LIA14112

LEAD INDUSTRIES ASSOCIATION, INC.

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TELEPHONE — AREA CODE 212
[illegible]

October 3, 1966

Subject: JRAIC REPRINT ABOUT
LEAD FOR NOISE CONTROL

To Members of the Lead Industries Association, Inc.:

The enclosed reprint, "Architectural Applications of Lead for Noise Control," is taken from the May issue of the Journal of the Royal Architectural Institute of Canada and represents [illegible] Phillips of the Cominco Product Research Centre. The article presents up-to-date tests results on barriers and "over the ceiling" uses of lead as well as generally helpful handbook information related to the field. The weights of lead considered are 1 to 3 pounds per square foot.

This reprint will be distributed to our list of 17,000 architects, builders and contractors by direct mail. Additional copies in quantities up to 25 are available for your use without charge.

Very truly,

Bruce Fader

Bruce Fader
Manager, Technical Services

BF:cmd
Enc.

Look Ahead with Lead

by

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and
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Reprinted from
Journal of the Royal
Architectural Institute
of Canada
May, 1966

LIA14114

Miscellaneous Helpful Information

Weights of Material
(Weights given are average)

Masonry and Concrete Materials	lbs./cu. ft.
Cinders or ashes	40–45
Granite, without mortar	156–168
Limestone, marble, without mortar	165
Sand or gravel, dry and loose	90–105
Sand or gravel, dry and packed	100–120
Sandstone, bluestone, with mortar	147
Wood (12% Moisture Content)	
Birch, red oak	44
Cedar	22
Douglas fir (coast region)	34
Oak, white	47
Pine, long-leaf southern	29
Pine, short-leaf southern	36
Concrete	
Cinder, concrete fill	60
Cinder, reinforced	100–115
Stone	144
Brick Masonry (Including Mortar)	
Common	120
Mortar and Plaster	
Plaster	96

Exterior Walls and Wall Materials

Masonry (Including Mortar)	lbs./sq. ft.
4" brickwork	36
8" brickwork	74
8" concrete, reinforced stone or gravel	100
12" concrete, reinforced stone or gravel	150
4" concrete block, stone or gravel	27–33
8" concrete block, stone or gravel	50–60
Partitions	
3" Gypsum block, plaster 2S	21
4" Gypsum block, plaster 2S	25
6" Gypsum block, plaster 2S	31
Gypsum board, ½" thick	2.1
Lath and plaster, 2" x 4" wood studs	14–18
Plaster	4–6
2" Solid plaster partition	18

The Relation of Noise in Decibels to Commonly Heard Sounds

Noise Level in Decibels	Description or Example	Remarks
0	faintest possible sound	the lower limit of audibility varies widely among people and varies with the pitch of the sound
20	leaves rustling in a faint breeze	
40	whisper at four to five feet	
50	quiet conference room	
60	typical busy office	
80	loud radio or hi-fi	
90	inside a typical railroad car	
100	subway platform with a train pulling in	this is about the loudest noise which can be tolerated eight hours a day without some risk of hearing damage
110	full symphony orchestra playing loud passage	
120	many noisy industrial operations	
130	noise level at the ramp when a jet airliner takes off	
135	noise beginning to be painful	many experts feel that half a minute exposure may produce permanent hearing loss
150	near a jet airliner at full throttle	

Architectural Applications of Lead for Noise Control

Fig. 1
Effect of Lead Sheet on the Transmission Loss of 2½" Thick Moveable Steel Office Partition.
Action du plomb en feuille sur l'insonorisation d'une cloison métallique de bureau de 2½" d'épaisseur.
Fig. 2
Effect of Lead Sheet on Transmission Loss of ½" Gypsum board on Both Sides of 2½" Steel Studs.
Action du plomb en feuille sur l'insonorisation d'une cloison en colombages d'acier de 2½" recouverts de planches de gypse de ½" sur les deux faces

Control and reduction of noise presents a problem of increasing concern to society. The growing popularity of many automatic household appliances and the expanding use of efficient but noisy business and data processing machines have resulted in a general increase in ambient noise levels and the development of a new source of acoustical problems. Adding to these problems is the increased number of noisy vehicles on our streets and highways and the increased popularity of air transportation. The overall result of this combination of circumstances is that the noise level with [illegible] to increase unless adequate corrective measures are taken. At the same time there is a definite trend toward the use of more economical lightweight construction materials which inherently give a low degree of sound insulation. The result of these trends is an increasing demand for materials which can provide a high degree of sound isolation while maintaining the desirable property of lightness.

The design of proper acoustical environments is a most important and often most neglected consideration in the design of modern buildings. The use of a good sound absorbing acoustical ceiling is not, in itself, sufficient to ensure a satisfactory acoustical environment. Sound absorbing materials only control reverberation of noise originating within a room. The exclusion of outside noise and the preservation of the privacy of conversations within a room can be accomplished only by using materials which are good barriers to airborne sound. It is necessary, therefore, to consider the specific requirements of the occupants of a space and to design a partition and ceiling assembly to give the desired acoustical absorption and also the required degree of privacy and freedom from external noise.

The prime requirements of a good sound barrier material are: high density, natural limpness, good damping capacity and non- [illegible] because the sound vibrations are reduced in intensity in overcoming the inertia of the barrier. The acoustical efficiency of a material as a sound barrier, however, depends not only on its weight, but also on its bending stiffness. If the barrier is too stiff it can actually lose much of the advantage it gains by being heavy. This occurs because stiffness increases much more rapidly than weight as the thickness of a barrier is increased. The physical requirements for high transmission loss barriers are most effectively combined in thin lead sheet. Pound for pound, lead is a more effective sound barrier than any other conventional building material. For this reason acoustical barriers constructed of lead are invariably lighter and thinner than barriers of equal sound transmission class constructed of other materials.

This almost ideal combination of properties has been recognized for many years and the first uses of lead for acoustical purposes date back to antiquity. Lead sheet, however, was never used extensively due to the high cost of rolling the sheet to the thin gauges generally required. The recent development of a continuous lead sheet casting machine has significantly reduced its cost and made its application economically attractive. Recent research has resulted in the development of lead-containing high transmission loss barriers which are thin, lightweight, simple, and very easy to install.

Partitions and Walls

Lead sheet can be used in many thin lightweight partition systems to increase their sound transmission loss. It can be readily attached to other materials with elastomeric adhesives to add weight without increasing the stiffness. In this manner the maximum available improvement as predicted by the theoretical mass law for transmission loss can be obtained. Additional and sometimes spectacular benefits can be obtained if the material to which the lead is bonded has a coincidence effect in the speech range. In cavity wall constructions, the frequency at which cavity resonance occurs can often be shifted out of the range of interest by the use of a small amount of lead.

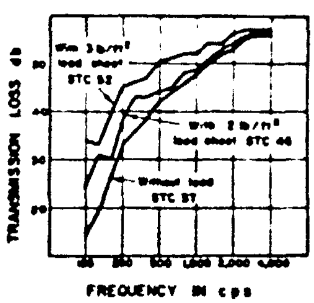

Fig. 1

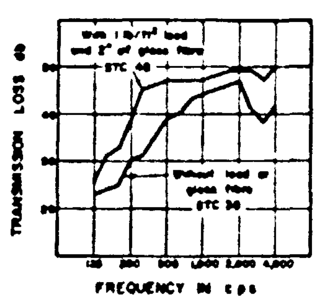

Fig. 2

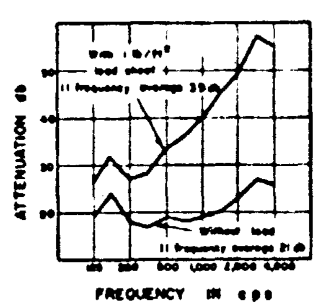

Fig. 3

Fig. 3
Attenuation of Low-TL Ceiling Board with and without Lead Ceiling Blanket. Tested by Geiger and Hamme Inc.
Insonorisation de carreaux acoustiques à faible facteur de transmission, avec ou sans coussin de plomb. Epreuves par Geiger and Hamme Inc.

Fig. 4
Transmission Loss of Low-TL Ceiling Board with or without Lead Plenum Barrier. Tested by Geiger and Hamme Inc.
Insonorisation de carreaux acoustiques avec ou sans coussin de plomb dans le plenum. Epreuves par Geiger and Hamme Inc.

Fig. 5
Recommended Method of Installation of Lead Plenum Barrier
Mode d'installation recommandé des feuilles de plomb pour plenum.

The effect of lead on two types of partition is shown graphically in Figures 1 and 2. Figure 1 illustrates the improvement obtained by the addition of lead to a 2½" thick movable steel partition. The acoustical ability of the partition without lead was restricted by the occurrence of a cavity resonance effect at about 125 cps. The incorporation of only 2 lb/ft² lead sheet (1/32" thick) into the internal construction of the steel partition by bonding to the inside of the metal skins with a rubber-based adhesive lowers the resonance frequency sufficiently to result in a significant increase in transmission loss. Further improvement is obtained by the use of a heavier weight of lead.

Another example of the efficient use of lead sheet is illustrated by Figure 2. In this case the gypsum board-steel stud wall is inherently weak at approximately 3000 cps due to the occurrence of a coincidence dip. The use of only 1 lb/ft² of lead (1/64" thick) has almost completely removed the coincidence effect and significantly increased the sound transmission class of the partition system. The result is a lightweight, low cost wall in the STC 45-50 range, suitable for offices requiring confidential speech privacy.

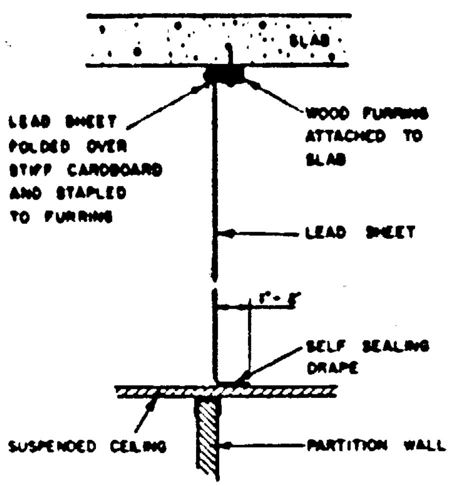

Fig. 5

Suspended Acoustical Ceilings

In many buildings the suspended acoustical ceilings which control reverberation and make speaking and listening conditions pleasant are responsible for low transmission loss between adjacent rooms or offices. The properties which make these materials good acoustical absorbers are their combination of lightness and porosity. It is this combination of properties which also makes these materials poor barriers to the transmission of sound. The use of thin lead sheet offers two simple but very effective methods of strengthening suspended acoustical ceilings to prevent the transmission of "over-the-ceiling" noise which is often the cause of speech privacy problems.

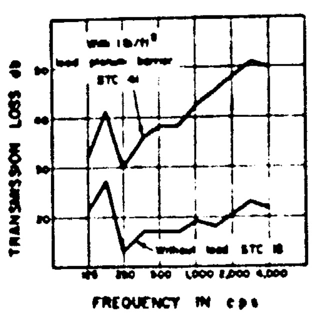

Fig. 4

Laboratory data for lead ceiling blankets and plenum barriers are presented in Figures 3 and 4. Both methods are equally effective, but the free hanging plenum barrier (Figure 5) is usually preferred because it uses less material and often costs less. Due to the inherent softness and ductility of thin lead sheet it can be easily cut and fitted around pipes and ducts or other obstructions in the plenum chamber to provide a tight barrier. Other materials used in this application are either more expensive or more difficult to install. If return air is not ducted a hole must be cut in the plenum barrier above the corridor partitions, having approximately the same area as the return air grille; this allows the return air to escape into the open plenum. The use of silencers at these openings is not usually required because the sound waves are forced to travel a relatively lengthy route to reach the adjacent offices.

The ceiling blanket arrangement is sometimes preferred if the plenum chamber is badly cluttered. The ceiling blanket can be laid directly over the light fixtures and actually assists in dispersing heat from the fixtures. If the return air is not ducted, it is often necessary to cover the ceiling grilles with hoods or cross-talk silencers.

Mechanical Noise Problems

A problem of major concern in modern high-rise buildings is the isolation of noise

Fig. 6
Schematic Drawing of Floor-Ceiling Construction Above and Below Mechanical Spaces.
Schéma de construction des planchers et plafonds au-dessus et au-dessous des chambres de mécanique.

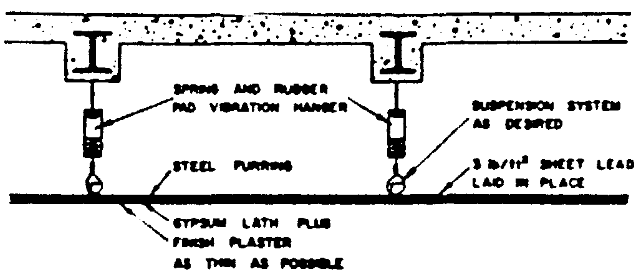

Fig. 6

generated in mechanical rooms located on the upper floors. The noise problem is often compounded by structural vibration; however, proper vibration isolation of the machinery is not always the complete solution. There are various ways of obtaining the required transmission loss between a machinery room and the floor below. Two common methods are the use of a thicker structural slab or the use of a floating slab. The floating slab is the more effective of the two, but its effect is mainly to increase the transmission loss between the machinery room and the area below, and it is still necessary to completely isolate all the machinery. As an alternative to these two methods of increasing airborne transmission loss, vibration isolated, high transmission loss ceilings incorporating thin lead sheet have been used effectively on several occasions. The use of this method has several advantages. It provides a further high transmission loss barrier in addition to the slab to which it is resiliently attached, plus a considerable air space. This effective combination provides increased sound transmission loss at minimum cost. Figure 6 illustrates schematically the floor-ceiling arrangement designed by Goodfriend-Ostergaard Associates, Cedar Knolls, New Jersey for the new Canadian Pacific hotel "le Chateau Champlain", now under construction in Montreal. Modified versions of this ceiling have been used with good results at CIL House in Montreal to isolate the machinery penthouse from the top occupied level,[1] and at Champlain School in Ottawa where a band practice room is located under the library.

Lead has also been used to quiet noisy duct work. The lead can either be adhered directly to the duct or used as an outer wrapping around fibrous material applied to the outside of the duct, depending on the gauge of metal which is used.

Acoustical Design of Private Offices and Small Conference Rooms

Good acoustical design is as important as aesthetic appearance in producing a pleasant environment in which people can work efficiently. They are not incompatible but if acoustics are ignored, even minor design details may result in major acoustical problems. Remedial action after construction is always expensive. The additional cost of effective sound control incorporated in the planning stage is a small part of the overall cost and will be repaid many-fold in occupant satisfaction.

A most important consideration in the design of private offices and conference rooms is the privacy requirements of the occupants. These requirements should be defined during the preliminary design stage and kept in mind when planning layouts and specifying components and materials. Another important consideration in the acoustical design of a room is the background noise level. Generally it is desirable to have the ambient noise level of a particular room as high as possible without letting it become a distraction in itself. The ambient noise has a beneficial effect in masking noise originating outside the room, but of course, it must not be high enough to interfere with normal conversation within the room, or make use

are generally designed in accordance with the data given in Table I.

Table II contains recommended transmission loss requirements for various degrees of privacy at two different levels of ambient or background noise assuming the use of an acoustical ceiling. The suggested STC ratings are based on a minimum office width of 10 ft and may require adjustment if

Table I. Noise Criteria for Different Types of Spaces

NC Curve	Typical Applications
NC-20 to NC-30	Executive offices and conference rooms for 50 people
NC-30 to NC-35	Private or semiprivate offices, reception rooms, and small conference rooms for 20 people
NC-35 to NC-40	Medium-sized offices and industrial business offices
NC-40 to NC-50	Large engineering and drafting rooms, etc
NC-50 to NC-55	Secretarial areas (typing), accounting areas (business machines), blueprint rooms, etc.
Above NC-55	Not recommended for any type of office

Reference: Lead Industries Association Publication *Practical Application of Sheet Lead for Sound Barriers* 1966.

[1] Lead Solves Noise Problem for Montreal Skyscraper, *Building Management*, December 1964

dimensions differ from this significantly or if carpeting is used. Any change which tends to increase the amount of absorption in a room with respect to the size of the common partitions will have a slightly beneficial effect on transmission loss.

Installed barriers frequently fall short of their laboratory performance rating since the ideal laboratory test conditions seldom exist in the field. This fact is particularly important when high transmission loss is required. An allowance of at least 5 db should be made when choosing a movable [illegible]

The variation is not so important when permanent walls are used as their installation more closely approaches the ideal. A more generous allowance of 7 to 10 db should be made when choosing the suspended acoustical ceiling since ceilings are tested in the laboratory without light fixtures or air returns.

When a particular office layout consists primarily of non-critical areas it may be economically advantageous to choose an inexpensive low transmission loss ceiling and then strengthen the ceiling above critical private offices by the use of either a lead plenum barrier or a ceiling blanket. Even when acoustical ceilings with high transmission loss ratings are used a plenum barrier or blanket is usually required to obtain the high transmission loss necessary for confidential privacy.

Table II. Recommended Transmission Loss for Different Types of Offices

Typical Applications	Hearing Conditions	Transmission Loss (STC) Background NC-25	Transmission Loss (STC) Background NC-35
Privacy not required. Partitions used only as space dividers.	Normal speech can be understood quite easily and distinctly through the wall.	35 or less	30 or less
Suitable for dividing non-critical areas. Provides fair degree of freedom from distrac-tion.	Loud speech can be understood fairly well. Normal speech can be heard but not easily understood.	35–40	30–35
Provides good degree of freedom from distraction. Suitable for junior executives, engineers, etc.	Loud speech can be heard, but is not easily intelligible. Normal speech can be heard only faintly, if at all.	40–45	35–40
Provides a confidential degree of speech privacy. Suitable for doctors, lawyers, senior executives, etc.	Loud speech can be faintly heard but not understood. Normal speech is inaudible.	45–50	40–45
Suitable for dividing private offices from noisy areas containing typewriters, telex, computers, etc.	Very loud sounds, such as loud singing, brass musical instruments, or a radio at full volume can be heard only faintly or not at all.	50 or more	45 or more

When high transmission loss walls and ceilings are used the effect of doors and other possible flanking paths for sound must be taken into consideration. When privacy is required in one office, the occupant cannot expect his neighbors to close their doors, and so either solid core or lead lined doors properly gasketed and fitted with drop seals must be used. If air is distributed through continuous perimeter convectors it is necessary to seal the convectors acoustically where they pass through the partitions. This can be accomplished by fitting thin sheet lead around the piping in the convectors. Lead can also be used effectively in filler panels above the perimeter convectors or between internal structural columns and window mullions.

A most important factor in the performance of an acoustical barrier is the care with which the installation is carried out. Failure to eliminate sound leaks through cracks around doors and perimeter joints will seriously jeopardize the performance of an otherwise good acoustical barrier. Even hair-line cracks may spoil a good barrier's effectiveness. A leak which constitutes only 1/10 of 1% of the area of concern will reduce the performance of a 45 db partition to only 30 db.

The dramatic improvement in noise control accomplished by the use of thin lead sheet in building partitions and ceilings has been illustrated in a few examples described in this article. While these have referred specifically to office buildings, similar problems exist in schools, apartment buildings, hotels and in private residences, where the use of high transmission loss partitions and ceilings containing lead may also provide the most satisfactory solution to noise problems.

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LIA14119

Useful Test Data

Frame or Core	One Face	Other Face	STC
Wood Stud Walls			
2 x 4 Wood Studs Fibreglass in cavity	½" gypsum board	½" gypsum board	37
2 x 4 Wood Studs Fibreglass in cavity	½" gypsum board 1 lb. lead stapled to studs	½" gypsum board 1 lb. lead stapled to studs	42
2 x 4 Wood Studs	⅝" gypsum board		38
2 x 4 Wood Studs	½" gypsum board plus 1 lb. lead (bonded)		31
Steel Stud Walls			
1⅝" Steel Studs	½" gypsum board	½" gypsum board	36
1⅝" Steel Studs Fibreglass in cavity	½" gypsum board plus 1 lb. lead (bonded)	½" gypsum board	43
2½" Steel Studs	½" gypsum board	½" gypsum board	38
2½" Steel Studs Fibreglass in cavity	½" gypsum board plus 1 lb. lead (bonded)	½" gypsum board	48
Steel Office Partitions			
Paper Honeycomb Core	22 gauge steel	22 gauge steel	34
Fibreglass Core	22 gauge steel	22 gauge steel	37
Fibreglass Core	22 gauge steel plus 1 lb. lead (bonded)	22 gauge steel	42
Fibreglass Core	22 gauge steel plus 2 lb. lead (bonded)	22 gauge steel	48
Fibreglass Core	22 gauge steel plus 3 lb. lead (bonded)	22 gauge steel	52
Doors			
Hollow Core Wood (with gasketing)	¼" plywood	¼" plywood	16
Hollow Core Wood (with gasketing)	¼" plywood plus 2 lb. lead (bonded)	¼" plywood	28
Hollow Core Wood (with gasketing)	¼" plywood plus 2 lb. lead (bonded)	¼" plywood plus 2 lb. lead (bonded)	31

How to Improve the Sound Transmission Loss of an Existing Wall	STC
Steel Office Partitions	34
1" x 2" furring screwed to steel partition. Laminate of 1 lb. lead and ¼" plywood attached to furring. Fibreglass in cavity.	41
1" x 2" furring screwed to steel partition. Laminate of 1 lb. lead and ½" gypsum board attached to furring. Fibreglass in cavity.	46
2" x 2" furring screwed to steel partition. Laminate of 1 lb. lead and ½" gypsum board attached to furring. Fibreglass in cavity.	50

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For additional information write to:

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