series 324 | 6 |
| 1 | 33 | Vertically pivoted window 1/4" plate, 1/2" air space 1/4" plate. 4' x 5' test specimen. | 27 | | | 28 | | | 37 | | | 41 | | | 31 | | | 35 | 7.1 | RAL TL62-255 | 17 | Venetian blind window | 1,4 |
| 2-3/8 | 45 | Aluminum frame containing two 1/4" plates separated by 1-7/8" air space with venetian blind 6' wide x 7' high max. 2'4" x 3' min. | 30 | | | 38 | | | 42 | | | 47 | | | 44 | | | 54 | - | RAL TL66-173 | 14 | Venetian Blind window | 1,4 |
| 2-7/16 | 42 | Pivoted window with thermal brick and sun control. 3/16" plate, 2" space, 1/4" plate. | 21 | 24 | 30 | 31 | 36 | 39 | 39 | 43 | 44 | 45 | 47 | 46 | 46 | 47 | 48 | 49 | 7.1 | RAL TL70-255 | 110 | Sun Control window | 2,4 |
| 2-1/2 | 37 | Dual glazed window. 1/8" plate, 2-1/4" space, 1/8" plate, custom or standard sizes. | 13 | 20 | 24 | 25 | 29 | 33 | 35 | 37 | 40 | 44 | 47 | 49 | 49 | 50 | 51 | 43 | 5 | RAL TL69-244 | 49 | DEVAC Model 650 with 1/8" plate | 2,4 |
| 2-5/8 | 41 | Dual glazed window with panels, 3/8" plate, 2" (nom) space, 3/16" tempered glass. Swing down window had 1" insulating glass section. 12' wide x 8'6" long test specimen. | 23 | 25 | 29 | 32 | 36 | 39 | 40 | 41 | 42 | 43 | 43 | 43 | 44 | 42 | 42 | 47 | 6.0 | RAL TL71-128 | 163 | Series 325 window-panel combination. | 3,5,7 |

TABLE 33 WINDOWS (Contd)

| Description | Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| Dual glazed window. Frame of aluminum and 6063 alloy. 1/4" plate, 2-1/4" space, 1/4" plate. Sizes to 6', custom and standard. | 2-3/4 | 40 | 27 | 27 | 27 | 32 | 34 | 31 | 36 | 40 | 42 | 43 | 42 | 42 | 38 | 41 | 47 | 51 | 7.1 | RAL TL69-236 | 49 | Devac Model 660 | 2,4 |
| Dual glazed window. 1/4" plate, 2-1/4" space, 1/4" plate. Custom and standard sizes. 3'8" x 5'9". | 2-3/4 | 44 | 20 | 30 | 32 | 35 | 37 | 40 | 42 | 45 | 47 | 47 | 49 | 47 | 44 | 45 | 52 | 53 | 7.6 | RAL TL69-246 | 49 | Devac Model 650 with 1/4" plate. | 2,4 |
| Dual glazed window. 1/4" plate, 2-1/2" space, 5/16" plate. 4' x 5' test size. | 3-1/16 | 40 | 28 | | | 34 | | | 38 | | | 42 | | | 40 | | | 48 | 7.6 | RAL TL62-256 | 17 | Amelco window - 3 | 1,4 |
| Dual glazed window. 1/4" polycarbonate, 2 5/8" space, 1/4" plate. Basic unit. Max. size 48'2". Max. linear dimension 10'. | 3-1/8 | 27 | 18 | 24 | 25 | 27 | 27 | 29 | 30 | 27 | 24 | 22 | 25 | 28 | 30 | 31 | 31 | 36 | - | KAL 1247-1-71 | 17 | Dual glazed window basic unit | 3 |
| Same as above. Weather side sealed with non-hardening sealing compound. | 3-1/8 | 37 | 20 | 25 | 25 | 30 | 30 | 33 | 35 | 36 | 38 | 41 | 41 | 38 | 35 | 40 | 46 | 45 | - | KAL 1247-3-71 | 17 | Dual glazed window, sealed | 3 |
| Same as above. Fiberglass packed into top of unit. | 3-1/8 | 38 | 25 | 27 | 28 | 32 | 32 | 35 | 37 | 37 | 33 | 33 | 36 | 42 | 44 | 46 | 51 | 53 | - | KAL 1247-5-71 | 17 | Dual glazed window, packed with fiberglass | 3 |
| Same as above. With neoprene seals from pivot to top of window. | 3-1/8 | 38 | 25 | 26 | 30 | 32 | 30 | 35 | 36 | 35 | 33 | 33 | 37 | 42 | 43 | 45 | 49 | 52 | - | KAL 1247-5-71 | 17 | Dual glazed window with partial neoprene seals. | 3 |
| Same as above. Neoprene seals on top, non-hardening sealer on bottom half of frame. | 3-1/8 | 38 | 24 | 27 | 30 | 33 | 30 | 35 | 36 | 37 | 33 | 34 | 38 | 43 | 44 | 46 | 50 | 55 | - | KAL 1247-6-71 | 17 | Dual glazed window with neoprene and non-hardening sealer. | 3 |
| Same as above. Neoprene seals all around. | 3-1/8 | 39 | 23 | 27 | 29 | 34 | 33 | 36 | 37 | 37 | 35 | 35 | 39 | 44 | 45 | 47 | 51 | 54 | - | KAL 1247-7-71 | 17 | Dual glazed window with neoprene and non-hardening sealer. | 3 |

TABLE 33 WINDOWS (Concl)

| Thickness (inches) | STC | | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-1/8 | 39 | Same as above. Neoprene seals all around. | 23 | 25 | 28 | 32 | 32 | 35 | 37 | 36 | 37 | 38 | 40 | 43 | 43 | 46 | 50 | 54 | - | KAL 1247-8-71 | 17 | Dual glazed window with neoprene seals all around. | 3 |
| 3-1/8 | 41 | Same as above. Neoprene seal on top, pivots sealed with non-hardening sealing compound. | 24 | 27 | 29 | 34 | 34 | 38 | 39 | 41 | 40 | 40 | 41 | 44 | 45 | 47 | 52 | 55 | - | KAL 1247-9-71 | 17 | Dual glazed window with neoprene and non-hardening sealer. | 3 |
| 3-1/8 | 43 | Same as above. Entire perimeter sealed on both sides with non-hardening sealing compound. | 25 | 27 | 27 | 32 | 32 | 38 | 41 | 43 | 46 | 49 | 49 | 52 | 51 | 52 | 55 | 58 | - | KAL 1247-2-71 | 17 | Dual glazed window with non-hardening sealer on both sides. | 3 |
| 3-1/8 | 43 | Same as above. Thermal insulation and self contained venetian blind. | 25 | 27 | 29 | 34 | 34 | 38 | 39 | 42 | 42 | 45 | 47 | 50 | 50 | 51 | 54 | 55 | - | KAL 1247-10-71 | 17 | Dual glazed window with thermal insulation and venetian blind. | 3 |
| 4-7/32 | 48 | Dual glazed window, 7/32" plate, 3-3/4" space, 1/4" plate. Max. standard size 7' x 5' | 34 | | | 41 | | | 46 | | | 51 | | | 48 | | | 54 | 8 | RAL TL63-34 | 124 | Dual glazed window with aluminum frame. AUD-O-FEN | 1,4 |
| 4-7/16 | 48 | Dual glazed window, 1/4" plate, 4" space, 3/16" plate. 5'3" x 5'3" test specimen. | 27 | 32 | 34 | 37 | 40 | 41 | 45 | 49 | 52 | 56 | 58 | 59 | 56 | 53 | 51 | 60 | 7 | RAL TL71-242 | 49 | Devac Model 720 | 3,5 |
| 4-1/2 | 40 | Vandal and Burglar resistant window 12' x 10' sizes. Plexiglas or polycarbonate. | | | | | | | | | | | | | | | | | 8.6 | RAL TL71-309 | 42 | ISOCOUSTIC | 6 |
| 4-9/16 | 52 | Dual glazed window, 1/4" grey plate, 4" space, 5/16" clear plate, 2'6" x 7' test panel. | 35 | 39 | 43 | 47 | 50 | 50 | 53 | 55 | 54 | 55 | 53 | 51 | 50 | 50 | 55 | 55 | - | RAL TL71-71 | 71 | Acoustical window wall. | 3 |
| 5-3/16 | 48 | Dual glazed window, 3/16" plate, 4-3/4" space, 1/4" plate, 3'9" x 5'9" test specimen. | 27 | 33 | 36 | 39 | 41 | 42 | 44 | 48 | 50 | 52 | 53 | 54 | 54 | 54 | 55 | 59 | 9 | RAL TL72-156 | 49 | Devac Model 650 with wide airspace | 3,5 |
| - | 45 - 50 | Dual glazed window. Two pieces of plate glass separated by 1-1/2 - 2" airspace. (no data given). | | | | | | | | | | | | | | | | | 6.5 - 10 | - | 66 | Dual glazed window. | |
| - | - | Windows with various combinations of weights (thicknesses) and types (plain or laminated) of glass with varying air spaces. | | | | | | | | | | | | | | | | | - | - | 185 | Custom sound Windows 40005 series. | |

FOOTNOTES FOR TABLE 33

WINDOWS

1. Tested and evaluated according to ASTM E90-61T.
2. Tested and evaluated according to ASTM E90-66T.
3. Tested and evaluated according to ASTM E90-70.
4. Tested and evaluated according to ASARP-Z24.19-1957.
5. Tested and evaluated according to ASTM E413-70T.
6. Data reported for comparison only on standard test.
7. Window and panels contain gasket and stops and cap bead on weather side.

TABLE 34

SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR

Ceiling systems and their sound attenuation factors are listed. Figure 34 shows the test facility required to measure sound attenuation factors. The wall between the noise source room and the receiving room should be a much better sound barrier when compared to the ceiling system undergoing the test. This will result in the acoustic propagation as indicated by the arrows, and the test result will reflect the attenuation provided by the ceiling. Properly measured sound attenuation factors report the sound insulation or sound barrier characteristics of ceiling systems as actually installed. Between two rooms separated by a good sound barrier wall, and having a common plenum, the noise reduction is mainly dependent upon the sound attenuation provided by the common, suspended ceiling. This table may therefore be used on an approximate basis to compare the performances of wall partitions and ceilings. The companies (by numbers shown in Section II) with products listed in Table 34 are: 5, 6, 109, 128.

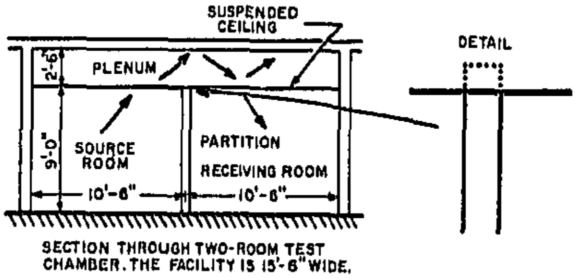



Figure 34 AIMA Approved Test Setup to Measure Sound Attenuation Factors of Ceilings

## TABLE 34 SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR

| Thickness (inches) | STC | Attenuation Factors (decibels) | | | | | | | | | | | | | | | | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | | | | | |
| Mineral fiber tile with a finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 36 | 28 | 34 | 32 | 25 | 26 | 31 | 31 | 32 | 35 | 40 | 43 | 49 | 50 | 52 | 53 | 53 | 15 | G&H | 128 | Solitude panels | 1 |
| Mineral fiber tile with a non-directional finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 36 | 30 | 39 | 38 | 30 | 28 | 31 | 31 | 33 | 34 | 35 | 39 | 44 | 50 | 52 | 52 | 47 | 15 | G&H | 128 | Fire shield solitude panels | 2,3 |
| Moisture resistant mineral fiber tile with a finish of scrubbable acrylic plastic. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 39 | 30 | 37 | 38 | 29 | 29 | 32 | 33 | 36 | 37 | 42 | 47 | 52 | 54 | 54 | 54 | 56 | 15 | G&H | 128 | MR Fire shield solitude panels | 1 |
| Mineral fiber tile with a non-directional finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 40 | 31 | 39 | 38 | 29 | 30 | 33 | 34 | 37 | 38 | 42 | 45 | 49 | 53 | 55 | 56 | 56 | 15 | G&H | 128 | Fire shield solitude panels. Micro perforated batteries. | 1,2,3 |
| Moisture resistant mineral fiber tile with a finish of scrubbable acrylic plastic. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 40 | 32 | 39 | 39 | 30 | 29 | 33 | 36 | 37 | 39 | 42 | 47 | 52 | 56 | 55 | 56 | 54 | 15 | G&H | 128 | MR Solitude panels fissured pattern | 1,2,3 |
| Mineral fiber tile with a finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 40 | 31 | 37 | 37 | 30 | 30 | 34 | 34 | 36 | 39 | 43 | 45 | 50 | 53 | 54 | 55 | 57 | 15 | G&H | 128 | Solitude panels non-directional | 1,2,3 |
| Moisture resistant mineral fiber tile with a finish of scrubbable acrylic plastic. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 40 | 30 | 38 | 37 | 31 | 29 | 32 | 34 | 36 | 38 | 42 | 46 | 51 | 54 | 54 | 51 | 46 | 15 | G&H | 128 | MR fire shield solitude panels needle perforated pattern | 1,2,3 |
| Mineral fiber tile with a non-directional finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 40 | 30 | 36 | 36 | 29 | 30 | 35 | 34 | 37 | 39 | 43 | 46 | 48 | 52 | 51 | 52 | 50 | 15 | G&H | 128 | Solitude panels needle perforated pattern | 1,2,3 |
| Mineral fiber tile with a non-directional finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 41 | 35 | 40 | 40 | 31 | 32 | 36 | 36 | 39 | 40 | 42 | 45 | 52 | 54 | 56 | 58 | 57 | 15 | G&H | 128 | Fire shield solitude panels fissured pattern | 1,2,3 |
| Mineral fiber tile with a finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 41 | 30 | 36 | 36 | 29 | 30 | 36 | 35 | 38 | 41 | 43 | 45 | 45 | 51 | 51 | 53 | 54 | 15 | G&H | 128 | Solitude panels fissured pattern | 1,2,3 |

TABLE 34 SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR (Contd)

| | | Attenuation Factors (decibels) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Density lb/ft³ | Lab. | Co. | Product | Foot-note |
| | | Vinyl film facing backed with gypsum substrate reinforced with glass fiber filaments. | | | | | | | | | | | | | | | | | | | | |
| 1/2, 5/8 | - | 28 | | | 30 | | | 37 | | | 42 | | | 45 | | | 41 | - | G&H | 6 | Vinyl rock gypsum ceiling panel | 1,4 |
| | | Non-directional random sized fissures in a filled mineral fiber. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 37 | 29 | 36 | 36 | 30 | 29 | 32 | 32 | 34 | 36 | 38 | 41 | 45 | 49 | 50 | 52 | 53 | - | G&H | 109 | Quadrette | 5 |
| | | Fissured filled miner fiber. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 28 | 29 | 37 | 32 | 31 | 36 | 37 | 39 | 40 | 44 | 44 | 49 | 50 | 51 | 52 | 55 | - | - | 109 | Spintone standard | 5 |
| | | Filled mineral fiber pierced with a mixture of large and small perforations. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 31 | 36 | 37 | 30 | 30 | 34 | 34 | 36 | 38 | 41 | 44 | 49 | 55 | 57 | 58 | 59 | - | - | 109 | Spintone pierced | 5 |
| | | Filled mineral fiber tile with random sized and spaced non-directional fissures with tiny perforations. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 31 | 38 | 37 | 30 | 29 | 35 | 35 | 38 | 41 | 43 | 46 | 48 | 51 | 53 | 55 | 56 | - | - | 109 | Spintone 360 | 5 |
| | | Filled mineral fiber tile with small, uniformly dispersed non-directional fissures. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 26 | 36 | 35 | 29 | 30 | 33 | 35 | 39 | 42 | 43 | 46 | 50 | 55 | 56 | 57 | 59 | - | - | 109 | Spintone - 720 | 5 |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 30 | 40 | 40 | 32 | 33 | 38 | 39 | 40 | 40 | 43 | 44 | 49 | 53 | 55 | 58 | 60 | - | - | 109 | Temperatone 360 firedike tile | 5 |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 30 | 39 | 40 | 33 | 33 | 38 | 39 | 42 | 43 | 46 | 49 | 55 | 57 | 55 | 55 | 58 | - | - | 109 | Temperatone fire-dike pierced pattern. | 5 |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 30 | 38 | 39 | 32 | 32 | 37 | 37 | 41 | 42 | 45 | 48 | 52 | 54 | 55 | 56 | 58 | - | - | 109 | Firedike panels pierced pattern | 5 |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 29 | 38 | 37 | 31 | 29 | 34 | 34 | 37 | 39 | 43 | 46 | 50 | 52 | 53 | 55 | 58 | - | - | 109 | Firedike panels fissured pattern | 5 |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 42 | 33 | 43 | 59 | 32 | 32 | 36 | 37 | 39 | 40 | 42 | 46 | 54 | 55 | 56 | 56 | 57 | - | - | 109 | Acousti-clad Delta Pattern | - |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 5/8 | 47 | 34 | 42 | 41 | 34 | 36 | 41 | 43 | 46 | 49 | 53 | 54 | 57 | 58 | 57 | 56 | 57 | - | - | 109 | Particle grad LPC firedike | 5 |
| | | Mineral fibers blended with a cementitious Binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 28 | 25 | 33 | 33 | 24 | 23 | 24 | 23 | 24 | 24 | 26 | 28 | 31 | 34 | 35 | 39 | 44 | 15 | G&H | 128 | Travacoustic-c-tiles cumulus pattern | 1,6 |

TABLE 34 SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR (Contd)

| Thickness (Inches) | STC | Attenuation Factors (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1003 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 29 | 28 | 34 | 32 | 24 | 23 | 24 | 24 | 24 | 26 | 27 | 29 | 32 | 36 | 38 | 41 | 41 | 15 | G&H | 128 | Fireshield Travacoustic-c-tiles fissured pattern. | 1,3,6 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 31 | 28 | 34 | 33 | 25 | 24 | 25 | 26 | 27 | 29 | 29 | 31 | 34 | 40 | 43 | 48 | 53 | 15 | G&H | 128 | Travacoustic-c-tiles fissured pattern. | 1,3,6 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 36 | 31 | 37 | 38 | 29 | 29 | 30 | 31 | 33 | 33 | 35 | 39 | 44 | 49 | 52 | 54 | 54 | 15 | GAH | 128 | Travacoustic-c-tiles Abbey pattern. | 1,3,6 |
| | | Cast mineral fiber. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 37 | 31 | 39 | 37 | 28 | 28 | 30 | 31 | 32 | 34 | 35 | 39 | 44 | 50 | 54 | 59 | 60 | - | - | 109 | Permacoustic standard fissures | 5 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 38 | 26 | 32 | 34 | 29 | 29 | 32 | 35 | 37 | 38 | 38 | 38 | 40 | 42 | 42 | 42 | 44 | 15 | G&H | 128 | Travacoustic-c-tonico panels cumulus ATN pattern. | 1,2 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 39 | 25 | 34 | 34 | 29 | 30 | 34 | 35 | 38 | 40 | 39 | 39 | 42 | 44 | 42 | 43 | 44 | 15 | G&H | 128 | Travacoustic-c-tonico panels fissured ATN | 1,2 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 40 | 32 | 39 | 38 | 31 | 32 | 35 | 37 | 39 | 39 | 40 | 42 | 46 | 49 | 51 | 52 | 54 | 15 | G&H | 128 | Travacoustic-c-tiles cumulus ATN pattern | 1,3,6 |
| | | Mineral fibers blended with a cementitious binder. Standard finish is a white factory applied coating. Also available with a scrubbable vinyl plastic coating. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 41 | 31 | 39 | 38 | 31 | 32 | 34 | 37 | 38 | 40 | 42 | 43 | 48 | 51 | 53 | 53 | 52 | 15 | G&H | 128 | Travacoustic-c-tiles fissured ATN pattern. | 1,3,6 |
| | | Filled mineral fiber tile with small, uniformly dispersed non-directional fissures. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 42 | 30 | 38 | 38 | 31 | 30 | 33 | 36 | 36 | 38 | 40 | 43 | 49 | 55 | 56 | 55 | 55 | - | - | 109 | Temperatone 720 | 5 |

TABLE 34 SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR (Concl)

| Thickness (inches) | STC | Attenuation Factors (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Density lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Non-directional random sized fissures in a filled mineral fiber. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 42 | 28 | 35 | 36 | 29 | 29 | 36 | 36 | 38 | 41 | 42 | 42 | 44 | 46 | 46 | 46 | 47 | - | - | 109 | Quadrette | 5 |
| | | Small directional fissures in a filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 42 | 29 | 36 | 40 | 33 | 33 | 38 | 38 | 41 | 42 | 46 | 48 | 53 | 57 | 52 | 53 | 57 | - | - | 109 | Temperatone DCF small fissures | 5 |
| | | Large random sized and spaced non-directional fissures. | | | | | | | | | | | | | | | | | | | | |
| 3/4 | 47 | 31 | 39 | 40 | 35 | 36 | 40 | 40 | 43 | 45 | 48 | 50 | 56 | 57 | 54 | 56 | 57 | - | - | 109 | Temperatone-360 Non-directional fissures | |
| | | Filled mineral fiber tile. | | | | | | | | | | | | | | | | | | | | |
| 7/8 | 47 | 30 | 37 | 41 | 33 | 34 | 38 | 40 | 43 | 45 | 47 | 50 | 55 | 56 | 58 | 59 | 60 | - | - | 109 | Acousti-clad'p' diagonally perforated | |
| | | Mineral fiber tile with a non-directional finish of washable vinyl acrylic. Also available with a scrubbable acrylic plastic coating. | | | | | | | | | | | | | | | | | | | | |
| - | 40 | 30 | 38 | 40 | 32 | 31 | 34 | 35 | 37 | 39 | 40 | 44 | 50 | 56 | 58 | 58 | 58 | 15 | G&H | 128 | Fire shield Solitude panels Needle perforation | 1,2, 3 |
| | | Perforated 24 gauge cold rolled or electrogalvanized steel or 0.025" or 0.032" aluminum with a baked enamel finish. | | | | | | | | | | | | | | | | | | | | |
| - | 48 | 30 | 38 | 35 | 39 | 44 | 43 | 43 | 49 | 51 | 57 | 54 | | | | | | - | G&H | 128 | Acousti metal pans 1105 | 1,3, 7,8 |
| | | Perforated, galvanized, 0.016" metal pan backed with 0.75 lb/ft$^3$ fiberglas pads. | | | | | | | | | | | | | | | | | | | | |
| - | - | 25 | [26] | | 25 | [35] | | 35 | [40] | | 46 | [50] | | 56 | [61] | | 63 | - | G&H AMC-5 FT | 5 | Acousti Ceilings | 1,9 |
| | | Perforated, galvanized, 0.016" metal pan backed with 0.75 lb/ft$^3$ fiberglas pads. | | | | | | | | | | | | | | | | | | | | |
| - | - | 26 | [27] | | 27 | [29] | | 35 | [34] | | 29 | [38] | | 43 | [48] | | 50 | - | - | 6 | Asbestos faced Rigid boards | 1,9 |

FOOTNOTES FOR TABLE 34

SUSPENDED CEILINGS -- SOUND ATTENUATION FACTOR

1. Tested according to AIMA two room procedure 1-II.
2. AIMA Mounting CE: Continuous over partition with exposed T system.
3. Temperature Range: up to 150°F. Flame spread: 20. Poor resistance to chemicals.
4. Flame spread AMA Class A, SS-A-118b class 25.
5. Flame spread: 25.
6. AIMA Mounting CCT: Continuous over partition with concealed T spline suspension system.
7. AIMA Mounting ICX: Interrupted over partition using Z bars for a suspension system.
8. Tested with 1/2" gypsum board backing.
9. Numbers in brackets refer to center frequencies of 177, 354, 707, 1414, and 2828 Hz respectively.

TABLE 35

ROOF DECKS (BARRIER)

The sound transmission losses of roof decks are listed. Roof decks with thicknesses ranging from 1-1/2 inches to 7-1/2 inches made from steel panels of different thicknesses are shown in the table. The roof decks can also provide good sound absorption as can be seen from Table 25. Figure 25B appearing with Table 25 shows a roof deck design which provides good sound absorption and transmission loss. The company (by number shown in Section II) with products listed in Table 35 are: 106, 120.

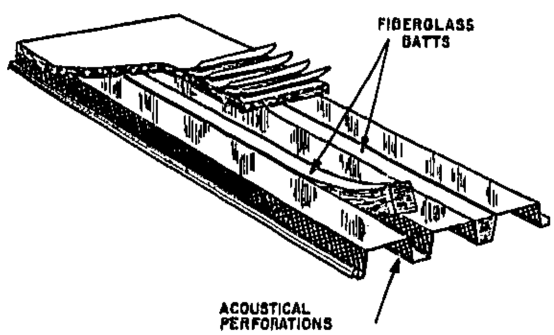



Figure 35 Roof Deck

TABLE 35 ROOF DECKS (BARRIER)

| Thickness (inches) | STC | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) | | | | | | | | | | |
| | | | Steel roof decking, 22 gage | | | | | | | | | |
| 1-1/2 | 45 | 29 | 38 | 45 | 48 | 49 | 49 | - | - | 106 | Type S Acoustideck | 1 |
| | | | Steel roof decking, 22 gage | | | | | | | | | |
| 1-1/2 | 45 | 29 | 38 | 45 | 48 | 49 | 49 | - | - | 106 | Type B Acoustideck | 1 |
| | | | Steel roof decking 20 gage | | | | | | | | | |
| 1-1/2 | 46 | 30 | 39 | 46 | 49 | 50 | 50 | - | - | 106 | Type S and B Acoustideck | 1 |
| | | | Steel roof decking, 18 gage | | | | | | | | | |
| 1-1/2 | 47 | 31 | 40 | 47 | 50 | 51 | 51 | - | - | 106 | Type S and B Acoustideck | 1 |
| | | | Steel roof decking 20-18 gage | | | | | | | | | |
| 1-5/8 | 49 | 33 | 42 | 49 | 52 | 53 | 53 | - | - | 106 | Type 1-5/8" NF | 1 |
| | | | Steel roof decking, 18-18 gage | | | | | | | | | |
| 1-5/8 | 50 | 34 | 43 | 50 | 53 | 54 | 54 | - | - | 106 | Type 1-5/8" NF | 1 |
| | | | Steel roof decking, 16-18 gage | | | | | | | | | |
| 1-5/8 | 52 | 36 | 45 | 52 | 55 | 56 | 56 | - | - | 106 | Type 1-5/8" NF | 1 |
| | | | Steel roof decking, 20 gage | | | | | | | | | |
| 3 | 46 | 30 | 39 | 46 | 49 | 50 | 50 | - | - | 106 | Type 3" H&N Acoustideck | 1 |
| | | | Steel roof decking, 20 gage | | | | | | | | | |
| 3 | 48 | 30 | 39 | 46 | 49 | 50 | 50 | - | - | 106 | Type 3" H&N Acoustideck | 1 |
| | | | Steel roof decking, combination 16 gage and 20-18 gage. | | | | | | | | | |
| 3 | 50 | 34 | 43 | 50 | 53 | 54 | 54 | - | - | 106 | Type 3" N 16 gage and Type 3" NF 20-18 Acoustideck | 1 |
| | | | Steel roof decking, 18-18 gage | | | | | | | | | |
| 3 | 52 | 35 | 45 | 52 | 55 | 56 | 56 | - | - | 106 | Type 3" NF Acoustideck | 1 |
| | | | Steel roof decking, 20 gage | | | | | | | | | |
| 4-1/2 | 47 | 31 | 40 | 47 | 50 | 51 | 51 | - | - | 106 | Type 4-1/2" H Acoustideck | 1 |
| | | | Steel roof decking, 18 gage | | | | | | | | | |
| 4-1/2 | 49 | 33 | 42 | 49 | 52 | 53 | 53 | - | - | 106 | Type 4-1/2" H Acoustideck | 1 |
| | | | Steel roof decking, 20 gage | | | | | | | | | |
| 4-1/2 | 50 | 34 | 43 | 50 | 53 | 54 | 54 | - | - | 106 | Type 4-1/2" HF Acoustideck | 1 |

TABLE 35 ROOF DECKS (BARRIER) (Concl)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Steel roof decking, 16 gage | | | | | | | | | |
| 4-1/2 | 51 | 35 | 44 | 51 | 54 | 55 | 55 | - | - | 106 | Type H Acoustideck | 1 |
| | | | Steel roof decking, 18-18 gage | | | | | | | | | |
| 4-1/2 | 52 | 36 | 45 | 52 | 55 | 56 | 56 | - | - | 106 | Type 4-1/2" HF Acoustideck | 1 |
| | | | Steel roof decking, 16-18 gage | | | | | | | | | |
| 4-1/2 | 53 | 37 | 46 | 53 | 56 | 57 | 57 | - | - | 106 | Type 4-1/2" HF Acoustideck | 1 |
| | | | Steel roof decking, 18 gage | | | | | | | | | |
| 6 | 50 | 34 | 43 | 50 | 53 | 54 | 54 | - | - | 106 | Type 6" H Acoustideck | 1 |
| | | | Steel roof decking, 16 gage | | | | | | | | | |
| 6 | 52 | 36 | 45 | 52 | 55 | 56 | 56 | - | - | 106 | Type 6" H Acoustideck | 1 |
| | | | Steel roof decking, 16-18 gage and 18-18 gage | | | | | | | | | |
| 6 | 53 | 37 | 46 | 53 | 56 | 57 | 57 | - | - | 106 | Type 6" HF and NF 16-18, 18-18 gage Acoustideck | 1 |
| | | | Steel roof decking, 16-16 gage | | | | | | | | | |
| 6 | 54 | 38 | 47 | 54 | 57 | 58 | 58 | - | - | 106 | Type 6" HF 16-16 gage Acoustideck | 1 |
| | | | Steel roof decking, 18 gage | | | | | | | | | |
| 7-1/2 | 51 | 35 | 44 | 51 | 54 | 55 | 55 | - | - | 106 | Type 7-1/2" H 18 gage Acoustideck | 1 |
| | | | Steel roof decking, 16 gage and 18-18 gage | | | | | | | | | |
| 7-1/2 | 53 | 37 | 46 | 53 | 56 | 57 | 57 | - | - | 106 | Type 7-1/2" H 16 gage and HF 18-18 gage Acoustideck | 1 |
| | | | Steel roof decking, 18 gage | | | | | | | | | |
| 7-1/2 | 54 | 38 | 47 | 54 | 57 | 58 | 58 | - | - | 106 | Type 7-1/2" HF 16-18 gage and 16-16 gage Acoustideck | 1 |
| 3 | - | | Planks for roof decks, floors, etc. | | | | | 18 | - | 120 | A73-4 Acoustiplank | 2 |
| - | - | | Cast textured slabs of wood fibers bonded with portland cement | | | | | 6 to 8 | - | 120 | A70-130 Fibroplank | 2,3 |

FOOTNOTES FOR TABLE 35

ROOF DECKS (BARRIER)

1. The transmission losses of the Inland Ryerson roof decks were estimated from tests made at Riverbank Acoustical Laboratory; Test Nos. TL72-112, TL72-48, TL72-2. STC values are based on 7.5 lb/ft² built up roof. Weight range of the acoustidecks is 2-5 lb/ft².

2. Size 3" x 15" x 120".

3. Thicknesses of 2", 2-1/2", 3", 3-1/2", and 4". Width 32". Length up to 12'6". Flame Spread 15.

TABLE 36

CURTAINS (BARRIER)

Transmission losses of curtain systems are listed. It is often necessary to isolate a moderately noisy environment from the surrounding less noisy area. A sound barrier curtain can provide enough attenuation in some cases to make it an economical and convenient arrangement. Figure 36 shows a sound barrier curtain system with a guide rail for ease of opening and closing the curtains. Usually the curtains are made from lead or lead-filled vinyl. It should be noted that not all possible curtain materials are listed in this table. It is possible to fabricate a curtain from many of the materials listed in Tables 6 through 15 and Table 18. The barrier curtain also may have sound absorbent facing on one side or both sides. It should be further noted that most of the curtains were tested free hanging in a test opening with their edges sealed to the sides of the opening by means of a dense flexible mastic. In industrial applications however, the sides of the curtains are usually not sealed, relying only on their overlap for a seal. Sound absorption coefficients of some of the curtains are shown in Table 23. The companies (by numbers shown in Section II) with products listed in Table 36 are: 6, 12, 27, 45, 59, 72, 155.

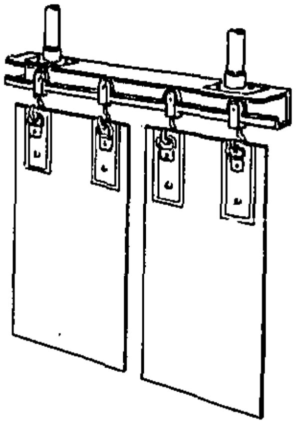


Figure 36 Sound Barrier Curtain Hanging from a Guide Rail

GLOSSARY

Lead Loaded: Lead was added to the fabric type material to increase its sound transmission loss.

TABLE 36 CURTAINS (BARRIER)

| Thickness (Inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
| | | Sheet lead | | | | | | | | | | | | | | | | | | | | |
| .008 | - | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 18 | 19 | 22 | 23 | 24 | 27 | 28 | 30 | 32 | .5 | - | 12 | Airtex Acoustic Curtain Mass 505 Sheet lead | 5,11 |
| | | Sheet lead | | | | | | | | | | | | | | | | | | | | |
| .016 | - | 18 | 19 | 20 | 21 | 23 | 24 | 26 | 26 | 28 | 29 | 31 | 33 | 35 | 36 | 38 | 40 | 1 | RAL | 12 | Airtex Acoustic Curtain Mass 510 Sheet lead | 8,11 |
| | | Nylon base cloth with vinyl coating front and back | | | | | | | | | | | | | | | | | | | | |
| .032 | 17 | 10 | 8 | 12 | 10 | 9 | 11 | 11 | 13 | 16 | 18 | 20 | 23 | 24 | 25 | 26 | 28 | .25 | RAL TL71-172 | 27 | NYCO-18 | 2,12, 13,14 |
| | | Same as above, modified top suspension | | | | | | | | | | | | | | | | | | | | |
| .032 | 17 | 10 | 8 | 12 | 10 | 9 | 11 | 11 | 13 | 16 | 18 | 20 | 22 | 23 | 23 | 24 | 26 | .25 | RAL TL71-173 | 27 | NYCO-18 | 2,14, 15 |
| | | Lead loaded vinyl material reinforced with beta-glass fabric | | | | | | | | | | | | | | | | | | | | |
| .033-.040 | 19 | 5 | | | 9 | | | 15 | | | 21 | | | 27 | | | 33 | .50 | - | 45 72 | KNC-50 Curtains | 4 |
| .037 | 20 | 9 | 8 | 10 | 12 | 12 | 14 | 15 | 17 | 19 | 20 | 22 | 24 | 26 | 27 | 28 | 30 | 0.44 | RAL TL72-232 | 155 | Sound Stopper lead Vinyl Curtain | 12,13 |
| .064 | 25 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 24 | 26 | 27 | 29 | 31 | 33 | 34 | 35 | 0.76 | RAL TL73-67 | 155 | Loaded Vinyl Curtain | 12,13 |
| | | Lead loaded vinyl material reinforced with beta-glass fabric | | | | | | | | | | | | | | | | | | | | |
| .070-.075 | 27 | 15 | 15 | 17 | 17 | 19 | 20 | 21 | 24 | 27 | 28 | 30 | 31 | 33 | 35 | 35 | 37 | 1 | KAL 1083-1-71 | 45 72 | KNC-100 Curtains | 7,12 |
| | | Uncured rubber | | | | | | | | | | | | | | | | | | | | |
| .100 | - | 27 | 28 | 29 | 30 | 33 | 35 | 38 | 38 | 37 | 35 | 36 | 36 | 37 | 38 | 39 | 41 | 1 | - | 12 | Airtex Acoustic Curtain Mass 550 Dead rubber | 9 |
| | | Barium filled vinyl | | | | | | | | | | | | | | | | | | | | |
| .125 | - | 14 | 14 | 16 | 20 | 21 | 22 | 23 | 25 | 27 | 29 | 31 | 32 | 34 | 36 | 36 | 38 | 1 | RAL | 12 | Airtex Acoustic Curtain Mass 520 Barium vinyl | 6,11 |
| | | Fiberglas cloth coated on both sides with lead filled vinyl | | | | | | | | | | | | | | | | | | | | |
| - | 19 | 11 | 8 | 9 | 10 | 11 | 13 | 14 | 16 | 18 | 19 | 20 | 22 | 23 | 24 | 24 | 26 | .50 | - | 111 | Noiseguard flexible acoustical curtains | 3 |
| | | Lead reinforced with fiberglas | | | | | | | | | | | | | | | | | | | | |
| - | 28 | 12 | 15 | 19 | 20 | 21 | 23 | 24 | 25 | 26 | 28 | 32 | 34 | 36 | 37 | 39 | 40 | 1.5 | KAL | 129 | NMC Curtain system | 12 |
| | | Mass filled vinyl with a woven glass fabric reinforcement | | | | | | | | | | | | | | | | | | | | |
| - | - | | (13) | | 12 | (13) | | | (16) | | | (22) | | | (28) | | (33) | .50 | - | 6 | Sound Guard noise control curtains | 16 |
| | | Mass filled vinyl with a woven glass fabric reinforcement | | | | | | | | | | | | | | | | | | | | |
| - | - | | (16) | | 17 | (16) | | | (20) | | | (25) | | | (31) | | (36) | .75 | - | 6 | Sound Guard noise control curtains | 16 |

## TABLE 36 CURTAINS (BARRIER) (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Polyurethane foam fused to polyvinyl | | | | | | | | | | | | | | | | | | | | |
| - | - | | 15 | 18 | 20 | 19 | 21 | 20 | 20 | 24 | 28 | 28 | 32 | 32 | 34 | 36 | 37 | 1.1 | CT | 59 | Acoustidrape | 10 |
| | | Mass filled vinyl with woven glass reinforcement | | | | | | | | | | | | | | | | | | | | |
| - | - | | (22) | | 23 | (23) | | | (26) | | | (32) | | | (37) | | (44) | 1.5 | - | 6 | Sound Guard noise control curtains | 16 |
| | | Mass filled vinyl with woven glass reinforcement | | | | | | | | | | | | | | | | | | | | |
| - | - | | (26) | | 28 | (28) | | | (32) | | | (36) | | | (36) | | (47) | 3 | - | 6 | Sound Guard noise control curtains | 16 |
| - | - | Barium filled vinyl with top layer of embossed leather and bottom layer of urethane foam | | | | | | | | | | | | | | | | - | - | 12 | Airtex Acoustic Curtain Mass 525 | 1,11 |

### FOOTNOTES FOR TABLE 36
### CURTAINS (BARRIER)

1. 28" wide rolls, sheets, and custom fabricated parts and curtain systems. Temperature range: 0 to 180°F. Humidity: 0 to 100 percent. Self-extinguishing. Layers of urethane foam thicker than 1/4" available by custom laminating.
2. Designed as required. Anti-static, abrasion resistant, washable and flame retardant.
3. Can be found to have partial enclosures and total enclosures for noisy places. Necessary equipment for suspending curtains is also made. Flame resistant, moisture proof, rotproof and mildew resistant.
4. For use where noise level is low and application is not critical. Standard size: 50" wide by 60' long roll.
5. Can be formed or draped to any contour. Maximum width: 36". Maximum length: 72' roll. Temperature range: 0 to 400°F. Humidity: 0 to 100 percent. Nonburning.
6. Temperature range: 0 to 180°F. Humidity: 0 to 100 percent. Self-extinguishing.
7. 50" wide x 60' long roll.
8. Maximum width: 36". Maximum length: 36' roll. Temperature range: 0 to 130°F. Humidity: 0 to 100 percent. Nonburning. Can be formed or draped to any contour.
9. Maximum width: 54". Maximum length: 72" sheet. Temperature range: 0 to 130°F. Humidity: 0 to 100 percent. Self-extinguishing.
10. Type 250 - 5/16", Type 500 - 9/16". Supplied in sheets 54" wide by up to 20' long. Self-extinguishing. Temperature range: -20° to +200°F. Gasoline, oil and abrasion resistant.
11. May be cut to rectangular sheets, die cut to irregular patterns, and laminated to open or closed cell flexible foams and/or pressure sensitive adhesives on one or two surfaces.
12. Tested and evaluated according to ASTM E90-70.
13. Tested and evaluated according to ASTM E413-70T.
14. Two curtains (each .032" thick) were used here to form a barrier. Separation between curtains was 28".
15. Data were obtained for comparison purposes only.
16. Numbers in parentheses were obtained at the following frequencies: 150, 350, 600, 1200, 2400, 4800, respectively.

TABLE 37
OPERABLE PARTITIONS

Operable partitions, defined here as room dividers which are less flexible than curtains but which can still be easily folded or extended by the room occupants, are listed. Usually the operable partitions are suspended from an overhead track and they ride on rolling bearings for ease of operation. Many shapes and configurations are available. Figure 37 shows one type of operable partition where the rectangular leaves can be stacked together to open the partition. The table contains a brief description of each partition and shows the transmission losses measured according to the standard procedures referred to in the footnotes. The companies (by numbers shown in Section II) with products listed in Table 37 are: 95, 98, 101, 134, 167, 179.

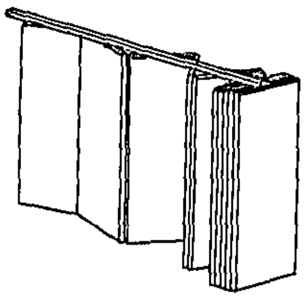


Figure 37 A Manually Operable Partition

## TABLE 37 OPERABLE PARTITIONS

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft 2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lamination of wood particle core, faced with wood veneer hinged with dualwall vinyl extrusion. | | | | | | | | | | | | | | | | | | | | | | |
| 13/16 | 25 | 15 | 20 | 19 | 18 | 18 | 20 | 22 | 24 | 25 | 26 | 26 | 26 | 26 | 27 | 28 | 28 | 3.0 | RAL TL69-3 | 134 | Scale/8 | 2 |
| Wood particle core, pressure plastic laminated and hinged with dual wall vinyl extrusions. | | | | | | | | | | | | | | | | | | | | | | |
| 17/16 | 29 | 19 | 21 | 19 | 23 | 23 | 24 | 26 | 27 | 29 | 29 | 28 | 30 | 32 | 33 | 32 | 32 | 4.2 | RAL TL69-238 | 134 | Scale/12 | |
| Wood framing panels (mineral wool insulation between frames) outer covering of .220 hard-board laminated to wood framing, 3/4" operating clearance be-tween top of panels and head trim assembly 3/4" clearance between panels and floor. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 38 | 15 | 22 | 27 | 32 | 36 | 37 | 38 | 39 | 39 | 39 | 40 | 38 | 37 | 40 | 43 | 45 | 4.9 | RAL TL71-151 | 179 | 700 series folding wall | 2 |
| Wood framing panel (mineral wool insulation between frames); outer covering of .270 hardboard laminated to wood framing. 5/8" clearance between top of panels and head trim assembly, 5/8" clearance between panels and floor. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 38 | 14 | 19 | 26 | 31 | 35 | 37 | 37 | 38 | 40 | 41 | 41 | 41 | 41 | 41 | 41 | 43 | 4.2 | RAL TL71-11 | 179 | 702 Series folding wall | 3 |
| 168" wide x 108" high woodlined steel test frame. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 40 | 17 | 26 | 29 | 32 | 35 | 36 | 37 | 40 | 41 | 39 | 42 | 43 | 45 | 46 | 46 | 47 | 4.9 | RAL TL70-225 | 95 | wall series | 3 |
| 168" wide x 108" high woodlined steel test frame. | | | | | | | | | | | | | | | | | | | | | | |
| 2-1/4 | 41 | 18 | 25 | 31 | 32 | 35 | 37 | 40 | 41 | 42 | 43 | 43 | 45 | 47 | 46 | 46 | 45 | 5.2 | RAL TL69-200 | 95 | Foldout folding wall series One | 3 |
| #240 vinyl covering panels hinged to operate as a single unit - stan-dard aluminum base. | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 38 | 14 | 19 | 28 | 32 | 33 | 35 | 37 | 37 | 40 | 41 | 41 | 43 | 43 | 43 | 44 | 40 | - | RAL OT67-8 | 101 | #380 folding wall with #240 panels | 1,3 |
| Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 18 | 24 | 27 | 29 | 31 | 36 | 39 | 40 | 42 | 43 | 44 | 46 | 46 | 46 | 43 | 44 | 6.0 | RAL OT71-5 | 98 | Hufcor Series 7610 | 2 |

TABLE 37 OPERABLE PARTITIONS (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Steel surface gypsum board. | | | | | | | | | | | | | | | | | | | | |
| 3 | 41 | 21 | 25 | 26 | 30 | 32 | 37 | 40 | 41 | 43 | 44 | 46 | 48 | 47 | 46 | 44 | 46 | 6.6 | RAL OT71-3 | 98 | Hufcor Series 7610 | 2 |
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3 | 43 | 22 | 31 | 28 | 31 | 35 | 42 | 43 | 44 | 45 | 46 | 48 | 47 | 46 | 47 | 43 | 46 | 6.4 | RAL OT71-4 | 98 | Hufcor Series 7630 | 2 |
| | | #245 vinyl covered panels, hinged to operate as a single unit. Standard aluminum base automatic bottom pressure and seal gasket. | | | | | | | | | | | | | | | | | | | | |
| 3 | 43 | 25 | 30 | 36 | 41 | 39 | 40 | 40 | 41 | 44 | 44 | 44 | 45 | 46 | 46 | 45 | 41 | - | RAL OT68-1 | 101 | #380 Folding wall with #245 panels | 3 |
| | | Steel surface gypsum board. | | | | | | | | | | | | | | | | | | | | |
| 3 | 44 | 26 | 32 | 30 | 34 | 38 | 42 | 45 | 45 | 45 | 46 | 47 | 49 | 48 | 47 | 44 | 47 | 7.2 | RAL OT71-7 | 98 | Hufcor Series 7630 | 2 |
| | | #2245 vinyl covered panels standard aluminum base and automatic bottom pressure seal gasket. | | | | | | | | | | | | | | | | | | | | |
| 3 | 45 | 22 | 31 | 36 | 40 | 41 | 43 | 45 | 46 | 47 | 45 | 44 | 44 | 45 | 47 | 49 | 50 | - | RAL OT68-2 | 101 | #380 folding wall with #245 panels | 1,3 |
| | | Vinyl clad surface particle board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 38 | 16 | 21 | 25 | 28 | 32 | 36 | 40 | 41 | 42 | 41 | 42 | 43 | 45 | 39 | 41 | 45 | 5.8 | RAL OT70-8 | 98 | Hufcor Series 8510 | 2 |
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 39 | 17 | 24 | 24 | 28 | 31 | 36 | 39 | 40 | 42 | 42 | 44 | 45 | 47 | 43 | 41 | 46 | 5.8 | RAL OT71-7 | 98 | Hufcor Series 8310 | 2 |
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 39 | 20 | 21 | 25 | 29 | 32 | 35 | 39 | 41 | 40 | 40 | 41 | 43 | 45 | 42 | 39 | 44 | 6.2 | RAL OT70-5 | 98 | Hufcor Series 8510 | 2 |
| | | Steel surface gypsum board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 39 | 23 | 23 | 23 | 30 | 33 | 37 | 41 | 42 | 41 | 40 | 40 | 40 | 38 | 38 | 44 | 47 | 7.3 | RAL OT70-3 | 98 | Hufcor Series 8510 | 2 |
| | | Vinyl clad surfaces particle board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 43 | 20 | 27 | 33 | 39 | 40 | 44 | 44 | 45 | 44 | 41 | 42 | 43 | 47 | 45 | 47 | 50 | 6.2 | RAL OT70-6 | 98 | Hufcor Series 8500 | 2 |
| | | Steel surface gypsum board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 43 | 27 | 32 | 36 | 39 | 41 | 44 | 46 | 46 | 44 | 42 | 41 | 42 | 40 | 42 | 46 | 47 | 7.7 | RAL OT72-2 | 98 | Hufcor Series 8530 | 2 |

TABLE 37 OPERABLE PARTITIONS (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 44 | 22 | 29 | 33 | 39 | 41 | 44 | 46 | 46 | 45 | 42 | 43 | 43 | 47 | 49 | 49 | 48 | 6.6 | RAL OT70-4 | 98 | Hufcor Series 8530 | 2 |
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 45 | 21 | 30 | 33 | 36 | 39 | 42 | 45 | 47 | 47 | 45 | 43 | 45 | 49 | 49 | 48 | 49 | 6.2 | RAL OT71-6 | 98 | Hufcor Series 8330 | 2 |
| | | Vinyl fabric surface tack board. | | | | | | | | | | | | | | | | | | | | |
| 3-5/8 | 48 | 25 | 35 | 37 | 41 | 42 | 47 | 48 | 49 | 50 | 48 | 48 | 49 | 51 | 52 | 53 | 55 | 8.0 | RAL OT71-8 | 98 | Hufcor Series 8350 | 2 |
| | | Clipboard laminated to both sides of steel core | | | | | | | | | | | | | | | | | | | | |
| 5-1/2 | 36 | 12 | 17 | 21 | 26 | 29 | 35 | 39 | 42 | 44 | 44 | 44 | 46 | 46 | 47 | 48 | 49 | 3.0 | RAL OT72-3 | 98 | Hufcor Series 3500 | 2 |
| | | Vinyl fabric surfaces clip-board laminated to both sides of steel core. | | | | | | | | | | | | | | | | | | | | |
| 5-1/2 | 39 | 15 | 19 | 24 | 28 | 32 | 38 | 43 | 44 | 45 | 44 | 44 | 45 | 47 | 46 | 47 | 48 | 3.8 | RAL OT72-2 | 98 | Hufcor Series 4500 | 2 |
| | | Vinyl fabric surfaces clip-board laminated to both sides of steel core. | | | | | | | | | | | | | | | | | | | | |
| 5-1/2 | 41 | 17 | 20 | 28 | 31 | 35 | 40 | 44 | 46 | 46 | 46 | 47 | 46 | 47 | 46 | 46 | 48 | 4.4 | RAL OT72-1 | 98 | Hufcor Series 4800 | 2 |
| | | Lamination of wood particle core, panel faced with grade wood veneer and backed with sound damping material. | | | | | | | | | | | | | | | | | | | | |
| - | 36 | 17 | 23 | 23 | 27 | 29 | 31 | 33 | 36 | 38 | 39 | 40 | 41 | 40 | 40 | 38 | 38 | 4.4 | RAL TL69-129 | 134 | Sonic wall/66 | 2 |
| | | Vinyl fabric in facing & backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 37 | 15 | 19 | 23 | 24 | 29 | 33 | 36 | 36 | 39 | 42 | 45 | 46 | 48 | 49 | 50 | 51 | 4.8 | RAL TL71-316 | 95 | X8 foldoor Sound Guard | 2 |
| | | Vinyl fabric in facing & backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 38 | 17 | 21 | 23 | 26 | 30 | 33 | 35 | 38 | 41 | 43 | 46 | 46 | 48 | 49 | 51 | 51 | 5.4 | RAL TL71-232 | 95 | X8 Foldoor super Sound guard | 2 |
| | | Vinyl fabric in facing & backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 39 | 20 | 21 | 24 | 27 | 29 | 33 | 37 | 43 | 44 | 42 | 43 | 47 | 49 | 50 | 52 | 53 | 5.1 | RAL TL72-5 | 95 | X12 Foldoor super sound guard | 2 |
| | | Vinyl fabric in facing & backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 39 | 19 | 24 | 27 | 28 | 30 | 31 | 35 | 41 | 47 | 49 | 50 | 48 | 49 | 50 | 51 | 51 | 6.1 | RAL TL71-256 | 95 | X16 Foldoor super sound guard | 2 |

TABLE 37 OPERABLE PARTITIONS (Concl)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Vinyl fabric in facing & backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 40 | 20 | 23 | 26 | 28 | 30 | 36 | 38 | 44 | 48 | 48 | 48 | 50 | 51 | 53 | 53 | 54 | 5.8 | RAL TL72-23 | 95 | X12 Foldoor super sound guard | 2 |
| | | Lamination of wood particle core, layers of asbestos felt membrane backed fiber insulation. Faced and backed pressure plastic laminate clad panels. | | | | | | | | | | | | | | | | | | | | |
| - | 40 | 20 | 26 | 26 | 28 | 31 | 33 | 35 | 39 | 42 | 43 | 45 | 45 | 45 | 46 | 46 | 46 | 6.0 | RAL TL69-40 | 134 | Sonic wall/88 | 2 |
| | | Vinyl fabric in facing and backing steel slats backed with vinyl impregnated liner. | | | | | | | | | | | | | | | | | | | | |
| - | 41 | 22 | 24 | 26 | 29 | 32 | 34 | 37 | 42 | 45 | 46 | 48 | 49 | 51 | 52 | 54 | 55 | 6.24 | RAL TL71-210 | 95 | X24 Foldoor super sound guard | 2 |
| | | Fabric covered panels; 46" wide and one panel 21" wide, all x 102-1/2" high. | | | | | | | | | | | | | | | | | | | | |
| - | 42 | 22 | 27 | 31 | 34 | 34 | 36 | 40 | 41 | 42 | 42 | 44 | 47 | 49 | 50 | 48 | 49 | 5.3 | RAL TL72-210 | 95 | Foldoor folding walls series two | 2 |
| | | Fabric covered panels; Two-26 1/2" wide and One 29" wide, all x 103-1/2" high. | | | | | | | | | | | | | | | | | | | | |
| - | 46 | 31 | 33 | 36 | 37 | 40 | 42 | 43 | 44 | 46 | 46 | 48 | 50 | 49 | 48 | 47 | 50 | - | RAL TL72-238 | 95 | Foldoor folding walls series Three | 2 |
| | | Folding partions and doors. Two or three layers of lead-filled vinyl on each side of frame. VL-8 has 3 layers lead-filled vinyl plus glass fiber blanket each side. | | | | | | | | | | | | | | | | | | | Curtain Models: | |
| | 37 | | | | | | | | | | | | | | | | | 2.5 | | | VL-2 | |
| | 38 | | | | | | | | | | | | | | | | | 3.0 | | | VL-6 | |
| | 41 | | | | | | | | | | | | | | | | | 3.5 | | 167 | VL-8 | |

FOOTNOTES FOR TABLE 37

OPERABLE PARTITIONS

1. Automatic bottom pressure seal gasket, internal with vinyl strip - overhead trim section, fitted with standard automatic top pressure seal.
2. Tested and evaluated according to ASTM E90-70.
3. Tested and evaluated according to ASTM E90-66T.

## TABLE 38
## SEMIPERMANENT PARTITION ASSEMBLIES

Semipermanent partition assemblies defined here as partitions or walls which can be erected or demounted on site, such that the component panels, etc., can be reused, are listed. These are not operable partitions in the sense that, though they can be moved from the site, they cannot be folded or extended as a room divider on a routine basis. In other words the partitions are treated here as semipermanent walls which completely close off two adjoining spaces. The table is divided in three parts on the basis of the materials used in the partitions:

38A Metal-faced gypsum board partitions
38B Vinyl-faced gypsum board partitions
38C Vinyl-faced plywood partitions

The companies (by numbers shown in Section II) with products listed in Table 38 are: 53, 84, 101, 104.

### GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other outside surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |
| Gypsum: | A hydrated sulphate of Calcium. $CaSO_4 \cdot 2H_2O$. Used for making wallboards, plaster of Paris, etc. |
| Stud: | An upright piece in a frame to which wallboards are applied |

TABLE 38A SEMIPERMANENT PARTITION ASSEMBLIES
(Metal faced gypsum board partitions)

| | | Transmission Loss (decibels) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
| | | Pre-assembled units made of metal studs, stud extensions, stud track, metal clad panels, honeycomb filler, post covers. | | | | | | | | | | | | | | | | | | | | |
| 3 | 36 | 15 | 20 | 27 | 25 | 26 | 30 | 34 | 39 | 40 | 41 | 39 | 41 | 45 | 45 | 40 | 36 | 5.1 | RAL TL71-21 | 53 | Unitized Wall Partition | 1,2 |
| | | Partition is made of metal clad gypsum board, Crusader studs and other accessories as required. There is 2" thick insulation in end panels. | | | | | | | | | | | | | | | | | | | | |
| 3 | 39 | 24 | 24 | 29 | 32 | 34 | 37 | 40 | 41 | 40 | 36 | 35 | 40 | 45 | 47 | 49 | 49 | 6.9 | RAL TL68-117 | 53 | Crusader metal Partition | 1 |
| | | Pre-assembled units made of metal studs, studs extension stud track, metal clad panels, honeycomb filler, post covers, mineral fiber insulation, sound seal gasketing. | | | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 17 | 23 | 29 | 30 | 30 | 32 | 37 | 43 | 44 | 45 | 46 | 48 | 50 | 50 | 48 | 47 | 5.1 | RAL TL71-18 | 53 | Unitized Partition System | 1,2 |
| | | Partition is made of metal clad gypsum board, Crusader studs, And other accessories as required. There is 2" thick insulation in end panels and base of center panel. | | | | | | | | | | | | | | | | | | | | |
| 3 | 41 | 27 | 26 | 31 | 35 | 36 | 40 | 42 | 43 | 42 | 38 | 37 | 41 | 46 | 48 | 49 | 49 | 6.9 | RAL TL68-123 | 53 | Crusader metal Partition | 1 |
| | | Partition wall is made from metal clad gypsum board, crusader studs and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 3 | 44 | 27 | 29 | 36 | 41 | 42 | 45 | 46 | 45 | 43 | 41 | 40 | 42 | 46 | 47 | 49 | 49 | 7.0 | RAL TL68-124 | 53 | Crusader metal Partition | 1 |
| | | Partition is made of 32" module steel faced gypsum panels. 2" Thermafiber wrapped insulation in cavity and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 3 | 45 | 21 | 28 | 33 | 38 | 45 | 50 | 51 | 53 | 54 | 54 | 53 | 51 | 48 | 48 | 48 | 50 | 8.2 | RAL TL71-22 | 53 | Crusader Partition | 1,2 |
| | | Partition is made of metal faced gypsum panels snapped into metal studs 2" Thermafiber roll insulation in cavity and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 3 | 45 | 21 | 28 | 33 | 38 | 45 | 50 | 51 | 53 | 54 | 54 | 53 | 51 | 48 | 48 | 48 | 50 | 8.2 | RAL TL71-22 | 53 | 32" module Dividing wall | 1,2 |

TABLE 38A SEMIPERMANENT PARTITION ASSEMBLIES (Concl)
(Metal faced gypsum board partitions)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partition is made of 4" thick panels with heavy gauge steel surfaces welded to a steel frame and filled with a combination of sound impeding materials. | | | | | | | | | | | | | | | | | | | | |
| 4 | 43 | 24 | [28] | | 32 | [37] | | 43 | [46] | | 48 | [49] | | 52 | [52] | | 54 | 8.25 (Panels only) | | 104 | Tracwall | 4,5,8 |
| | | Partition is made of 4" thick panels with heavy gauge steel surfaces welded to a steel frame and filled with a combination of sound impeding materials. | | | | | | | | | | | | | | | | | | | | |
| 4 | 48 | 38 | [35] | | 40 | [42] | | 46 | [47] | | 51 | [49] | | 48 | [48] | | 49 | 8.25 (Panels only) 17.7 Total | RAL TL64-273 | 104 | Tracwall | 2,3 4,5 |
| | | Partition wall with a central access on one side is made of metal faced gypsum boards, Crusader studs and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 5 | 42 | 19 | 25 | 28 | 32 | 35 | 38 | 41 | 45 | 48 | 48 | 48 | 48 | 44 | 43 | 46 | 48 | 6.7 | RAL TL70-127 | 53 | Crusader 5" Laboratory wall (Access one side) | 1 |
| | | Partition wall with a central access on both sides of wall is constructed of metal faced gypsum board, Crusader studs and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 5 | 43 | 19 | 28 | 30 | 33 | 36 | 40 | 42 | 45 | 48 | 50 | 50 | 50 | 47 | 46 | 47 | 49 | 6.7 | RAL TL70-129 | 53 | Crusader 5" Laboratory wall (Access both sides) | 1 |
| | | Partition wall with a central access on one side of wall is constructed of metal faced gypsum board, Crusader studs, 1-1/2" fiberglass insulation in cavity and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| 5 | 46 | 23 | 30 | 33 | 38 | 39 | 44 | 68 | 50 | 52 | 52 | 52 | 50 | 46 | 46 | 48 | 50 | 6.7 | RAL TL70-108 | 53 | Crusader 5" Laboratory wall (Access one side) | 1 |
| | | Partition wall consists of double 3" Crusader walls back to back with 2" thermafiber on back of board and other accessories. | | | | | | | | | | | | | | | | | | | | |
| 6-1/8 | 52 | 28 | 36 | 42 | 47 | 51 | 54 | 57 | 57 | 58 | 57 | 57 | 57 | 58 | 56 | 58 | 60 | 8.6 | RAL TL71-30 | 53 | Crusader 6" Double Wall | 6,7 |
| | | Partition wall consists of pre-assembled wall units made of metal panels, 1/4" gypsum wall board, trim pieces and other accessories as required. | | | | | | | | | | | | | | | | | | | | |
| | 37 | 15 | 19 | 24 | 26 | 29 | 33 | 36 | 37 | 40 | 42 | 45 | 46 | 42 | 42 | 45 | 48 | 6.7 | RAL TL72-116 | 53 | Single line Unitized wall | 6,7 |
| | | Partition wall is made from pre-assembled wall units made of: steel panels, 1/4" gypsum wall board, trim pieces as required and 1" thick thermafiber insulation in ends and base of unit. | | | | | | | | | | | | | | | | | | | | |
| | 41 | 18 | 20 | 28 | 30 | 32 | 36 | 40 | 42 | 44 | 45 | 48 | 49 | 52 | 52 | 53 | 54 | 6.8 | RAL TL72-117 | 53 | Single line Unitized wall | 6,7 |
| | | Partition wall is made from pre-assembled wall units made of steel panels, 1/4" gypsum wallboard backer, trim pieces as required and 1" thick thermafiber insulation inside the entire wall. | | | | | | | | | | | | | | | | | | | | |
| • | 43 | 19 | 24 | 29 | 33 | 36 | 39 | 42 | 45 | 48 | 49 | 51 | 53 | 54 | 55 | 55 | 55 | 6.9 | RAL TL72-115 | 53 | Single wall Unitized wall | 6,7 |

TABLE 38B SEMIPERMANENT PARTITION ASSEMBLIES
(Vinyl faced gypsum board partitions)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Partition wall is made from vinyl covered gypsum wallboard panels and an insulation in the cavity between the panels. | | | | | | | | | | | | | | | | | | |
| 2-3/4 | 40 | 20 | 23 | 25 | 32 | 36 | 41 | 42 | 42 | 42 | 42 | 44 | 47 | 46 | 42 | 39 | 40 | 4.6 | G&H OBR-1ST | 84 | Quick change Movable Partition | 6,7 |
| | | | | Partition wall is made from gypsum wallboard panels and an insulation in the cavity. | | | | | | | | | | | | | | | | | | |
| 2-3/4 | 42 | 18 | 23 | 28 | 35 | 38 | 43 | 44 | 45 | 45 | 46 | 46 | 48 | 48 | 43 | 42 | 43 | 4.6 | G&H OBR-2ST | 84 | Quick Change Movable Partition | 6,7 |
| | | | | Partition wall is made of vinyl faced gypsum boards, fiberglass insulation and other accessories. It has an operable door. | | | | | | | | | | | | | | | | | | |
| 3 | 37 | 20 | 25 | 30 | 30 | 30 | 34 | 36 | 36 | 35 | 35 | 36 | 36 | 38 | 40 | 41 | 42 | 2.01 | RAL TL70-8 | 53 | Crusader Modular Drywall System with Operable Door | 1,2 |
| | | | | Partition wall consists of 48" modules of 1/2" vinyl covered gypsum board, staggered joints, insulation in the cavity; Vanguard studs; and other accessories as required. | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 16 | 21 | 26 | 30 | 37 | 42 | 44 | 46 | 48 | 48 | 48 | 50 | 50 | 47 | 44 | 48 | 4.8 | RAL TL71-180 | 53 | Vanguard Partition | 6,7 |
| | | | | Partition wall is made of 48" modules of 1/2" vinyl covered gypsum board (common joints). Insulation in cavity, Vanguard studs and other accessories as required. | | | | | | | | | | | | | | | | | | |
| 3 | 40 | 17 | 20 | 23 | 29 | 35 | 41 | 43 | 45 | 48 | 48 | 48 | 49 | 49 | 45 | 43 | 46 | 4.8 | RAL TL71-181 | 53 | Vanguard Partition | 6,7 |
| | | | | Partition wall is made of 24" modules 1/2" vinyl covered board (Gypsum); insulation in cavity; Vanguard studs; and accessories as required. | | | | | | | | | | | | | | | | | | |
| 3 | 41 | 17 | 21 | 27 | 31 | 37 | 43 | 46 | 48 | 49 | 49 | 49 | 49 | 49 | 46 | 43 | 46 | 4.8 | RAL TL71-190 | 53 | Vanguard Partition | 6,7 |
| | | | | Partition wall is made of vinyl clad gypsum board; crusader studs; 1-7/8" thick fiberglass insulation in cavity and other accessories as required. | | | | | | | | | | | | | | | | | | |
| 3 | 41 | 17 | 24 | 29 | 33 | 32 | 37 | 42 | 45 | 47 | 49 | 50 | 51 | 52 | 51 | 48 | 48 | 5.2 | RAL TL69-279 | 53 | Crusader Modular Drywall System | 1,2 |

TABLE 38B SEMIPERMANENT PARTITION ASSEMBLIES (Concl)
(Vinyl faced gypsum board partitions)

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight $lb/ft^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Partition wall is made of vinyl clad gypsum board; Crusader studs; 2" thick fiberglass insulation in cavity and other accessories as required. | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 44 | 20 | 27 | 30 | 35 | 34 | 33 | 43 | 45 | 47 | 49 | 49 | 51 | 51 | 50 | 47 | 47 | 5.2 | RAL TL69-232 | 53 | Crusader Modular Drywall System | 1,2 |
| Partition wall consists of 48" modules of 5/8" vinyl covered gypsum board, staggered joints Vanguard studs and other accessories as required. | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 37 | 13 | 17 | 23 | 26 | 30 | 35 | 39 | 39 | 44 | 46 | 45 | 47 | 41 | 33 | 44 | 49 | 5.6 | RAL TL71-187 | 53 | Vanguard Partition | 6,7 |
| Partition wall is made of vinyl covered gypsum board (common joints) insulation in the cavity and other accessories as required. | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 42 | 19 | 23 | 24 | 29 | 37 | 41 | 44 | 46 | 47 | 47 | 47 | 48 | 47 | 45 | 48 | 49 | 2.54 | RAL TL71-185 | 53 | Vanguard Partition | 6,7 |
| Partition wall is made of 24" modules of 5/8" vinyl covered gypsum board with insulation. Vanguard studs and other accessories as required. | | | | | | | | | | | | | | | | | | | | | | |
| 3-1/4 | 43 | 19 | 25 | 31 | 36 | 40 | 44 | 46 | 48 | 48 | 48 | 48 | 48 | 48 | 45 | 46 | 49 | 6.0 | RAL TL71-189 | 53 | Vanguard wall Partition | 5,7 |
| Partition wall is made of 1/2" thick gypsum panels screwed onto metal stud framing. | | | | | | | | | | | | | | | | | | | | | | |
| - | 42 | 26 | | | 33 | | | 40 | | | 47 | | | 50 | | | 40 | 4.55 | RAL TL62-18 | 53 | DW Partition with 3" studs | 2,3 |
| Partition is made of studs; 1/2" gypsum board panels, snap in battens, 1-1/2" thick glass fiber insulation and other accessories as required. | | | | | | | | | | | | | | | | | | | | | | |
| - | 43 | 19 | 23 | 30 | 35 | 38 | 42 | 45 | 47 | 47 | 46 | 45 | 46 | 47 | 46 | 43 | 44 | 4.40 | RAL TL68-104 | 53 | Crusader 4c Partition | 1 |

TABLE 38C SEMIPERMANENT PARTITION ASSEMBLIES
(Vinyl faced plywood partitions)

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Partition is made of 1/4" thick plywood boards with Acousticore pre-crushed honeycomb core. | | | | | | | | | | | | | | | | | | | | |
| 1-9/16 | 23 | 16[19] | | | 18[23] | | | 23[26] | | | 27[23] | | | 20[24] | | | 27 | 2 | RAL TL65-218 | 101 | Air wall Portable and Movable Partitions | 2, 3,4 |
| | | Partition wall is made of panels which consist of 1/4" plywood covered with vinyl, with a core of fiber-glass. | | | | | | | | | | | | | | | | | | | | |
| 2 | 38 | 19[25] | | | 25[32] | | | 35[39] | | | 62[47] | | | 50[51] | | | 51 | 3.1 | RAL TL65-219 | 101 | Air Wall Portable and Movable Partitions | 2, 3,4 |

FOOTNOTES FOR TABLE 38A, 38B, 38C

SEMIPERMANENT PARTITION ASSEMBLIES

1. Tested and evaluated according to ASTM E90-66T.
2. Tested and evaluated according to ASARP-Z24.19-1957.
3. Tested and evaluated according to ASTM E90-61T.
4. Numbers in brackets refer to one-third octave bands with center frequencies: 175, 350, 700, 1400, and 2800 Hz respectively.
5. Metal facing. Basic material not given.
6. Tested and evaluated according to ASTM E90-70.
7. Tested and evaluated according to ASTM E413-70T.
8. Numbers given are noise reduction data obtained from a test performed on a field installation by an independent acoustical consultant using the two-room method.

TABLE 39

PREFABRICATED SOUND BARRIER PANELS

Prefabricated sound barrier panels are listed. These panels can be used in machinery enclosures, walls, facings, etc. They are usually composite products using sound barrier materials for facing and backing and a sound absorbent material in the core. The exposed surfaces of the panels are available in different colors, textures, and materials to suit the requirements of a specific application. The companies (by numbers shown in Section II) with products listed in Table 39 are: 10, 15, 35, 45, 55, 59, 73, 82, 87, 93, 104, 106, 109, 111, 116, 119, 129, 142, 147, 151, 156, 157, 169, 172, 173, 181.

GLOSSARY

| | |
|---|---|
| Facing: | The outside surface of the specimen. In general the side facing the sound source |
| Backing: | The other outside surface of the specimen. In general the side not facing the sound source |
| Core: | The region between the facing and the backing |
| Septum: | A layer that separates two surfaces |

TABLE 39 PREFABRICATED SOUND BARRIER PANELS

| Thickness (Inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lightweight panels | | | | | | | | | | | | | | | | | | | | | | |
| 7/8 | 26 | 21 | 21 | 18 | 21 | 22 | 21 | 21 | 23 | 22 | 25 | 26 | 29 | 33 | 34 | 35 | 36 | 1.7 | CT | 109 | J-M Marinite Panels 23 MV-2 | 1 |
| Bulkhead panels | | | | | | | | | | | | | | | | | | | | | | |
| 7/8 | 28 | 24 | 21 | 22 | 24 | 23 | 23 | 25 | 26 | 25 | 26 | 26 | 29 | 34 | 36 | 36 | 37 | 2.6 | CT | 109 | J-M Marinite Panels 36 MV-2 | 1 |
| Polyurethane core with .032" aluminum facing both sides | | | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | - | [12] | | | [18] | | | [20] | | | [24] | | | [19] | | | [20] | 1.5 | CT | 10 | Dualite Panel | 2 11 |
| Glass or mineral wool core, 22 ga. perforated steel sheet facing & 16 ga. cold rolled steel backing | | | | | | | | | | | | | | | | | | | | | | |
| 2 | - | 24 | | | 32 | | | 40 | | | 49 | | | 53 | | | 58 | - | - | 111 | Standard Noise-guard Panels | 12 |
| Machinery enclosure panels | | | | | | | | | | | | | | | | | | | | | | |
| 2 | - | 16 | | | 20 | | | 26 | | | 32 | | | 39 | | | 41 | - | - | 82 | Modular Noise-Control Panel | |
| Lead septum with 16 ga. steel on both sides | | | | | | | | | | | | | | | | | | | | | | |
| 2 | - | 36 | | | 42 | | | 45 | | | 57 | | | 67 | | | 70 | 6 | - | 157 | Sound Control Panels | 3 |
| Insulating material core with 18 ga. steel facing; back is 22 ga. steel with 23% perforations | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 38 | 26 | 23 | 26 | 29 | 29 | 30 | 33 | 36 | 40 | 44 | 46 | 50 | 52 | 54 | 58 | 60 | 4.52 | KAL 1180-3-71R | 151 | Semco Equipment Housing Panels | 4,21 |
| Hard panel board septum with perforated laquered hardboard facing; back is unperforated hardboard | | | | | | | | | | | | | | | | | | | | | | |
| 2-3/8 | 28 | 15 | 20 | 24 | 26 | 25 | 27 | 28 | 26 | 28 | 28 | 24 | 28 | 29 | 31 | 38 | 42 | 5.75 | KAL 1306-2-72 | 129 | NMC Laminated Noise Control Panels | 5 |
| Machinery enclosure panels | | | | | | | | | | | | | | | | | | | | | | |
| 3 | - | 26 | | | 30 | | | 35 | | | 43 | | | 49 | | | 53 | - | - | 82 | Modular Noise Control Panel | |
| Fiberglas insulation core with 20 ga. steel facing; perforated 20 ga. steel backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 37 | 16 | | | 23 | | | 35 | | | 45 | | | 53 | | | 58 | 5.1 | RAL TL71-37 | 172 | Uni-Housing Panels | 21,22 |
| 18 ga. perforated steel face and backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 38 | 23 | 21 | 23 | 25 | 27 | 31 | 34 | 41 | 47 | 49 | 51 | 53 | 54 | 55 | 54 | 54 | 7.5 | RAL TL72-49 | 104 | 4" Septum Panel | 21 |

TABLE 39 PREFABRICATED SOUND BARRIER PANELS (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fiberglas core with 18 ga. steel face and backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 38 | 14 | 19 | 22 | 27 | 31 | 36 | 40 | 44 | 48 | 51 | 52 | 54 | 55 | 56 | 57 | 58 | 5.25 | RAL TL71-62 | 87 | Sound Panel | 21 |
| Fiberglas insulation core with 18 ga. steel facing, 20 ga. perforated steel backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 40 | 19 | | | 27 | | | 40 | | | 53 | | | 58 | | | 63 | 5.5 | RAL TL71-327 | 172 | Uni-Housing Panel | 6,21 |
| Mineral wool core with 18 ga. metal facing and 22 ga. metal backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 40 | 23 | 22 | 26 | 29 | 30 | 34 | 38 | 43 | 46 | 49 | 51 | 51 | 52 | 54 | 55 | 57 | 6 | RAL TL72-18 | 147 | Acoustical Panel | 7,21 |
| Fiberglas core with perforated sheet facing & metal backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 42 | 21 | 22 | 28 | 35 | 38 | 38 | 42 | 44 | 43 | 42 | | | 45 | | | 50 | 6.2 | CT | 119 | Modular Acoustical Panel | 8 |
| 20 ga. perforated steel facing & backing with 4 mil mylar inserts | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 42 | 18 | 25 | 29 | 32 | 37 | 41 | 43 | 46 | 48 | 47 | 48 | 50 | 52 | 54 | 56 | 57 | 5.25 | RAL TL71-61 | 93 | Sound Panel | 21 |
| Mineral wool core with solid metal facing & perforated metal backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 43 | 24 | 28 | 29 | 31 | 36 | 38 | 40 | 43 | 44 | 46 | 47 | 48 | 49 | 50 | 53 | 53 | 9.1 | RAL TL67-1 | 129 | NMC Acoustical Panel | 9,23 |
| Insulating material core with 18 ga. steel facing & 22 ga. steel backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 43 | 26 | 27 | 29 | 32 | 34 | 37 | 38 | 43 | 47 | 51 | 54 | 58 | 60 | 64 | 65 | 67 | 4.58 | KAL 1180-4-71R | 151 | Semco Equipment Housing Panel | 4,21 |
| 18 ga. galvanized steel facing & 22 ga. galvanized steel backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 44 | 20 | 26 | 31 | 34 | 35 | 39 | 42 | 46 | 52 | 56 | 59 | 62 | 66 | 69 | 71 | 71 | 6.01 | KAL 1233-1-71 | 181 | Vibrasonics Sona-Guard Panel | 10,21 |
| Wall panel | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 46 | 28 | 30 | 30 | 33 | 38 | 41 | 43 | 46 | 50 | 54 | 56 | 56 | 57 | 58 | 58 | 58 | 11.9 | RAL TL72-64 | 142 | Music Practice Room Wall Panel | 21,22 |
| Machinery enclosure panel | | | | | | | | | | | | | | | | | | | | | | |
| 4 | - | 34 | | | 42 | | | 48 | | | 59 | | | 69 | | | 73 | - | - | 82 | Modular Noise Control Panels | |
| Foamed-in-place polyurethane core with galvanized steel facing and backing | | | | | | | | | | | | | | | | | | | | | | |
| 4 | - | | | | | | | | | | | | | | | | | - | CT | 156 | Sound Control Enclosure Panel | |

TABLE 39 PREFABRICATED SOUND BARRIER PANELS (Contd)

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Glass or mineral wool core with 22 ga. perforated steel facing & 16 ga. steel backing | | | | | | | | | | | | | | | | | | | | |
| 4 | - | 27 | | | 39 | | | 45 | | | 54 | | | 58 | | | 62 | - | - | 111 | Standard Noise Guard Panel | 12 |
| | | 16 ga. steel facing & 22 ga. steel backing | | | | | | | | | | | | | | | | | | | | |
| 4 | - | [23] | | | [30] | | | [42] | | | [51] | | | [59] | | | [58] | 6.3 | RAL TL66-120 | 104 | 4" Noishield Panel | 13,24 |
| | | 16 ga. steel facing & 22 ga. steel backing | | | | | | | | | | | | | | | | | | | | |
| 4 | - | [28] | | | [34] | | | [40] | | | [48] | | | [56] | | | [62] | 7.5 | RAL TL66-122 | 104 | 4" Noise-Lock Panel | 13,24 |
| | | Polyurethane core panel for enclosures | | | | | | | | | | | | | | | | | | | | |
| 4 | - | 12 | | | 20 | | | 30 | | | 37 | | | 31 | | | 42 | 2.5 | CT | 10 | Acoustic Panel | 2 |
| | | Decorative panel | | | | | | | | | | | | | | | | | | | | |
| 4 | - | 7 | | | 11 | | | 12 | | | 13 | | | 14 | | | 12 | 9.1 | CT | 104 | 4" Noishield Louver Model-R | 23 |
| | | 9" airspace core prefabricated with panels; 3/16" steel facing & 2" builtup panel backing | | | | | | | | | | | | | | | | | | | | |
| 12-1/4 | 60 | 42 | 44 | 46 | 51 | 53 | 54 | 56 | 58 | 61 | 64 | 68 | 69 | 68 | 68 | 68 | 70 | 15.6 | RAL TL72-205 | 169 | Noisecon-12 | 21 |
| | | Polyurethane foam core with 27 ga. galvanized steel facing & 26 ga. galvanized steel backing | | | | | | | | | | | | | | | | | | | | |
| - | 25 | 23[22] | | | 24[24] | | | 25[28] | | | 28[29] | | | 25[31] | | | 42 | 2.4 | RAL TL63-236 | 35 | F-103 | 14, 16,25 |
| | | Galvanized steel facing & backing | | | | | | | | | | | | | | | | | | | | |
| - | 32 | 28[35] | | | 35[32] | | | 32[34] | | | 34[33] | | | 30(29] | | | 32 | - | RAL TL61-64 | 55 | Monopanl | 15, 16,25 |
| | | 20 ga. liner panels with 18 ga. exterior | | | | | | | | | | | | | | | | | | | | |
| - | 34 | 18 | 19 | 22 | 22 | 23 | 27 | 30 | 34 | 37 | 38 | 38 | 39 | 41 | 44 | 47 | 51 | 5.27 | RAL TL71-248 | 106 | L-21 Acoustiwall | 21 |
| | | Sound-proof room panels | | | | | | | | | | | | | | | | | | | | |
| - | 44 | 26 | | | 33 | | | 39 | | | 48 | | | 57 | | | 61 | - | CKAL 694-11 | 59 | Panel Systems Series HS & CS | 23 |
| | | Perforated steel-faced panel | | | | | | | | | | | | | | | | | | | | |
| - | 45 | 25 | 26 | 30 | 33 | 38 | 41 | 45 | 48 | 51 | 52 | 53 | 55 | 58 | 60 | 61 | 63 | 7.2 | RAL TL71-146 | 73 | Sound Control Panel | 21 |
| | | Solid steel-faced panel | | | | | | | | | | | | | | | | | | | | |
| - | 49 | 30 | 29 | 35 | 40 | 41 | 45 | 47 | 49 | 51 | 52 | 51 | 51 | 53 | 55 | 56 | 57 | 10.4 | RAL TL71-147 | 73 | Sound Control Panel | 21 |

TABLE 39 PREFABRICATED SOUND BARRIER PANELS (Concl)

| Thickness (inches) | STC | Description | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | Precompressed molded fiberglass panels bonded to plywood | | | | | | | | | | | | | | | | | - | - | 45 | Kinetic Isolation Panel | 17 |
| - | - | Soundproof enclosure panels | 19 | | | 30 | | | 39 | | | 50 | | | 58 | | | 60 | - | CKAL 694-12 | 73 | Panel Systems, Series H & C | 18 |
| - | - | Panels for air-conditioning systems and moist equipment | | | | | | | | | | | | | | | | | - | - | 173 | Acoustic Panels | |
| - | - | Mineral fill core with solid 18 ga. galvanized steel facing & 20 ga. perforated galvanized steel backing | 34 | | | 42 | | | 48 | | | 59 | | | 69 | | | 73 | - | - | 82 | Modular Noise Control Panel | 19 |
| - | - | Rigid glass fiber core with perforated vinyl facing and 3/8" particle board backing. | | | | | | | | | | | | | | | | | - | - | 116 | Vicracoustics Type C & D | 20 |
| - | - | Corridor panels using perforated aluminum or steel facing. | | | | | | | | | | | | | | | | | - | - | 15 | Alpro Sigma Panels | |

FOOTNOTES FOR TABLE 39

PREFABRICATED SOUND BARRIER PANELS

1. 3'x8', 4'x8', or 4'x10' sizes in various finishes. Flame spread: 0. Fuel contribution: negligible.
2. Temperature range: -40° to 180°F.
3. Sizes range from 36"x60" to 48"x96". Weight range: 90 lbs to 200 lbs. Available with sound-absorptive perforation on one or both sides.
4. Temperature range: -40° to 400°F. Flame spread: 15.
5. Temperature range up to 125°F; combustible. Perforated side has NRC of .65.
6. Temperature range up to 350°F; sizes 36" wide, 6' and 12' lengths.
7. Temperature range up to 600°F. Flame spread 15 UL 723. Sizes up to 48"x144".
8. Sizes: 2' and 3' widths, 4' to 12' lengths. Temperature range up to 250°F. Flame spread: 15.
9. Temperature range up to 500°F. Good resistance to chemicals. Perforated side has NRC of .95.
10. Temperature range: 0° to 1300°F. Flame spread: 15. Resistant to most chemicals. Sizes 1, 2, 3, or 4 ft wide panels cut to desired lengths.
11. Numbers shown in brackets [ ] correspond to octave bands 75-150, 150-300, 600-1200, 1200-2400, and 2400-4800 Hz.
12. Heights: 8', 10', and 12'. Widths: 3' and 4'. Thicknesses: 2" and 4".
13. Temperature range up to 450°F. Flame spread: 25. Various standard and custom sizes available.
14. Used in walls and roofs of Butler buildings. Maximum temperature difference: 120°F. Self-extinguishing. 3' panel coverage. Maximum length 32'.

FOOTNOTES FOR TABLE 39 (Concl)

PREFABRICATED SOUND BARRIER PANELS

15. Used as wall panel in Butler buildings. Maximum temperature difference: 120°F. Flame spread: 10-20. 1' panel coverage. Maximum length: 60'.

16. Numbers in the brackets show transmission loss at frequencies 175, 350, 700, 1400, and 2800, respectively.

17. 4'x4' or 4'x8' panels.

18. Width 2', 3', or 4'. Length 4' to 12'. C series is same as H, but has an added connection system to clamp the panels together.

19. Standard sizes 2' to 4' wide; 6', 8', 10', and 12' long. Custom sizes available. Weight 16 to 18 $lb/ft^3$.

20. Maximum width 4'. Maximum length 10'. Weight 15 to 75 $lb/ft^3$.

21. Tested and evaluated according to ASTM E90-70.

22. Tested and evaluated according to ASTM E413-70T.

23. Tested and evaluated according to ASTM E90-66T.

24. Numbers shown in brackets correspond to octave bands 90-180, 180-355, 355-710, 710-1400, 1400-2800 and 2800-5600.

25. Tested and evaluated according to ASTM E90-61T.

TABLE 40

ENCLOSURES

Some enclosures and their effect on sound transmission are listed. An enclosure is defined here as a covering that attenuates the sound emanating from the inside of the enclosure as opposed to the "quiet room" where the unwanted noise originates in the surroundings exterior to the enclosing room. It is usually difficult to provide meaningful information about the enclosures because the performance depends on how the enclosure was designed to fit around a particular machine and the sizes of the openings which may have been made in the enclosure for the machine operation requirements. In the case of existing machinery, total or partial enclosures are often the most economical solution to the noise control problem. These enclosures can be custom designed to suit particular requirements by using many of the materials listed in Tables 6 through 18 and/or the panels listed in Table 39. Figure 40 shows a panel composed of many layers. Each layer has been placed for a specific task. The panel can be mounted on a machine to create an effective enclosure. The companies (by numbers shown in Section II) with products listed in Table 40 are: 9, 48, 59, 68, 82, 88, 155.

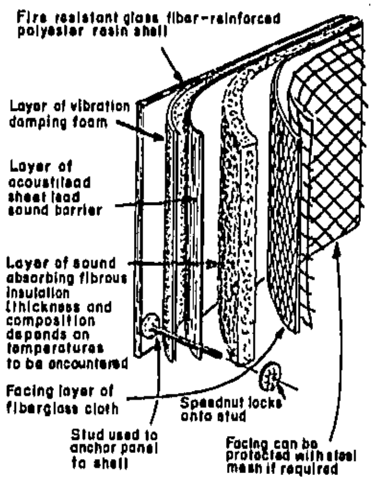



Figure 40 Construction Details of Typical Enclosure Panel

| CAUTION |
|---|
| VALUES PRESENTED ARE NOISE REDUCTIONS AND NOT TRANSMISSION LOSSES. SEE SECTION I-3.6 FOR EXPLANATION OF DIFFERENCES. |

TABLE 40 ENCLOSURES

| Thickness (Inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Noise Reduction (decibels) | | | | | | | | | | | | | | | | | | | | |
| | | Free standing enclosure. 72" x 96" x 84" high. Leaded vinyl supported by metal frame. | | | | | | | | | | | | | | | | | | | | |
| - | - | 9 | 6 | 6 | 7 | 9 | 11 | 13 | 16 | 19 | 21 | 21 | 19 | 21 | 23 | 26 | 26 | - | RAL NR72-1 | 155 | Sound stopper and free standing enclosure | 1,2 5 |
| | | Free standing enclosure. 72" x 96" x 84" high. Leaded vinyl supported by metal frame. | | | | | | | | | | | | | | | | | | | | |
| - | - | 11 | 8 | 7 | 10 | 10 | 14 | 16 | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 22 | 23 | - | RAL NR72-2 | 155 | Super Sound Stopper free standing enclosure | 1,2 5 |
| | | 7' x 7' x 7' 2-1/4" thick enclosure | | | | | | | | | | | | | | | | | | | | |
| - | - | 15 | | | 19 | | | 27 | | | 35 | | | 34 | | | 38 | - | G&H GJP-21T | 88 | INE Noise Enclosure | 3,6 |
| | | Fiberglass and vinyl enclosure | | | | | | | | | | | | | | | | | | | | |
| - | - | 2 | | | 4 | | | 6 | | | 6 | | | 8 | | | 12 | - | RAL LW72-32 LW-72-32 | 68 | Flexi View Sound Encapsulation | 4,7 |
| - | - | Sound proof rooms and chambers | | | | | | | | | | | | | | | | - | - | 59 | Custom designed enclosures and chambers | |
| - | - | Enclosures for turbines | | | | | | | | | | | | | | | | - | - | 9 | Gas turbines silencers | |
| - | - | Sound proof rooms. Modules are 28" wide and 8' to 10' high. | | | | | | | | | | | | | | | | - | - | 82 | GAC Sound Proof rooms | |
| - | - | Aluminum sound panel enclosures. | | | | | | | | | | | | | | | | - | - | 82 | 750 KW Gas Turbine Module | |
| - | - | Engine Test cell enclosures. | | | | | | | | | | | | | | | | - | - | 82 | Model 1260 jet engine test cells | |
| - | - | Custom made enclosures for office equipment. | | | | | | | | | | | | | | | | - | - | 48 | Noise isolation enclosures | |

FOOTNOTES FOR TABLE 40

ENCLOSURES

1. Tested and evaluated according to ASTM E 336-67T.
2. Tested and evaluated according to ASTM E 90-70.
3. Tested and evaluated according to ASTM E 336-71.
4. Tested and evaluated according to ANSI S1.2-1962
5. Numbers given are noise reduction data.
6. Numbers given are insertion loss data. Contact manufacturer for specific test details.
7. Acoustic data are derived from sound power measurements with and without FCA Flexi-View Noise Guard Shield.

TABLE 41

FLOOR COVERINGS -- TAPPING MACHINE DATA

Floor coverings and their effects on noise generated by objects dropped on the floors and by footsteps, etc., are listed. The table shows sound pressure levels generated in the room below by the tapping machine with the products placed on the floor assemblies. All the tests reported in the table were conducted in accordance with ISO Recommendation 140 of 1960.

Usually a floor covering does not have much effect on the sound transmission class of the floor assembly but it has a tremendous effect on impact insulation class of the floor-ceiling assembly. Tables 30 and 31 may be referred to for more detailed information on this point. The companies (by numbers as shown in Section II) with products listed in Table 41 are: 12, 44, 52, 55, 97, 143.

CAUTION

THE VALUES SHOWN ARE SOUND PRESSURE LEVELS GENERATED IN A ROOM BELOW WHEN THE STANDARD TAPPING MACHINE WAS OPERATED ON THE FLOOR COVERING. SEE SECTION I-3.4 FOR FURTHER EXPLANATION.

TABLE 41 FLOOR COVERINGS -- TAPPING MACHINE DATA

| Thickness (inches) | IIC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft2 | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sound Pressure Levels from Tapping Machine | | | | | | | | | | | | | | | | | | | | |
| | | | | .20" wearlayer facing, .09" vinyl foam backing, .03" asbestos felt core | | | | | | | | | | | | | | | | | | |
| .14 | 49 | 65 | 64 | 66 | 67 | 66 | 67 | 66 | 65 | 62 | 59 | 54 | 49 | 35 | 30 | 23 | | .47 | KAL 1286 2M2 | 44 | Peerless | 1,2 |
| | | | | Supplied in 2' wide x 187' long rolls of cork | | | | | | | | | | | | | | | | | | |
| .25 | - | [71] | | 76 | | | 69 | | | 53 | | | 38 | | | 33 | | - | KAL 372-2-66 | 52 | 1462 Dodge cork tiles | 1,3, 9 |
| | | | | Supplied in 6' wide x 45' to 90' long rolls of cushioned vinyl flooring | | | | | | | | | | | | | | | | | | |
| .28 | 53 | 64 | 63 | 64 | 65 | 63 | 61 | 57 | 50 | 40 | 38 | 38 | 35 | 27 | 21 | 16 | | .633 | KAL 1286-3-72 | 44 | Monogram | 1,4 |
| | | | | Supplied in 48" x 100' rolls of cork, 1/4" cork with 1/8" tile | | | | | | | | | | | | | | | | | | |
| .375 | - | [69] | | 71 | | | 59 | | | 43 | | | 37 | | | 32 | | - | KAL 372-1-66 | 52 | 1462 Dodge cork tiles | 1,5, 9 |
| | | | | Wood joist construction, 15/32" Homasote on two layers of 5/8" plywood, carpet and pad. | | | | | | | | | | | | | | | | | | |
| 15/32 | 59 | [62] | | [57] | | | [44] | | | [35] | | | [26] | | | [27] | | - | KAL L188-2-64 | 97 | Carpet board | 1,12 |
| | | | | Wood joist floor construction plywood, 15/32" Homasote over carpet pad | | | | | | | | | | | | | | | | | | |
| 15/32 | 65 | 49 | 46 | 40 | 33 | 32 | 29 | 28 | 25 | 21 | 18 | 17 | 17 | 18 | 18 | 17 | | 25* | KAL 790-6-69 | 97 | Carpet board | 1,6, 9 |
| | | | | 15/32" Homasote on 5" concrete slab | | | | | | | | | | | | | | | | | | |
| 15/32 | 70 | [53] | | [43] | | | [39] | | | [32] | | | [25] | | | [30] | | - | KAL L-188-1-64 | 97 | Carpet board | 1,13 |
| | | | | 1/2" Dodge cork supplied on rolls with 3/16" Dodge tiles | | | | | | | | | | | | | | | | | | |
| 11/16 | - | [66] | | 65 | | | 60 | | | 51 | | | 38 | | | | 31 | - | KAL 346-1-66 | 52 | 1462 Dodge cork & cork tiles | 1,7, 9 |
| | | | | 1" Dodge cork supplied on rolls with 3/16" Dodge cork tile | | | | | | | | | | | | | | | | | | |
| 13/16 | - | [74] | | 68 | | | 55 | | | 42 | | | 28 | | | | | - | KAL 346-2-66 | 52 | 1462 Dodge cork & cork tiles | 1,8, 9 |
| | | | | Floor ceiling panel, 12-1/2"x8', 1-11/32" thick Homasote floor deck; carpet pad on wood joists, isolated 1/2" thick Gypsum board ceiling and 3" rockwool batts between joists. | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 59 | [66] | | [46] | | | [37] | | | [28] | | | | | | | | - | KAL 370-12-66 | 97 | Floor decking | 1,14 |
| | | | | Floor ceiling panel 12-1/2'x8', truss joist floor with Homasote floor decking, carpet and pad, resilient channels with 1/2" Gypsum board ceiling. | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 65 | 45 | 39 | 35 | 31 | 32 | 26 | 26 | 22 | 15 | 15 | | | | | | | - | KAL 858-4-70 | 97 | Floor decking | 1,9, 10 |
| | | | | Floor ceiling panel 12-1/2'x8', wood joist floor with 1-11/32" Homasote floor decking, carpet and pad, resilient channels with 5/8" Gypsum board. | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 68 | 48 | 44 | 36 | 32 | 31 | 24 | 21 | 19 | 14 | 12 | | | | | | | - | KAL 790-2-69 | 97 | Floor decking | 1,9, 11 |

* Density in $lb/ft^3$

TABLE 41 FLOOR COVERINGS -- TAPPING MACHINE DATA (Concl)

| Thickness (inches) | IIC | Sound Pressure Levels from Tapping Machine: 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/8-3/4 | - | | | 48" x 96" wood panel board underlayment | | | | | | | | | | | | | | 47 | - | 55 | Duraflake floor | |
| - | - | | | Provides impact noise reduction | | | | | | | | | | | | | | - | - | 143 | rCA Rubber flooring | |
| - | - | | | Floor mattings for cabs, tractors | | | | | | | | | | | | | | - | - | 12 | Airtex Flourite | 15 |

FOOTNOTES FOR TABLE 41

FLOOR COVERINGS -- TAPPING MACHINE DATA

1. Conforms to ISO-R-140-1960 (see Section V-3 under ASTM E492-73T).
2. Temperature range: 60°F to 110°F. Relative Humitidy: 10 to 95 percent. Flame spread: 36.
3. INR = -2 for sound control in apartments, offices, motels, homes, etc. Bracketed number is for 100 Hz.
4. Temperature range: 60°F to 100°F. Relative humidity: 10 to 95 percent. Flame spread: 46.
5. INR = +2 for sound control in apartments, offices, motels, homes, etc. Bracketed number is for 100 Hz.
6. INR = +14, used with a variety of flooring materials to deaden impact noise.
7. INR = +6. Bracketed number is for 100 Hz.
8. INR = -1. Bracketed number is for 100 Hz.
9. In accordance with FHA 750.
10. INR = +14. Temperature range: -20°F to 100°F. Relative Humidity range: 30 to 90 percent. Flame spread: Class D.
11. INR = +17. Temperature range: -20°F to 100°F. Relative humidity range: 30 to 90 percent. Flame spread: Class D. Density of Homasote = 25 lb/ft³.
12. INR = +8. Bracketed numbers are for octave bands: 75 - 150, 150 - 300, 300 - 600, 600 - 1200, 1700 - 2400, 2400 - 4800 Hz, respectively.
13. INR = +19. Bracketed numbers are for octave bands: 75 - 150, 150 - 300, 300 - 600, 600 - 1200, 1200 - 2400, 2400 - 4800 Hz respectively. Temperature range: -20°F to 100°F. Relative humidity: 30 to 90 percent. Flame spread: Class D.
14. INR = +8. Bracketed numbers are for octave band centered frequencies of 75 - 150, 150 - 300, 300 - 600, 600 - 1200 Hz, respectively. Temperature range: -20°F to 100°F. Relative humidity range: 30 to 90 percent. Flame spread: Class D.
15. A composite assembly of Airtex Floor tile Number 125, two layers of 0.1" thick Airtex acoustic mass 550 separated by a 1/4" layer of Airtex Polycor foam 6152 and a wear surface of supported vinyl resulted in transmission reduction of 40 dB or more above 500 Hz in the laboratory test. The matting has temperature range up to 180°F and is self-extinguishing. See Table 42 for Airtex transmission loss data.

TABLE 42

FLOOR COVERINGS -- TRANSMISSION LOSS DATA

Floor coverings and the sound transmission losses of floor systems that include the mentioned floor coverings are listed. It should be emphasized that the transmission losses shown are for the complete assembly and not for the products alone. The products are, however, effective sound barriers and have considerable effects on sound attenuation provided by the assemblies. The companies (by numbers shown in Section II) with products listed in Table 42 are: 12, 97.

GLOSSARY

| | |
|---|---|
| Floor Deck: | A platform or a surface covering the structural framework to form a floor |
| Gypsum: | A hydrated sulphate of calcium $CaSO_4 \cdot 2H_2O$. Used for making boards, plaster of Paris, etc. |
| Wood Joist: | Parallel timbers that support the planks of a floor |

TABLE 42 FLOOR COVERINGS -- TRANSMISSION LOSS DATA

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft² | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wood joist construction, 15/32" Homasote on two layers of 5/8" plywood, carpeting, pad two sizes: 4'x 4' and 4'x 8' | | | | | | | | | | | | | | | | | | | | | | |
| 15/32 | 42 | 19 | [29] | | 31 | [42] | | 46 | [51] | | 52 | [57] | | 61 | [63] | | 64 | - | KAL L216-1-64 | 97 | Homasote Carpet Board | 1,2 |
| Wood joist floor construction, plywood, Homasote, carpet pad, resilient channels with Gypsum board. Floor ceiling panel was 12-1/2" long X 8' wide | | | | | | | | | | | | | | | | | | | | | | |
| 15/32 | 48 | 36 | 27 | 33 | 35 | 38 | 43 | 47 | 54 | 58 | 62 | 66 | 68 | 67 | 67 | 71 | 73 | - | KAL L790-7-69 | 97 | Homasote Carpet Board | 3,4 |
| Floor ceiling panel 12.5'x 8'wide, wood joist floor with Homasote floor decking, carpet and pad. Resilient channels with 1/2" Gypsum board ceiling; also available in 1-3/4" thickness. | | | | | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 48 | 28 | 28 | 36 | 38 | 40 | 41 | 47 | 51 | 55 | 60 | 63 | 66 | 72 | 71 | 71 | 72 | - | KAL 858-3-70 | 97 | Floor Decking | 3,5,6 |
| Floor ceiling panel 12-1/2'x 8'; wire joist floor with 1-11/32" Homasote floor decking, carpet and pad, resilient channels with 5/8" Gypsum board | | | | | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 49 | 34 | 31 | 31 | 35 | 38 | 44 | 49 | 56 | 61 | 65 | 67 | 72 | 70 | 68 | 72 | 76 | - | KAL 790-3-69 | 97 | Homasote Floor Decking | 3,5,6 |
| Floor ceiling panel 12-1/2'x 8'; 1-11/32" Hamosote floor deck; carpet and pad on wood joists; isolated 1/2" thick Gypsum board ceiling; 3" Rockwell batts between joists | | | | | | | | | | | | | | | | | | | | | | |
| 1-11/32 | 50 | 41 | [39] | | 39 | [44] | | 47 | [52] | | 53 | [56] | | 62 | [64] | | 68 | - | KAL 370-13-60 | 97 | Homasote Floor Decking | 1,2,5,6 |
| Laminate of supported vinyl bonded to 1/4" layer of airtex Polydor foam 6152 closed cell. Polyvinyl chlorine flexible foam which is bonded to 100" thick Airtex Acoustic Mass 500 dead rubber. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 22 | 24 | 25 | 27 | 28 | 32 | 40 | 40 | 37 | 37 | 38 | 39 | 41 | 48 | 51 | 51 | - | IATL | 12 | Airtex Flourite | 7 |
| Airtex Fluorite No.125, two layers each of 400" thickness of Airtex Acoustic Mass 550 dead rubber that is separated by a 1/4" layer of Airtex Polydor foam 6152 closed cell polyvinyl chloride flexible foam, top layer of supported vinyl. | | | | | | | | | | | | | | | | | | | | | | |
| - | - | 27 | 30 | 30 | 32 | 36 | 39 | 42 | 40 | 36 | 40 | 46 | 53 | 55 | 55 | 53 | 51 | - | IATL | 12 | Airtex flooring | 7 |

FOOTNOTES FOR TABLE 42

FLOOR COVERINGS -- TRANSMISSION LOSS DATA

1. Tested and evaluated according to ASTM E90-61T.
2. Bracketed numbers correspond to 175, 350, 700, 1400, and 2800 Hz respectively.
3. Tested and evaluated according to ASTM E90-66T.
4. Used with a variety of flooring materials to deaden impact noise and for floor comfort.
5. Temperature range: -20° to 100°F; flame spread: Class D; relative humidity range: 30% to 90%
6. Used in homes, gardens, and low-rise apartments; motels, nursing homes as subflooring and sound deadening resilient carpet pad.
7. Temperature range: to 180°F; relative humidity range: "normal"; Flame spread: self extinguishing; frequency data rounded off to nearest whole number. Used in floors of cabs, tractors, construction.

TABLE 43

PIPE LAGGINGS

Pipe laggings and the acoustic properties of some of the products are listed. Pipe laggings can effectively reduce the ambient noise levels if the pipe and fluid generated noise is of high amplitude compared to the other ambient noise. Pipe laggings consist essentially of a decoupling element and a "floating" barrier where the decoupling element stops the pipe vibrations from driving the barrier material. Thermal properties and ease of application are the important criteria in the selection of the most suitable lagging. The table provides necessary information about most of the listed products.

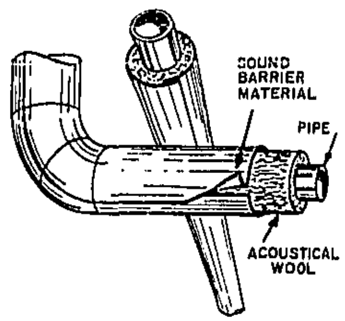
Figure 43 shows a typical application of pipe lagging where duct tapes are used to attach the lagging to the pipe. The table is subdivided into four parts because the acoustic information provided by the manufacturers was not of the same type:

- 43A Transmission loss
- 43B Sound pressure level reduction
- 43C Noise reduction
- 43D No data

The companies (by numbers shown in Section II) with products listed in Table 43 are: 2, 36, 45, 57, 72, 79, 127, 156, 157.

CAUTION

1. VALUES PRESENTED IN TABLE 43B ARE SOUND PRESSURE LEVEL REDUCTIONS. SEE SECTION I-3.5 FOR EXPLANATION.
2. VALUES PRESENTED IN TABLE 43C ARE NOISE REDUCTIONS. SEE SECTION I-3.6 FOR EXPLANATION.




SOUND-BARRIER PIPE TREATMENT

Figure 43 Pipe Laggings for Noise Control

GLOSSARY

Lagging: Strip or sheet of nonconducting material wrapped around a pipe to reduce sound (and heat) transmission

Refractory: Able to withstand high temperatures. Heat resistant

TABLE 43A PIPE LAGGINGS -- TRANSMISSION LOSS

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Footnote |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Made of vibration insulation layer (36" x 56"); 26 ga. aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | 18 | | | 22 | | | 23 | | | 24 | | | 32 | | | 40 | .75 | CT | 157 | Weather proof acoustical pipe & valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"); 26 ga. aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | 22 | | | 24 | | | 25 | | | 27 | | | 35 | | | 43 | 1 | CT | 157 | Weather proof acoustical pipe & valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"), 266A aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | 24 | | | 26 | | | 29 | | | 35 | | | 40 | | | 48 | 2 | CT | 157 | Weatherproof acoustical pipe and valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"), 266A, aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | | | | | | | | | | | | | | | | | 3 | CT | 157 | Weatherproof acoustical pipe and valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"), 266A, aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | | | | | | | | | | | | | | | | | 5 | CT | 157 | Weatherproof acoustical pipe and valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"), 266A, aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | | | | | | | | | | | | | | | | | 5.6 | RAL TL73-94 | 157 | Weatherproof acoustical pipe and valve covering | 5 |
| | | Made of vibration insulation layer (36" x 56"), 266A, aluminum and mass damping layer | | | | | | | | | | | | | | | | | | | | |
| 1 | - | | | | | | | | | | | | | | | | | 6 | CT | 157 | Weatherproof acoustical pipe & valve covering | |
| | | 1½" fiberglass and one layer of .04 in. thick Coustifilm-5; supplied in 5" x 20 yd. rolls. | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | - | 11 | 11 | 13 | 14 | 21 | 37 | 38 | 42 | 35 | 37 | 39 | 39 | 50 | 55 | 57 | 57 | .5 | RAL | 45 72 | Coustifilm 5 | 1,2, 3,4 |
| | | 1½" fiberglass and two layers of .04 in. thick Cousifilm-5; supplied in 50" x 20 yd. rolls | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | - | 15 | 15 | 16 | 19 | 25 | 42 | 41 | 43 | 40 | 42 | 44 | 44 | 55 | 60 | 62 | 62 | 1 | RAL | 45 72 | Coustifilm 5 | 1,2, 3,4 |
| | | 1½" fiberglass and three layers of .04 in. thick Coustifilm 5; supplied in 50" x 30 yd rolls. | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | - | 19 | 20 | 21 | 24 | 27 | 44 | 44 | 46 | 43 | 45 | 47 | 47 | 58 | 63 | 65 | 65 | 1.5 | RAL | 45 72 | Coustifilm 5 | 1,2, 3,4 |

TABLE 43B PIPE LAGGINGS -- SOUND PRESSURE LEVEL REDUCTION

| Thickness (inches) | STC | 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sound Pressure Level Reduction | | | | | | | | | | | | | | | | | | | | |
| | | Mineral fiber blended together with heat resistant organic binder, covered with .016" corrugated aluminum. Available in all standard pipe sizes up to 24" and 36" long. | | | | | | | | | | | | | | | | | | | | |
| 1-1/2 | - | 0 | 0 | 2 | 3 | 4 | 5 | 10 | 12 | 13 | 15 | 19 | 19 | 25 | 34 | 34 | 31 | 10 | RAL NR72-30 | 57 | Epitherm 1200 | 8, 9 |
| | | Mineral fiber blended together with heat resistant organic binder, covered with .016" corrugated aluminum. Available in all standard pipe sizes up to 24" and 36" long. | | | | | | | | | | | | | | | | | | | | |
| 2 | - | 4 | 0 | 5 | 5 | 7 | 10 | 16 | 17 | 17 | 18 | 25 | 24 | 30 | 38 | 27 | 31 | 10 | RAL NR72-31 | 57 | Epitherm 1200 | 8, 9 |
| | | Cellulose fibers laminated to polyethylene combined with lead felt, etc: available in 4' x 8' sheets; .25 lb/ft$^2$ surface density | | | | | | | | | | | | | | | | | | | | |
| - | - | | | [7] | | | [16] | | | [19] | | | [32] | | | [36] | | 2.5 | CT | 127 | K-13 Acoustical blankets | 10, |
| | | Cellulose fibers, laminated to polyethlene combined with lead felt available in 4' x 8' sheets. | | | | | | | | | | | | | | | | | | | | |
| - | - | | | [6] | | | [20] | | | [23] | | | [39] | | | [42] | | - | CT | 127 | K-13 Acoustical Blankets | 10, 11 |
| | | K-13, two layers, 1.0" total thickness in 4' x 8' sheets. | | | | | | | | | | | | | | | | | | | | |
| - | - | | | [5] | | | [9] | | | [8] | | | [12] | | | [15] | | - | CT | 127 | K-13 Acoustical Blankets | 10 |
| | | K-13, two layers, 1.5" total thickness in 4' x 8' sheets. | | | | | | | | | | | | | | | | | | | | |
| - | - | | | [5] | | | [10] | | | [12] | | | [19] | | | [21] | | - | CT | 127 | K-13 Acoustical Blankets | 10 |
| | | K-13, two layers, 2.5" total thickness in 4' x 8' sheets. | | | | | | | | | | | | | | | | | | | | |
| - | - | | | [5] | | | [10] | | | [15] | | | [22] | | | [30] | | - | CT | 127 | K-13 Acoustical Blankets | 10 |

TABLE 43C PIPE LAGGINGS -- NOISE REDUCTION

| Thickness (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 22 mil jacket on 1" foam. Supplied in 25 ft. rolls and sheets (1.83 lb/ft) | | | | | | | | | | | | | | | | | | |
| 1 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 8 | 10 | 10 | 10 | 16 | 22 | - | CT | 2 | Thermazip | 6, 7,8 |
| | | | | Leaded vinyl jacket on 1" foam supplied in 25 ft. rolls and sheets | | | | | | | | | | | | | | | | | | |
| 1 | - | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 10 | 12 | 12 | 17 | 17 | 17 | 17 | 21 | 28 | .5 | CT | 2 | Thermazip | 6, 7,8 |
| | | | | Leaded vinyl jacket on 1" foam supplied in 25 ft. rolls and sheets | | | | | | | | | | | | | | | | | | |
| 1 | - | 1 | 0 | 2 | 4 | 5 | 5 | 8 | 13 | 11 | 17 | 22 | 22 | 24 | 24 | 29 | 31 | 1.0 | CT | 2 | Thermazip | 6, 7,8 |
| | | | | 22 mil. jacket on 2" foam supplied in 72" wide sections, 25 ft. rolls and sheets (1.16 lb/ft.) | | | | | | | | | | | | | | | | | | |
| 2 | - | 0 | 0 | 0 | 2 | 6 | 6 | 5 | 7 | 10 | 12 | 16 | 17 | 17 | 18 | 21 | 27 | - | CT | 2 | Thermazip | 6, 7,8 |
| | | | | Refactory fiber insulation with lead vinyl cover | | | | | | | | | | | | | | | | | | |
| 2 | - | 0 | 2 | 1 | 7 | 10 | 12 | 13 | 21 | 25 | 20 | 32 | 29 | 32 | 29 | 32 | 37 | 9 | RAL NR72-10 | 79 | Forty Eight MF pipe insulation | 8,12, 13 |
| | | | | Refractory fiber insulation with lead cover | | | | | | | | | | | | | | | | | | |
| 2 | - | 0 | 3 | 0 | 8 | 11 | 14 | 13 | 26 | 26 | 20 | 33 | 31 | 32 | 30 | 32 | 37 | 9 | RAL NR72-11 | 79 | Forty Eight MF insulation | 8, 12,13 |
| | | | | Refractory fiber insulation with lead vinyl cover | | | | | | | | | | | | | | | | | | |
| 3 | - | .5 | 3 | 2 | 8 | 13 | 12 | 15 | 25 | 25 | 21 | 35 | 29 | 33 | 30 | 31 | 36 | 9 | RAL NR72-12 | 79 | Forty Eight MF insulation | 8,12, 13,14 |
| | | | | Refractory fiber insulation with lead cover | | | | | | | | | | | | | | | | | | |
| 3 | - | 0 | 5 | 3 | 10 | 14 | 14 | 13 | 25 | 28 | 22 | 36 | 30 | 33 | 31 | 32 | 38 | 9 | RAL NR72-13 | 79 | Forty Might MF insulation | 8,12, 13,14 |
| | | | | Refractory fiber insulation with lead vinyl cover | | | | | | | | | | | | | | | | | | |
| 4 | - | 0 | 4 | .5 | 9 | 12 | 13 | 12 | 27 | 27 | 23 | 36 | 30 | 37 | 30 | 32 | 37 | 9 | RAL NR72-14 | 79 | Forty Eight MF insulation | 8,12, 13,14 |
| | | | | 4" thick insulation with lead vinyl cover | | | | | | | | | | | | | | | | | | |
| 4 | - | 0 | 3 | 0 | 8 | 11 | 14 | 17 | 27 | 27 | 22 | 36 | 31 | 34 | 30 | 33 | 38 | 9 | RAL NR72-15 | 79 | Forty Eight MF pipe insulation | 8,12, 13,14 |
| | | | | Single layer of 2" thick MF segmental, mat faced mineral pipe insulation | | | | | | | | | | | | | | | | | | |
| 1 to 4 | - | .5 | 0 | 0 | 5 | 1 | 2 | 4 | 7 | 17 | 10 | 13 | 14 | 17 | 15 | 15 | 18 | 9 | - | 79 | Forty Eight MF pipe Insulation | 8,12, 13,14 |

### TABLE 43C PIPE LAGGINGS -- NOISE REDUCTION (Concl)

| Thickness (inches) | STC | Noise Reduction (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight $lb/ft^3$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Single layer of 2" thick MF segmental mat faced felted mineral pipe insulation | | | | | | | | | | | | | | | | | | |
| 1 to 4 | - | 4 | 2 | 1 | 9 | 5 | 9 | 14 | 19 | 23 | 23 | 32 | 27 | 33 | 28 | 31 | 32 | 9 | - | 79 | Forty Eight MF pipe Insulation | 12,13, 14,15 |
| | | | | Single layer of 2 ½" thick MF segmental mat faced felted mineral pipe insulation | | | | | | | | | | | | | | | | | | |
| 1 to 4 | - | 3 | 0 | 0 | 5 | 1 | 4 | 8 | 10 | 12 | 14 | 19 | 18 | 22 | 22 | 23 | 26 | 9 | - | 79 | Forty Eight MF pipe Insulation | 12,13, 14,15 |
| | | | | Single layer of 3" thick MF segmental mat faced felted mineral pipe insulation | | | | | | | | | | | | | | | | | | |
| 1 to 4 | - | 1 | 2 | 2 | 6 | 2 | 7 | 9 | 13 | 14 | 17 | 22 | 21 | 26 | 24 | 27 | 29 | 9 | - | 79 | Forty Eight MF pipe Insulation | 12,13, 14,15 |

TABLE 43D PIPE LAGGINGS--NO DATA

| Thickness (inches) | STC | Transmission Loss (decibels) 125 Hz | 160 Hz | 200 Hz | 250 Hz | 315 Hz | 400 Hz | 500 Hz | 630 Hz | 800 Hz | 1000 Hz | 1250 Hz | 1600 Hz | 2000 Hz | 2500 Hz | 3150 Hz | 4000 Hz | Weight lb/ft$^2$ | Lab. | Co. | Product | Foot-note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | Combines SFB-I barrier with a heavy aluminum jacket using a special quick lock joint and clamp to provide jacket insulation 4", 6", 8", 10", 12", custom sizes available. | | | | | | | | | | | | | | | | - | CT | 156 | Soun Jac for pipe treatment SFJ-I (1¼") | |
| - | - | Combines SFB-I barrier with a heavy aluminum jacket using a special quick lock joint and clamp to provide jacket insulation 4", 6", 8", 10", 12", custom sizes available. | | | | | | | | | | | | | | | | - | CT | 156 | Soun Jac pipe treatment SFJ-I-90° (ELLS) | |
| - | - | Combines SFB-I barrier with a heavy aluminum jacket using a special quick lock joint and clamp to provide jacket insulation 4", 6", 8", 10", 12", custom sizes available. | | | | | | | | | | | | | | | | - | CT | 156 | Soun Jac pipe treatment SFJ-T (Tees) | |
| - | - | Fiberglas or rock wool with sheald jacket. | | | | | | | | | | | | | | | | - | CT | 36 | Sheald | |

FOOTNOTES FOR TABLE 43A, 43B, 43C, 43D

PIPE LAGGINGS

1. Installation through use of knife or scissors and pressure sensitive tape.
2. Tested and evaluated according to ASTM E90-70.
3. Tested and evaluated according to ASTM E413-70T.
4. Temperature range: -50°F to 450°F, self-extinguishing per 191 FRD. Spec. method 5903.
5. Service temperature: -80°F to 450°F, nonburning, self-extinguishing, waterproof. Used to attenuate the sound of oil or gas pipe lines.
6. Temperature range: 0°-150°F, relative humidity range: 0 to 100 %.
7. May be installed with silicon resilient tube, pressure sensitive tape 2" by 3/4" wide.
8. Tested and evaluated according to ASTM E336-71.
9. Installed in similar manner to other rigid type pipe insulations. Good alkaline resistance.
10. Temperature less than 200°F. Use insulator between pipe and blankets. Bracketed numbers are for the old octave bands: 150 - 300, 300 - 600, 600 - 1200, 1200 - 2400, and 2400 - 4800 Hz.
11. Lead multilayer test.
12. Good up to 1200°F, asbestos free
13. Installation procedure: wrap around pipe covering, grooved to fit sizes up to 36".
14. Can be used on 14" flanged pipes also.
15. Tested and evaluated according to ASTM E336-67T.

TABLE 44
OTHER MATERIALS

Products which are not routinely used as sound control materials, but are ones that have some special properties which make them suitable for use in certain applications, are listed. These products perform as sound barriers, sound absorbers, or both in some cases. The description and the applications shown in the table should provide enough information to determine the potential of the product in any specific application. The companies (by numbers shown in Section II) with products listed in Table 44 are: 7, 12, 22, 32, 37, 45, 50, 52, 55, 67, 72, 76, 80, 87, 90, 91, 94, 103, 113, 133, 134, 150, 174, 177, 180, 188.

TABLE 44 OTHER MATERIALS

| Description | Application | Company | Product |
|---|---|---|---|
| Extruded UHMW polymer. Self-lubricating. Noise-deadening property. | Conveyor guide belts. | 174 | Ultra-Wear Rail |
| Aluminum & copper material. Temperature range to 900°F. Relative humidity range: 0-100%. Flame spread: none. | Attenuation for high-temperature application. | 37 | A-LUM-O |
| #9306 30-mesh ground rubber when mixed with concrete provides additional sound attenuation as compared to conventional concrete mix. | Wall construction. | 177 | Rubber |
| Expanded closed-cell foam neoprene rubber. Thickness: from 1/8" to 1-1/2". | Reduces noise when it eliminates metal to metal contact. | 12 | Lockcell Neoprene |
| Open-cell synthetic foam rubber with an integral skin on top & bottom surfaces. | Reduces noise when it eliminates metal to metal contact. | 12 | Sponge Rubber |
| Rubber linings. Can be applied on metal, wood, concrete, fabric, or cured rubber. Can be pressure-bonded using cement. | Noise abatement & abrasion resistance. Used in conveyors, hoppers, etc. | 87 | Acousta Lining |
| Open-cell sponge sheets, soft, medium, or hard. Thickness range: 1/4" to 1". Widths: 36" & 48". | Noise damping in machinery & enclosures. | 91 | Herco Sponge Rubber Sheets |
| Sintered stainless steel made from 8$\mu$ to 4 mils diameter fibers. | High temperature sound absorption. Also air tool exaust noise reduction. | 32 | Felt Metal Fiber Metal |
| Any combination of sheet metals (i.e., electro-galvanized steel, stainless, or aluminum) for constrained layer damping, elastomeric bond 10 to 20% of overall thicknesses. Temp. range to 300°F. Nonflammable. | Hoppers, conveyors, tote boxes, office machines, motor mounts, vibration control components, etc. | 180 | Mute-metal |
| Steel sheet perforated with thousands of tiny holes placed over 6" layers of fiberglas. | Steel soundproof enclosures. Exhaust silencers, intake silencers. | 50 | Perforated Stainless Steel Sheets |
| Glass ceramic material in honeycomb or matrix geometry. Available on cost-plus basis. Volume density varies from 20 lb/ft$^3$ to 40 lb/ft$^3$. Survives thermal shocks. | Sound absorption at temperatures to 2000°F. | 133 | CER-VIT |
| Ultrahigh molecular weight, high-density polyethylene, 35-mesh product. .939 gram/cc. | Noise reduction in bearings, gears, slide rails, etc. | 174 | LS 501 |
| Acoustical plaster. Available in 2.25 cubic feet sacks. | Interior brown coat for machine application. Provides sound absorption to the panel or wall. | 113 | Hy Lo |
| Refibered and recycled wood-based celluloric loose-fill type insulation available in 20 lb bags. Temperature range: -50° to 180°F. UL-listed flame spread: 35. Density: 2.5 lb/ft$^3$. | For pneumatic installation into wall & ceiling cavities for thermal & acoustical insulation. | 103 | Home Comfort Insulation |

TABLE 44 OTHER MATERIALS (Concd)

| Description | Application | Company | Product |
|---|---|---|---|
| Sheet lead bonded to other metal sheets (aluminum, stainless, etc.) | Barrier panels, doors, pipe coverings, enclosures, etc. In multiple layers, can achieve STC 65. | 180 | Lead-Veneermetal |
| Foam with oil- & grease-resistant PVC facing. Available in 1/2" & 1" thicknesses. Can be cut or formed into different sizes and shapes. | Tough, durable absorber for interiors of vehicles, railroad cars, etc. | 45<br>72 | Cousti-Headliner |
| Foam with perforated vinyl covering. Available in 54" wide, 60' long rolls. Various thicknesses available. Density: 2 lb/ft$^3$. Temperature range: -40° to 200°F. Resistant to flames. | Cab liner for on- & off-road vehicles. Has NRC of .50 for 1" thickness. | 150 | Perforated Vinyl/Pyrell |
| Lightweight concrete. Incombustible. Temperature range: to 1100°C. Supplied in crude tons or sold in cubic feet. | Sound absorption with thermal insulation. | 22 | Audex Vermiculite |
| Standard roll size 48"x100'. Different roll & tile thicknesses available. | Sound control in apartments, hotels, homes, etc. Provides sound attenuation & impact insulation. | 52 | Dodge 1462 Sound Deadening Cork & Tiles |
| Supplied in rolls or skeins. Fine, medium, and coarse fibers with diameters ranging from .0006" to .0015" available. | Sound absorption. Also filtering of liquids & air. Provides thermal insulation. | 80 | Glass Fiber & Wool |
| Specially-coated heavyweight cloth. Thickness: 3/10". | Sound barrier. Also absorbs sound. | 94 | Asbestos Cloth FH-2829F |
| Core stock. 48"x96" size. Custom sizes available. | Furniture core stock. Also used in wall panels, partitions, cabinets, etc. | 55 | Duraflake |
| Fiber polyester. Temperature range: to 300°F. In rolls .040" thick. 11.6 lb/ft$^2$. | Noise reduction by sound damping. | 188 | Westex II |
| Fiber polyester 3/4" thick. | Noise reduction by sound damping. | 188 | FIL-28 |
| Fiber nomex. Supplied in rolls 72" wide, .08" thick. | Sound-absorbing curtain requiring flame resistance. | 188 | Westex FIL-95 |
| Fiber polyester. Supplied in rolls 70" wide, .06" thick. | Sound-absorbing curtains, portable room dividers, acoustical panels. | 188 | Westex FIL-44 |
| 1" thick pink foam rubber bonded to outer 1/8" layer of perforated gray foam rubber. Available in 3/8" & 1/8" thicknesses also. | Sound absorption. NRC for 1-1/8" thick pad is .52. | 67 | Anechoic Pad |
| Aluminum & stainless steel sheets. | Sound control. | 134 | Sound Control Perforated Material |
| Perforated materials, steel, aluminum, plastic, etc. | Sound control. | 90 | Perforated Materials |
| Perforated sheet bonded to aluminum honeycomb. | Noise cowls, air inlets for jet aircraft engines. | 50 | Perforated aluminum sheets |

TABLE 44 OTHER MATERIALS (Concl)

| Description | Application | Company | Product |
|---|---|---|---|
| Silicone earmold. Putty can be molded quickly in the shape of human ear cavity using a non-sticky harderner. | Hearing protection. | 7 | Adcomold soft plastic |
| Ceramic tiles in various colors and designs. | On walls and floors. | 76 | Ceramic tile |

## TABLE 45
## GASKETS, SEALANTS, AND SEALING TAPES

Products which are very essential to the performances of sound barrier systems and materials are listed. A very good sound barrier system would be rendered ineffective by a small noise leak. The products listed in the table can be used in a variety of ways to stop such noise leaks. Meaningful acoustic information cannot be provided for such products as the performance depends upon the manner and the place of application. The companies (by numbers shown in Section II) with products listed in Table 45 are: 12, 26, 33, 45, 72, 130, 140, 157, 170.

TABLE 45 GASKETS, SEALANTS, AND SEALING TAPES

| Description | Application | Company | Product |
|---|---|---|---|
| Gasketing is applied with 3M 4693 adhesive to steel, aluminum, & wood in cove between door frame & stop. | Improves transmission losses through door openings, windows, & machinery enclosures. | 45 72 | Cousti-Gasket |
| Supplied in 5-gallon drums & quart cartridges. Temperature range: -40° to 158°F. | For dry-wall construction & cracks in ceiling & floor. Also around protrusions through wall. | 170 | Tremco Acoustical Sealant |
| Any quantity & size available to suit a particular application. Temperature range: -67° to 450°F. | For door seals & gasketing. | 140 | Pneuma-Seal |
| #9600 Sur-round surface-mounted threshold seal. Various sizes. | For door & threshold sealing against sound, light, & air. | 33 | #9600 Sur-round Threshold Seal |
| #9602 half-mortised threshold seal. Available in various sizes. | For door & threshold sealing against sound, light, & air. | 33 | #9602 Sur-round Threshold Seal |
| #9606 Sur-round adjustable door seal, 1/4" adjustable range. | To be applied to existing door stop as a sealant against sound, light, & weather. | 33 | #9606 Sur-round Adjustable Door Seal |
| #9610 half-mortised threshold seal, available in various sizes. | For door and threshold sealing against sound, light, & air. | 33 | #9610 Threshold Seal |
| #9601 full-mortised threshold seal, available in various sizes. Does not interfere with kick or armor plates. | Provides positive sealing for control of sound, light, air, & weather. | 33 | #9601 Sur-round Threshold Seal |
| #9603 Sur-round door seal cannot be used with existing stop or rabbeted frames. 3/8" adjustable range. | Sealant against sound, light, air, & weather in door threshold applications. | 33 | #9603 Sur-round Adjustable Door Seal |
| Acoustic tape 1" & 2" widths, .008" thick. Temperature range to 250°F. Relative humidity range: 0 to 100%, nonburning. | Sealing cracks & holes against sound leakage. | 12 | Airtex Acoustic Tape #505 |
| Acoustic tape 1" & 2" widths, .016" thick. Wider rolls by special order. | Sealing cracks & holes against sound leakage. | 12 | Airtex Acoustic Tape #510 |
| Acoustic tape, temperature range: -65° to 266°F. Chemicals, moisture, & fungus resistant. | Weatherstrip & seal for sound, vibration, dust, light, etc. | 26 | Series 5A Arlon Polyurethane Tape |
| Foam construction tape. Temperature range: -20° to 200°F. Resists absorption of water & other fluids. | Applied under & over plates, behind dry-wall or plaster, to fill cracks & isolate sound between walls; replaces bead caulking. | 26 | Series 6A-V8 Arlon Foam Construction Tape |
| Closed-cell sponge gasketing sealant tape. Available with pressure-sensitive backing. Available heavy-duty, custom-made, die-cut to size. | Prevent sound leaks & dampen vibration. | 157 | Sponge Gasketing Tape |
| Separate spring-activated hinged leaves for each door. 7' & 8' heights only. | Positive sealing at the meeting stiles of pairs of doors. Applied to inside. | 33 | #9611 Automatic interlocking Astragal |

TABLE 45 GASKETS, SEALANTS, AND SEALING TAPES (Concl)

| Description | Application | Company | Product |
|---|---|---|---|
| #9605 overlapping Astragel, applied to active leaf on the outside, does not interfere with flush bolts. | Provides positive sealing at the meeting stiles of pairs of doors. | 33 | #9605 Overlapping Astragel |
| #9604 T-type astragal applied to the leading edge of inactive leaf. Stop & seal unit on inside for security. | Provides positive sealing at the meeting stiles of pairs of doors. | 33 | #9604 T-type Astragel |
| Sealants. | Used in wall partition system | 130 | Norseal |
| Sealant 1/8" to 1/2" thickness. Temperature range: -30° to 160°F. Humidity: 0 to 100%. Excellent resistance to weather & oxidation. | Used to stop perimeter sound leaks in wall partition systems. | 130 | Norseal V730 |
| PVC foam sealant. Available in 1/16" to 3/8" thickness, 1/4" to 54" rolls. Temperature range: -20° to 160°F. Humidity: 0 to 100%. Resists weather & oxidation. | Used to stop perimeter sound leaks in wall partition systems. | 130 | Norseal V780 |
| 2.5 mil. cross-laminated polyethylene. | Applied to foam surfaces to protect them from wear, dirt, oil, moisture etc. | 12 | Protective Coating 767 |
| 1.0 mil. urethane. | Protects foam from liquids and dirt. | 12 | Protective Coating 762 |
| 1.5 mil. urethane. | Protects foam from liquids and dirt. | 12 | Protective Coating 763 |
| 4.0 mil. cross-laminated polyethylene sheeting. 1/2" thickness. Extremely good puncture & tear resistance. | Enclosures & environments where foam may be contaminated | 12 | Protective Film 768 |
| Cross-laminated polyethylene sheeting. 2" thickness. Extremely good puncture & tear resistance. | Enclosures & environments where foam may be contaminated. | 12 | Protective Film 768 |
| Pressure-sensitive adhesives. | Adhesives for mounting foam materials | 12 | 9415, 9417, 9419, 9420, 9421, 9430, & 9431 |
| Foam tapes. | Vibration isolation | 12 | Foam Tapes |

TABLE 46
SPECIAL APPLICATION PRODUCTS

Miscellaneous products, their description, and application are listed. All products listed have the potential to reduce noise, but they have very specific areas of application and are therefore not presented in the preceding tables. The description and the application of each product provides sufficient information to allow the user to decide whether the product is suitable for the intended use, in which case further information can be obtained from the manufacturer. The companies (by numbers shown in Section II) with products listed in Table 46 are: 8, 15, 19, 20, 39, 46, 55, 64, 106, 109, 157, 158, 193.

TABLE 46 SPECIAL APPLICATION PRODUCTS

| Description | Application | Company | Product |
|---|---|---|---|
| Available in nominal sizes of 2' x 2' or 4' x 4', Thickness 1-3/16". Weight: 1.7 lb/ft$^2$. | As decorative, sound-absorbing, fire-resistant ceilings aboard ships NRC of .70 for Mounting 7. | 109 | Marine Acoustic Unit |
| Fiberglas material. Size: 2' x 3' Other sizes up to 5' long. Density: 3 lb/ft$^3$. Thickness range: 3/4" to 2". | Lightweight marine insulation. | 109 | J-M Hullboard |
| One or more cylinders attached at right angles to stack with outside end closed. | Placed in stacks after the fans. Reduced noise radiation from stacks into the surrounding neighborhood. | 64 | Sound Attenuator for Stacks |
| Seal edges of doors and panels to prevent acoustic leaks. | Miscellaneous seals for doors, windows, panels, etc. | 193 | Zero Compresso-matic |
| Wood particle board sound barrier material. Density: 45 to 50 lb/ft$^3$. Sizes: 48" x 144" & 48" x 168". | For mobile home decking. STC = 25. | 55 | Duraflake Mobildeck |
| Chairs made from a variety of foam and upholstering materials. | Sound Absorption in music halls, opera houses etc. | 20 | Auditorium Chairs |
| 4" vane with 1½ lb. density fiberglas in 24 gauge galvanized steel. | Reduces duct noise | 158 | Souther Acoustic type turning vane |
| Door stops, latches, etc. for sound barrier doors. The hardware design is adjustable to compensate for door usage, building settlement, and sealing material compression. | Sound-insulating door systems. | 8 | Door Hardware |
| Upholstered chairs provide sound absorption. | Auditoriums, theatres, etc. | 19 | Auditorium Seating |
| Furring channel for walls. Applied horizontally against backing material. A section without a "contact" leg provides resiliency. | Wall construction. | 39 | Resiliant Furring Channel |
| Steel tube with sound-absorbent core material & helically wound, wear-resistant steel liner. | Silencing screw machines. | 46 | Silent Stock Tubes |
| Sheet material. Standard size: 22"x22"x3/32". | For leveling so that mounts & pads can be used. | 157 | Shim Stock Sheets |
| Long-span corridor panels made from aluminum or steel with different perforation patterns. | Sound absorption can be obtained by placing mineral wool or fiberglass batt in the panels. | 15 | ALPRO Sigma Panels |
| Galvanized steel, primed or finish-painted. Available in 4' to 30' lengths. Density range: 2 to 4 lb/ft$^2$. | Sound barrier for wall construction. | 106 | Type L21 Acoustiwall |

TABLE 47

GENERAL BUILDING MATERIALS AND FURNISHINGS

Sound absorption data of some generic types of commonly used materials and furnishings are listed. This information will be useful in assessing or predicting the acoustical characteristic of a room or an area.

## TABLE 47

### COEFFICIENTS OF GENERAL BUILDING MATERIALS AND FURNISHINGS

Complete tables of coefficients of the various materials that normally constitute the interior finish of rooms may be found in the various books on architectural acoustics. The following short list will be useful in making simple calculations of the reverberation in rooms.

| *Materials* | *Coefficients* 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|
| Brick, unglazed | .03 | .03 | .03 | .04 | .05 | .07 |
| Brick, unglazed, painted | .01 | .01 | .02 | .02 | .02 | .03 |
| Carpet, heavy, on concrete | .02 | .06 | .14 | .37 | .60 | .65 |
| Same, on 40 oz hairfelt or foam rubber | .08 | .24 | .57 | .69 | .71 | .73 |
| Same, with impermeable latex backing on 40 oz hairfelt or foam rubber | .08 | .27 | .39 | .34 | .48 | .63 |
| Concrete Block, coarse | .36 | .44 | .31 | .29 | .39 | .25 |
| Concrete Block, painted | .10 | .05 | .06 | .07 | .09 | .08 |
| Fabrics | | | | | | |
| Light velour, 10 oz per sq yd, hung straight, in contact with wall | .03 | .04 | .11 | .17 | .24 | .35 |
| Medium velour, 14 oz per sq yd, draped to half area | .07 | .31 | .49 | .75 | .70 | .60 |
| Heavy velour, 18 oz per sq yd, draped to half area | .14 | .35 | .55 | .72 | .70 | .65 |
| Floors | | | | | | |
| Concrete or terrazzo | .01 | .01 | .015 | .02 | .02 | .02 |
| Linoleum, asphalt, rubber or cork tile on concrete | .02 | .03 | .03 | .03 | .03 | .02 |
| Wood | .15 | .11 | .10 | .07 | .06 | .07 |
| Wood parquet in asphalt on concrete | .04 | .04 | .07 | .06 | .06 | .07 |
| Glass | | | | | | |
| Large panes of heavy plate glass | .18 | .06 | .04 | .03 | .02 | .02 |
| Ordinary window glass | .35 | .25 | .18 | .12 | .07 | .04 |
| Gypsum Board, ½" nailed to 2x4's 16" o.c. | .29 | .10 | .05 | .04 | .07 | .09 |
| Marble or Glazed Tile | .01 | .01 | .01 | .01 | .02 | .02 |
| Openings | | | | | | |
| Stage, depending on furnishings | | | .25 — | .75 | | |
| Deep balcony, upholstered seats | | | .50 — | 1.00 | | |
| Grills, ventilating | | | .15 — | .50 | | |
| Plaster, gypsum or lime, smooth finish on tile or brick | .013 | .015 | .02 | .03 | .04 | .05 |
| Plaster, gypsum or lime, rough finish on lath | .14 | .10 | .06 | .05 | .04 | .03 |
| Same, with smooth finish | .14 | .10 | .06 | .04 | .04 | .03 |
| Plywood Paneling, ⅜" thick | .28 | .22 | .17 | .09 | .10 | .11 |
| Water Surface, as in a swimming pool | .008 | .008 | .013 | .015 | .020 | .025 |
| Air, Sabins per 1000 cubic feet @ 50% RH | | | | .9 | 2.3 | 7.2 |

### ABSORPTION OF SEATS AND AUDIENCE

*Values given are in Sabins per square foot of seating area or per unit*

| | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
|---|---|---|---|---|---|---|
| Audience, seated in upholstered seats, per sq ft of floor area | .60 | .74 | .88 | .96 | .93 | .85 |
| Unoccupied cloth-covered upholstered seats, per sq ft of floor area | .49 | .66 | .80 | .88 | .82 | .70 |
| Unoccupied leather-covered upholstered seats, per sq ft of floor area | .44 | .54 | .60 | .62 | .58 | .50 |
| Wooden Pews, occupied, per sq ft of floor area | .57 | .61 | .75 | .86 | .91 | .86 |
| Chairs, metal or wood seats, each, unoccupied | .15 | .19 | .22 | .39 | .38 | .30 |

Reprinted Courtesy AIMA

☆ U.S. GOVERNMENT PRINTING OFFICE 1975-657-604/5563 Region No. 5-11

HEW Publication No. (NIOSH) 75—165

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational
Safety and Health

NIOSH

TECHNICAL INFORMATION