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Practical Application of Sheet Lead for Sound Barriers.
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Techniques for improving sound barriers through the use of lead sheeting are described. To achieve an ideal sound barrier a material should consist of the following properties--(1) high density, (2) freedom from stiffness, (3) good damping capacity, and (4) integrity as a non-permeable membrane. Lead combines these desired properties to a greater extent than any other common building material. The proper use of lead in combination with other materials can compensate for their deficiencies and improve the acoustical performance of the composite barrier. Three ways in which barriers are rated for their effectiveness are discussed and compared. Practical tips for designing better sound barriers as well as pitfalls to be avoided are listed. Design and construction information for installing practical lead walls is presented and guidelines are recommended. (TC)

A.I.A. No. 39
C.S.I. Div. 13

PRACTICAL APPLICATION OF SHEET LEAD FOR SOUND BARRIERS

- **LEAD IS AN EXCELLENT BARRIER MATERIAL for reducing the transmission of air-borne sound.**
- **LEAD IS TECHNICALLY SOUND because it combines high density, natural limpness, good damping capacity, and is non-porous.**
- **LEAD IS A WORKABLE MATERIAL since it is easily formed and fitted, requires no special tools, and can be readily adhered or fastened to other materials.**
- **LEAD IS ACOUSTICALLY GOOD because pound for pound it is a better sound barrier than any other conventional building material.**
- **LEAD IS ECONOMICAL because it is reasonable in cost, takes less space, often saves weight, is easy to install, and is salvageable.**

LEAD INDUSTRIES ASSOCIATION
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Look Ahead with Lead

C.S.I. Div. 13

Practical Sound Barriers Employing Lead

THE NATURE OF SOUND

The sounds we hear are the result of air pressure waves impinging upon our ultra sensitive ears. The frequency (pitch) of audible pressure waves ranges from 20-20,000 cycles per second. The intensity of these pressure waves in terms of their physical energy varies over a fantastic range and accordingly, it is expressed logarithmically in units known as decibels.

Sound can be pleasant, acceptable, tolerable, objectionable or injurious. Noise is unwanted sound and in today's society the control of noise is fast becoming a problem of major proportions. Unsuppressed noise can cause petty annoyance, loss of privacy, lowered working efficiency, higher accident rates and physical impairment of hearing.

The information presented here is concerned with air-borne noise rather than impact or structure-borne noise. Air-borne noise includes familiar sources such as the crying baby, TV & HiFi sets, loud conversation, office machines, motors, pumps, manufacturing operations, etc. It does not include noise from objects dropped or foot traffic on bare floors above, water hammer in pipes, vibration from heavy machinery or the rumble of a subway train, all of which are transmitted primarily through the ground or the structure involved.

The pressure waves in air-borne sound radiate in all directions from their source much like ripples in a pool radiate from a dropped pebble. These pressure waves will readily penetrate a porous barrier. They will also set a rigid barrier into unnoticed vibration which, in turn, generates new air-borne sound of lower intensity on the opposite side of the barrier. This is how sound "passes through" a wall.

WHAT CONSTITUTES A GOOD SOUND BARRIER

A good sound barrier wall is one which will reduce offending noise from adjacent areas to the level of the background noise normally present and accepted in the desired quiet area or to some slightly higher level which is still deemed acceptable to the occupant of the quiet area and which will provide speech privacy or freedom from annoyance or distraction. For example, an 80 db (decibel) noise impinging on a 30 db wall will generate a 50 db noise on the other side. If the normal and accepted level of background noise in the quiet area is 50 db, no annoyance will be experienced. If, however, the normal background noise level is 40 db, it will now increase to 50 db indicating that the barrier is inadequate.

The physical properties of a material or a composite wall that go to make up an ideal sound barrier are high density, freedom from stiffness, good damping capacity and integrity as a non-permeable membrane. Lead combines these desired properties to a greater extent than any other common building material. The proper use of lead in combination with other materials will compensate for their deficiencies and will improve the acoustical performance of the composite barrier.

HOW A BARRIER IS RATED

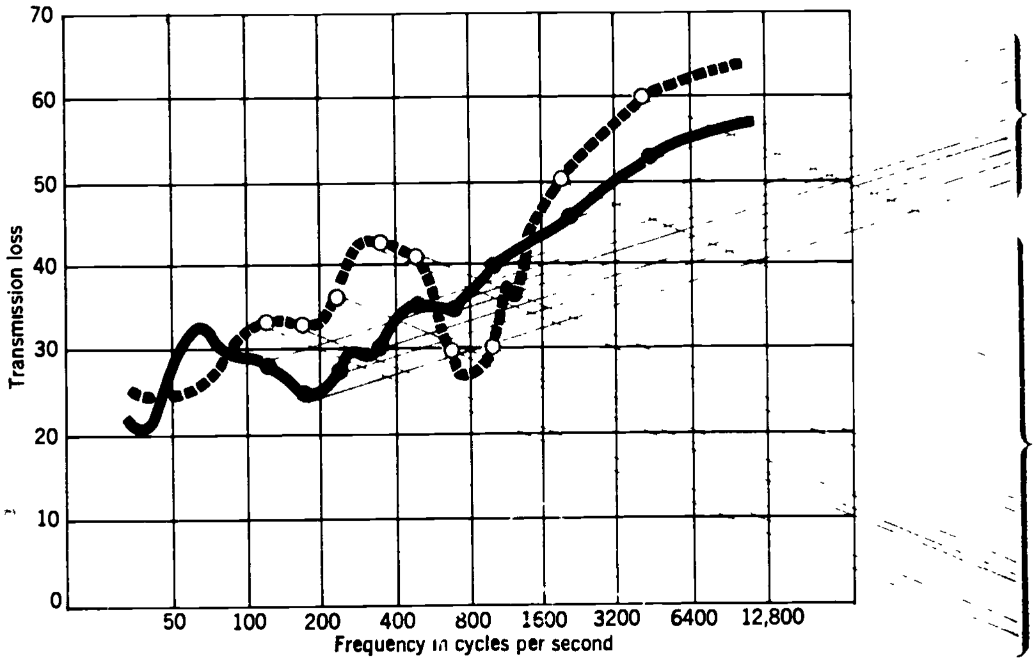
To select or design a barrier one must have a measure of its effectiveness. This is known as its Transmission Loss (TL) and represents the reduction in the level of air-borne sound transmitted by a given barrier as determined under controlled conditions. The TL is expressed in decibels as a single figure which, in turn, represents the arithmetic average of nine separate TL measurements taken at specified frequency ranges between 125-4000 cycles per second. This portion of the sound spectrum encompasses the frequencies most commonly encountered and most critical in effect upon speech intelligibility.

Transmission Loss is a fixed property of a barrier but varies with the frequency of the sound. The TL of all materials and barriers increases with frequency but at some point in the curve a plateau or dip will occur with most materials where the barrier develops traveling waves (like microscopic versions of the waves in a shaken rug) in sympathy with the disturbing sound waves.

When this "coincidence" occurs, the amplitude of vibration in the barrier increases and more sound is transmitted. Thus, in appraising the capacity of a barrier one should consider both the stated TL figure and the frequency plotting of the separate values that make up the figure.

Lead, by virtue of its limpness and density, does not exhibit this coincidence dip in the frequency range with which we are concerned. Thus, when properly combined with other materials, it will improve or dominate their inherent weak spots and improve the acoustical performance of the composite barrier.

Three Ways Barriers Are Rated

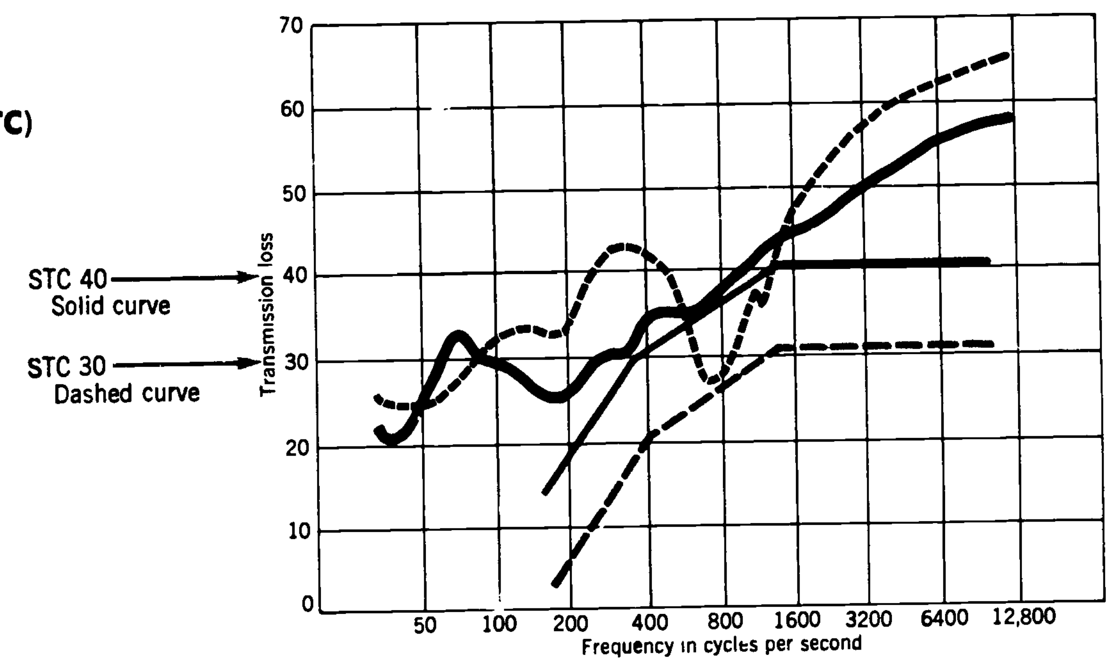


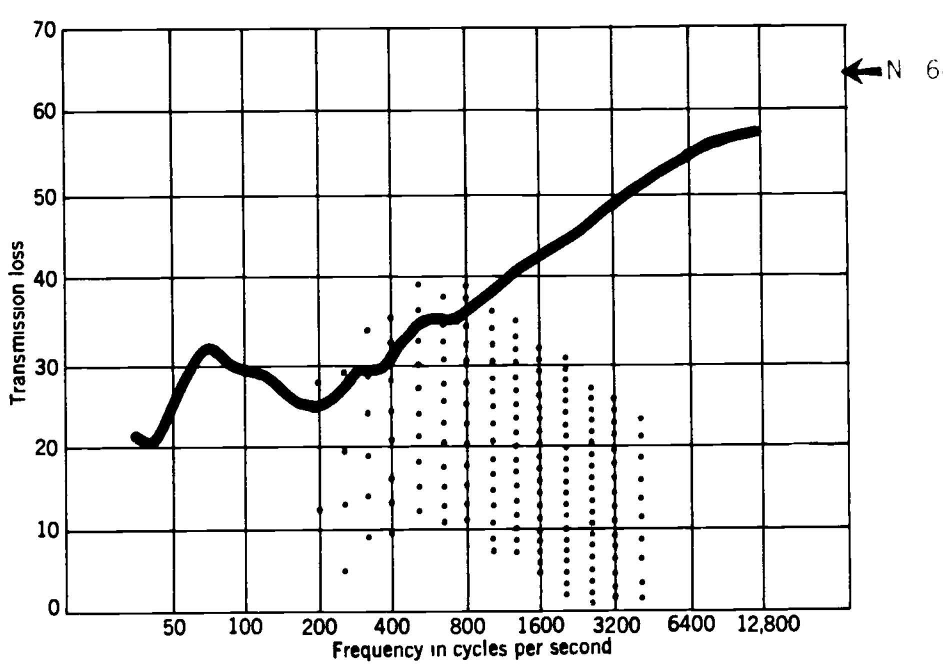
NINE-FREQUENCY AVERAGE

The average of the TL at nine specified frequencies (125, 170, 250, 350, 500, 700, 1000, 2000, and 4000 cycles per second) is the most usual rating for sound barriers. Note that the solid curve averages 35 db and the dashed curve averages 40 db on this basis.

SOUND TRANSMISSION CLASS (STC)

A standard STC "profile" can be located just under the performance curve so that the center section of the profile is just tangent to the curve. The two outer portions of the profile may average one db higher than the test curve. When this is done the high end of the profile is at the STC for the barrier. Note that the solid curve has a better STC than the dashed, even though its average performance is not as high.





PRIVACY ANALYZER

A standard "dot field" for one of several types of environment is adjusted over the test curve until exactly ten dots exceed the curve. The index of the dot field template then shows the privacy analyzer rating. In this case (same solid curve as above), the rating with an "N" dot field is 64.

A more recently accepted means of expressing the sound attenuation capacity of a barrier is known as the Sound Transmission Class (STC) number. This method has gained acceptance because it gives a more reliable single figure measure of barriers which have sharp dips in TL at certain frequencies.

There is a further improved method which expresses the adequacy of a barrier in the form of a specific Speech Privacy Index. It narrows the field of attention to the 200-4000 cps range, takes into account the type of background conditions and rates the barrier according to its capacity to shut out all but that portion of the sound which will be unintelligible on the receiving side. In ranking tests of various materials or panels for barrier performance, an arithmetic average of the noise reduction in the speech range from 200-4000 cps also provides a useful single figure rating.

The required index for a barrier in any given situation will depend upon the amount of background noise present, the degree of quiet desired, the amount of absorptive material present and the character and intensity of the offending noise.

For example in a typical private office without air conditioning and where reasonable quiet is desired, the partition barrier or wall should preferably have a minimum STC rating of 45 db. Recently revised F.H.A. minimum Standard Requirements for Apartment House construction call for party walls with higher STC ratings. See table, below.

FEDERAL HOUSING AUTHORITY "TABLE 4-6"

Sound transmission ratings for Partitions

Location of Partition	SOUND TRANSMISSION CLASS (STC)(1): Land-use intensity less than 6.0 (low background noise) (2) — Room adjacent to partition		Land-use intensity 6.0 or higher (high background noise) (3) — Room adjacent to partition	
	Bedroom (4)	Other	Bedroom (4)	Other
Living unit to living unit (5)	Class 50	Class 45	Class 45	Class 40
Living unit to corridor (6)	Class 45	Class 40	Class 45	Class 40
Living unit to public space (average noise) (7)	Class 55	Class 50	Class 50	Class 45
Living unit to public space and service areas (high noise) (8)	Class 60	Class 55	Class 55	Class 45
Bedrooms to other rooms within same living unit (9)	Class 45	NA	Class 40	NA

NOTES:

(1) Sound Transmission Class as determined by ASTM E90-61T.
(2) See M301 for Land-use intensity.
(3) Living units in buildings having year-round air-conditioning and in living units above the eighth floor, use column for Land-use intensity less than 6.0.
(4) Where bedrooms are separated from corridor or from adjacent living units with closets or storage walls, the effect of such noise attenuation may be considered in partition sound transmission.
(5) In high-rental apartments where an extreme tenant sensitivity is expected, an increase of 5 db over the values shown is recommended.
(6) These values assume floors in corridors are carpeted; otherwise increase 5 db. See M505-6 for corridor doors.
(7) Public space of average noise includes lobbies, laundries, storage rooms, stairways, etc.
(8) Areas of high noise include boiler rooms, mechanical equipment rooms, elevator shafts, incinerator shafts, garages and most commercial uses.
(9) Acoustic separation of bedrooms within living units is desirable, but not required.

Leaded Vinyl

Leaded vinyl sheet is a composite material comprising two vinyl sheets with a filler of lead powder embedded in vinyl. It is available in weights from ½ to 3 lbs. per sq. ft., up to ⅛" in thickness and is completely limp in the acoustical sense.

Where sheet lead and conventional constructions are ruled out, flexible leaded vinyl sheet has often answered. Its performance as a free-hanging septum is given by the curves in plate 5, page 7 and in the table

PITFALLS To

The installed barrier when tested in place will frequently fall short of its TL or STC rating. This can be due to faulty installation in failing to eliminate sound leaks in seams, doors, and perimeter joints. In many cases this lowered performance stems from the existence of numerous flanking paths through which the sound waves can circumvent the barrier wall. Common flanking paths include windows, back to back electrical fixtures, medicine cabinets, convector panels, cracks or leaky wall joints, door louvres, heating ducts, an open plenum above a hung ceiling, low TL doors in a high TL wall etc. Failure to apply relatively simple corrective measures to these common defects can seriously jeopardize the performance of an otherwise good barrier.

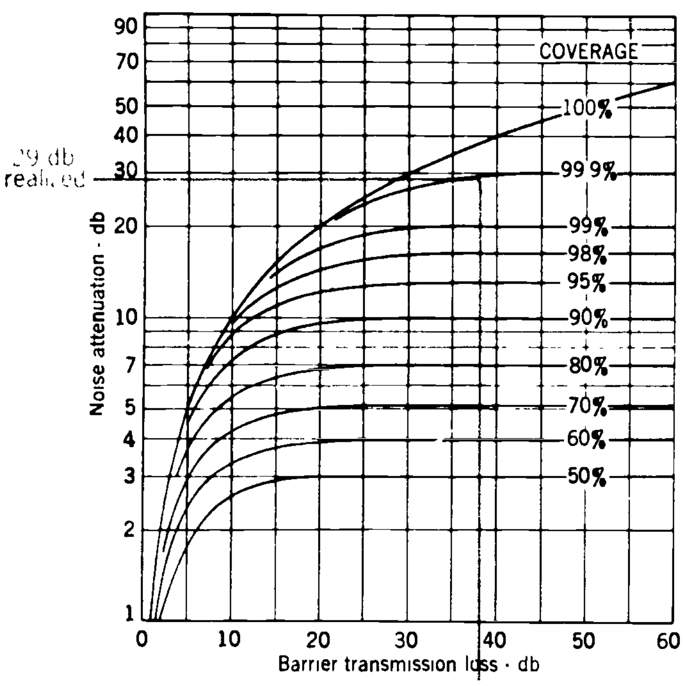
Even hairline cracks can spoil a good barrier's effectiveness. As the example shows, if leaks constitute 1/10 of 1 per cent of the area, a barrier with a potential TL of 38 db can only deliver 29 db.

Barrie...

under section 5, page 8.

While it is an expensive material, relative to sheet lead and other building materials, its use is often the least expensive way of solving a problem and not infrequently the only practical solution. One great convenience to the architect or designer is the wide variety of colors, embossed textures, or printed surface patterns available. It has a durable surface and can lend a handsome finish to the treated or covered area.

Be Avoided



PRACTICAL TIPS

For Better Sound Barriers

Acoustical theory shows the importance of *mass, limpness,* and *internal damping*. Field experience shows the vital importance of freedom from leaks. The practical tips listed here are based on experience and translate these theoretical factors into how-to-do-it information.

The importance of MASS

- A heavy wall is normally a more effective barrier than a light wall.
- The weight of lead in a composite skin should equal and preferably exceed that of the other material in order to offset the coincidence.

The penalties of STIFFNESS

- As a wall is made stiffer, the likelihood of problems with a coincidence dip increases.
- The presence of studs fastened directly to surface skins increases the stiffness of a wall and increases transmission of sound.
- Resilient mounting of surface skins is helpful.
- Thin skins are preferable to thick.
- Thin sheet lead applied to thin panel skins can solve coincidence problems and reduce drumming noise.
- Viscoelastic adhesives are better than rigid varieties for laminating leaded panels.
- Intermittent attachment or free hanging lead sheet can be beneficial.
- Stiff components of a composite panel are best located near the center or neutral plane.
- Leaded panel skins in double walls are frequently a more effective barrier than stiffer, heavier and thicker conventional wall board or plaster skins.

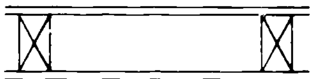
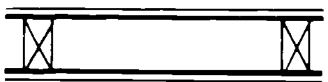
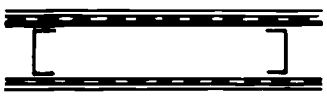
What to do about LEAKS

- Air leaks in walls thru convectors, back to back electrical fixtures, wire raceways and the like should be plugged with fibrous material and a septum where required.
- Wall or panel joints must be tight. Gasketing or calking is most effective.
- Never underestimate the importance of small air leaks.
- A thin lead membrane sealed at the edges is impermeable to air.
- Plenum barriers are essential over partitions which stop at a hung acoustical ceiling. Free hanging thin lead sheet is a most effective barrier and simple to install.
- Lightweight low-cost acoustical tile can acquire barrier capacity by an overlay of thin lead sheet.
- Gaskets are a must around door openings.
- Hollow core doors should be avoided. The same is true of louvres.
- If in doubt about potential leaks, gasket, calk, or tape during construction.

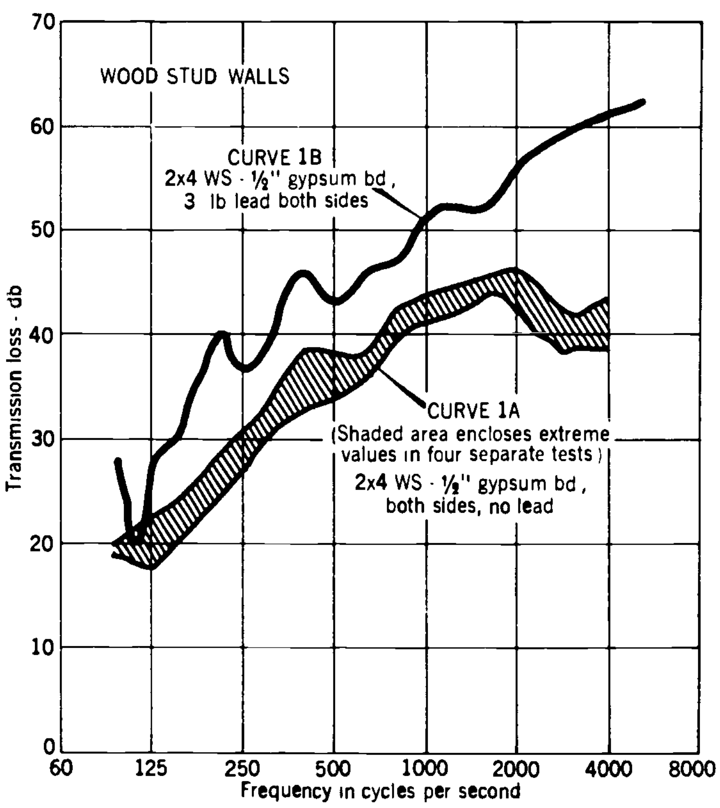
Other considerations

- A double wall is far more effective than a single one, even when the total weight is no greater.
- Increasing the air space between skins will improve results particularly in conjunction with a filler or fiber glass, mineral wool or other fibrous material.
- Inadequate existing walls can be substantially improved by adding a supplemental wall comprising a thin overlay of absorptive material and a leaded decorative surface skin.

Tabulation of Practical Soun

Curve No.	Frame or Core	One Face	Other Face	Nom. Wt. (psf)	125	170	250	350	500	700	1000	2000	4000	Average TL (db)	STC	Remarks
	WOOD STUD WALLS															
	 2 x 4 Wood Studs	½" gypsum board	½" gypsum board	5½	(maximum and minimum values) 22 / 17	26 / 22	31 / 27	37 / 32	38 / 35	40 / 37	44 / 41	46 / 43	43 / 39	35	40	Riverbank
	 2 x 4 Wood Studs	½" gypsum board plus 3 lb lead	½" gypsum board plus 3 lb lead	11½	28	35	36	45	43	47	51	56	61	44	47	Riverbank
	STEEL STUD WALLS															
	 1⅝" Steel Studs	⅜" gypsum lath plus ½" plaster	⅜" gypsum lath plus ½" plaster	13¼	27	32	37	41	43	44	46	39	47	39	41	Catalog data
	 1⅝" Steel Studs	⅜" gypsum lath plus ½" plaster plus 3 lb lead	⅜" gypsum lath plus ½" plaster	16¼	35	38	43	46	45	47	47	49	58	45	43	Riverbank
	 1⅝" Steel Studs	⅜" gypsum lath plus ½" plaster plus 3 lb lead	⅜" gypsum lath plus ½" plaster plus 3 lb lead	19¼	36	40	45	47	47	47	49	53	61	47	47	Riverbank

1



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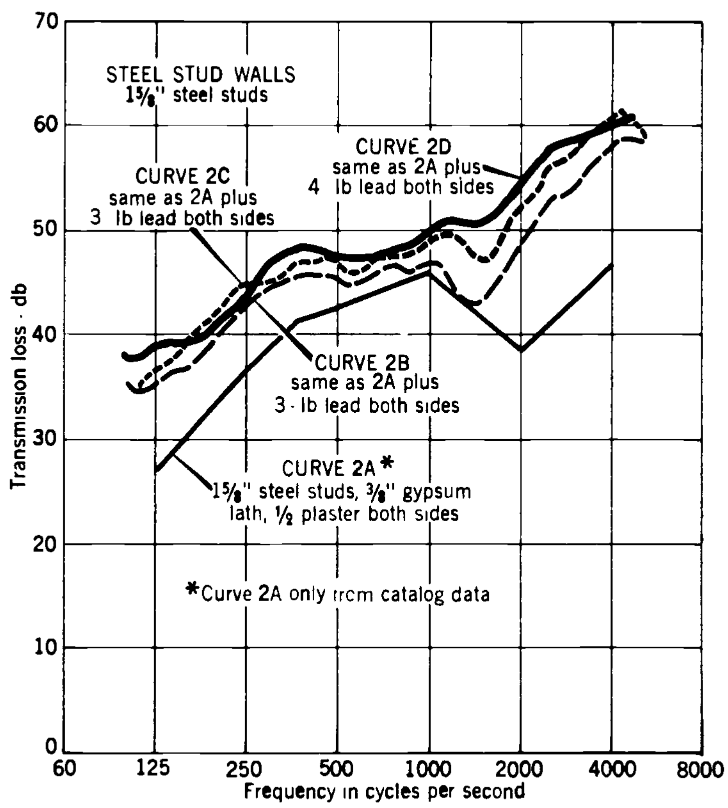
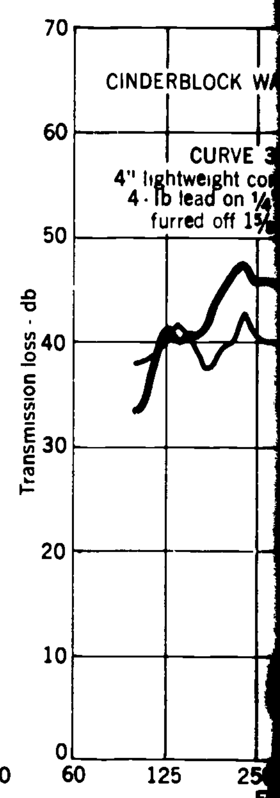
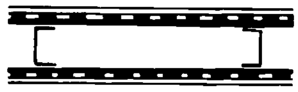




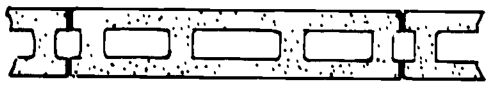
nd Barrier Walls Using Sheet Lead

Curve No	Frame or Core	One Face	Other Face	Nom. Wt. (psf)	125	170	250	350	500	700	1000	2000	4000	Average TL (db)	STC	Remarks
	DESCRIPTION				Transmission loss at stated frequency											

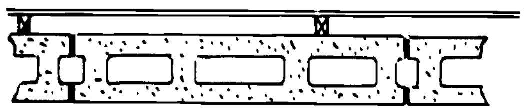


	1⅝" Steel Studs	⅜" gypsum lath plus ½" plaster plus 4 lb lead	⅜" gypsum lath plus ½" plaster plus 4 lb lead	21¼	39	40	44	48	48	48	50	55	60	48	50	Riverbank

CINDERBLOCK

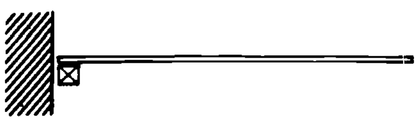


	4" lightweight cement block	paint	paint	—	40	38	40	38	40	45	48	55	56	45	44	Riverbank test. Much lower TL is typical for installed walls because of leaks.



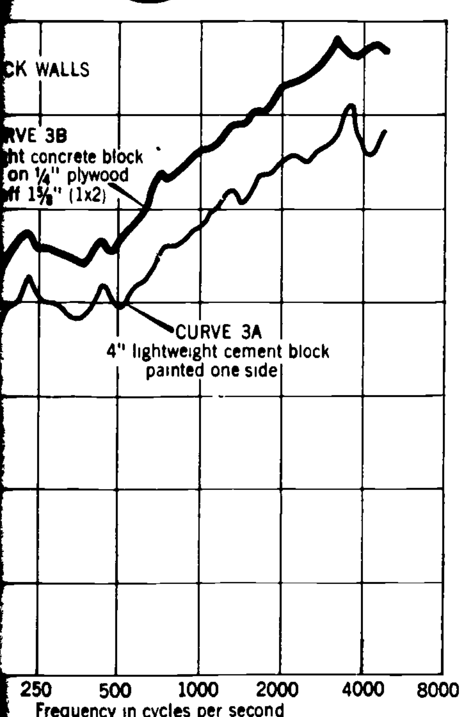
	4" lightweight cement block	none	4 lb lead on ¼" plyon 1 x 2 furring	—	41	43	46	44	47	54	56	63	67	51	49	Riverbank

PERIMETER FRAMED PARTITIONS AND MACHINERY ENCLOSURES



	Wood perimeter frame	⅜" plywood	none	1¼	18	18	16	21	21	24	25	27	22	21	24	Riverbank

3



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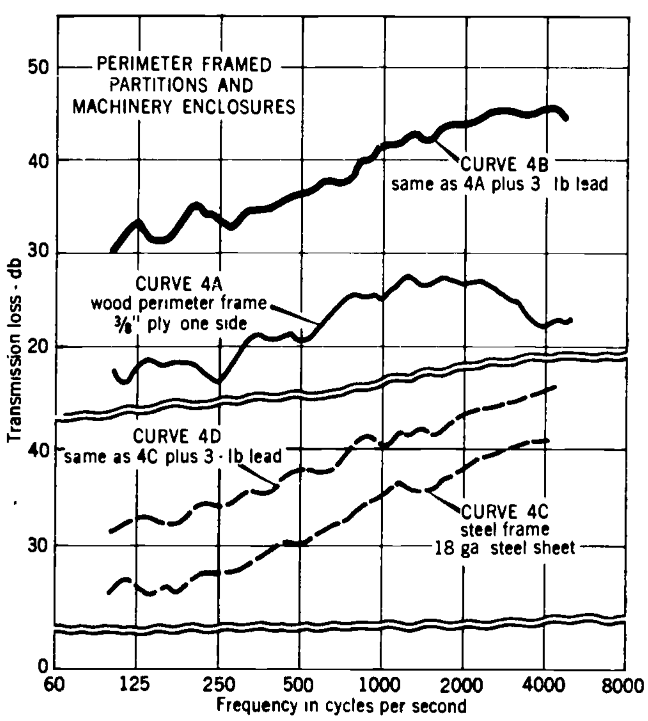

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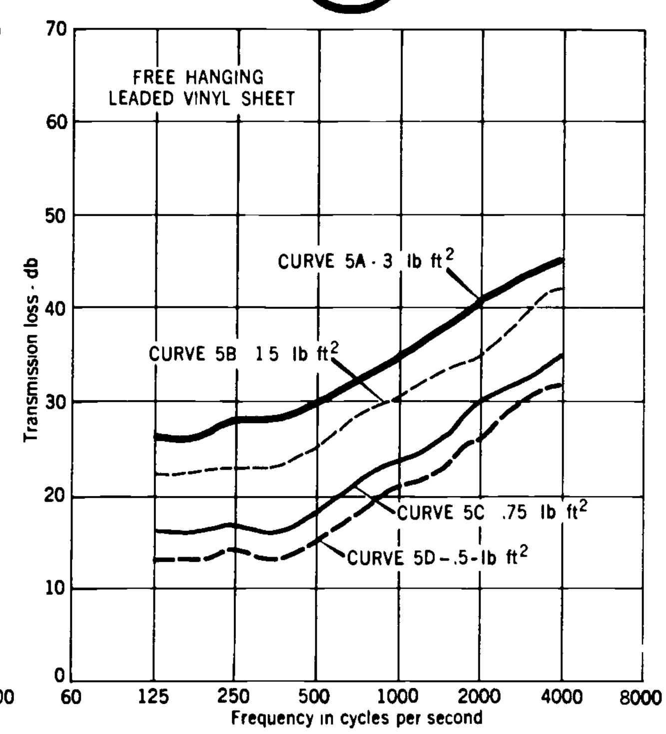
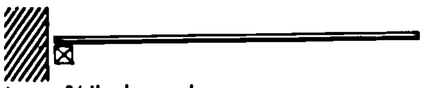
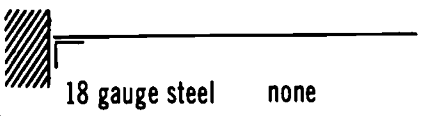


Tabulation of Practical Sound Barrier Walls Using Sheet Lead

(continued)

Curve No.	DESCRIPTION: Frame or Core	One Face	Other Faces	Nom. Wt. (psf)	Transmission loss at stated frequency: 125	170	250	350	500	700	1000	2000	4000	Average TL (db)	STC	Remarks
	PERIMETER FRAMED PARTITIONS AND MACHINERY ENCLOSURES															
	 Wood perimeter frame	⅜" plywood plus 3 lb lead	none	4¼	33	33	34	35	37	38	41	44	45	37	40	Riverbank
	 Steel angle and channel frame	18 gauge steel	none	2	26	25	27	23	30	32	35	38	41	31	33	Riverbank
	 Steel angle and channel frame	18 gauge steel plus 3 lb lead	none	5	33	32	34	35	38	39	41	44	46	38	40	Riverbank
	LEADED VINYL SHEET															
	Free-hanging leaded vinyl sheet			3.0	26	26	28	28	30	32	35	41	45	32	34	Riverbank
	Free-hanging leaded vinyl sheet			1.5	22	22	23	23	25	29	30	35	42	28	28	Riverbank
	Free-hanging leaded vinyl sheet			.75	16	16	17	16	18	21	24	30	35	22	22	Riverbank
	Free-hanging leaded vinyl sheet			.50	13	13	14	13	15	18	21	26	32	18	18	Riverbank
	DOORS															
	Hollow core wood (with gasketing)	existing	existing	2	14	12	12	15	12	19	24	27	28	18	16	Tested at Goodfriend-Ostergaard Associates
	Hollow core wood (with gasketing)	2 lb lead plus ⅛" plywood	existing	4.3	23	20	21	27	23	28	29	31	32	25	26	Tested at Goodfriend-Ostergaard Associates
	Hollow core wood (with gasketing)	2 lb lead plus ⅛" plywood	2 lb lead plus ⅛" plywood	6.6	21	23	26	30	28	29	32	33	35	28	31	Tested at Goodfriend-Ostergaard Associates
	Solid wood core door	existing	existing	—	23	31	23	26	28	21	29	27	35	27	23	Tested at Goodfriend-Ostergaard Associates

Design and Construction of Practical Leaded Walls

Better leaded walls are being developed and built every day. The limits of performance for new combinations of materials and methods of construction have surely not yet been reached. Therefore, this section offers no last word on good design and construction. It is intended, rather, to suggest to the designer and builder some guide lines for improving the performance of sound barriers.

Preparing sheet lead for use. Because it is a soft, limp material, lead is usually shipped in rolls. It is easily flattened by unrolling it on any clean, smooth surface. Where necessary, kinks or wrinkles may be removed by use of a roller or dressing with a padded block or small sandbag.

If the lead is to be mechanically fastened or hung loosely it is now ready for use. If it is to be mounted with an adhesive, the oil film present on rolled sheet lead must be removed. A solution of trisodium phosphate or any heavy duty alkaline cleaner does this quickly. Traces of the alkali are best flushed off with warm water. Solvent degreasing can also be employed. Continuous cast lead sheet has no oil film and requires no treatment.

Mechanically fastened construction poses no special problems. Because lead is soft, it should not be nailed or screwed without some sort of bearing pad to distribute the load. Otherwise it is liable to tear. It can be nailed through a batten or secured by screws with large washers, etc. It is also good practice to use a cement or calking compound to "butter" studs or furring strips which will receive sheet lead. Where the calking or adhesive has some strength, sheet lead can be nailed to the wood grid without any load distributors.

Lead adhesively bonded to a supporting panel is usually more convenient to work with and provides excellent acoustic results. Viscoelastic adhesives (rubber base "Contact" and similar types) give an added bonus with lead by aiding in damping panel vibration. Once the lead has been prepared for lamination the adhesive can be used following the manufacturer's directions. Wire brushing the lead will improve the adhesive bond.

Lead can be readily adhered to thin panels of plywood, hardboard, gypsum or asbestos cement board for use as a sub-assembly in finishing the wall. Such lead laminates can be worked with the tools appropriate to the base stratum and represent the easiest method of physically getting the lead into the wall. The use of lead sheet of equal or greater weight than the substrate will usually entirely eliminate the coincidence dip found in all conventional panel materials.

To get the best acoustical performance from any wall there are four cardinal points to be observed:

• **Plug all leaks.** The amount of sound that can leak through the tiniest gap or crack is unbelievable. The penalty imposed by these leaks becomes much greater as the wall's performance is improved. It is obviously unwise to jeopardize the improved performance of a leaded wall by neglecting to eliminate the leaks. When in doubt, use a gasket, tape, calking compound or paint. Designing skill and meticulous care in actual construction are absolutely necessary.

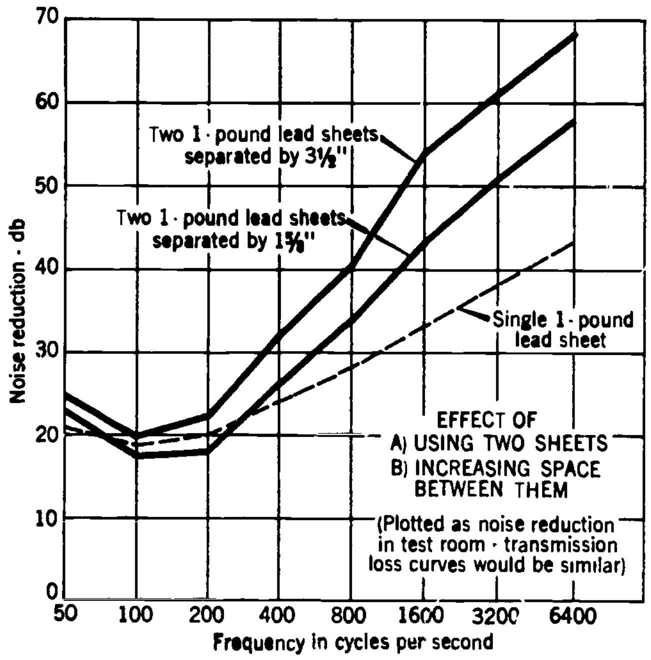
• **Always avoid construction details that needlessly stiffen the wall.** Part of lead's effectiveness comes from its limpness. If lead is rigidly adhered to a stiff wall, the improvement it affords will be minimal. In using lead to improve a cinderblock wall, for example, it is first adhered to 1/4" plywood or other surface skin and then installed on furring strips away from the wall. This has been shown to give a 6 db improvement.* Adhered directly to a leak-free stiff wall of this type, the same lead would have produced a negligible improvement.

In solid walls, where there is no isolating air space to allow the lead to assume its natural limpness, place the stiffest materials near the core of the wall, the more flexible near the surfaces.

* See curve 3B, page 7.

• **Provide an inner air space when wall thickness allows.** The same weight of materials properly split into two separate layers and separated will nearly always outperform a single solid wall acoustically. The more air space between the layers, generally, the better the result will be. There can be exceptions to this when the two layers are so mechanically tied together that they act as one. In this case the stiffness will be much greater and the wall will suffer. The common 2 x 4 stud wall is a case in point. Thin double wall surface skins of plywood, hardboard or gypsum board when backed with light gauge lead sheet will give better performance than unleaded skins of any single material of equal weight. Staggered studs and/or resilient ties between the two faces of the wall will provide further improvement for such walls.

• **Absorption inside hollow walls boosts the TL.** The hollow cores described above can act as resonating chambers unless they contain sufficient absorptive material. Inexpensive glass fiber or mineral wool batting in these spaces, particularly when in contact with the lead backed panel skins, will provide substantial improvement. It also provides some damping which improves the wall's impact noise behavior and helps produce the characteristic deadness associated with soundproofing.



Lead Plenum Barriers

Thin sheet lead makes an excellent plenum barrier and is simple to install. Inexpensive wallboard has frequently been used above the partition to carry it to the slab. A well-installed barrier of this type can be adequate though it is expensive in view of the labor needed to get the required fit around piping, wiring, ducts, etc. In practice a good fit is seldom achieved and thus the effort is wasted. A less expensive method employing thin lead sheet produces better results.

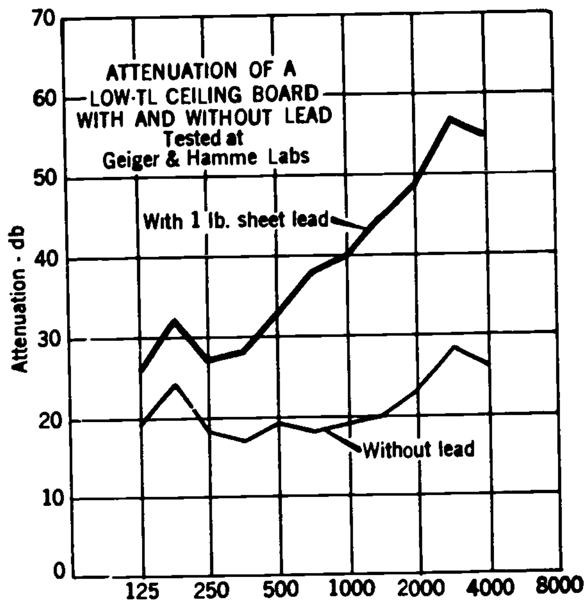
BLOCKING THE PLENUM PATH

Wherever partitions between rooms stop short of the slab above leaving a space or plenum between the hung ceiling and the slab, there is a potential sound path through this space. Since this common construction usually makes use of a lightweight acoustical ceiling, the flanking through the plenum is usually quite serious. Ceiling tiles and other acoustic surfacing materials are light and porous—as they must be to fill their role of *absorbing* sound generated in the room. It is this property that brings about the muted or hushed quality in the room in which the noise is being produced. But lightness and porosity necessary for absorption cannot fill the need for a barrier material. Thus it is relatively easy for noise to pass through one ceiling, bounce from the slab, and enter a nearby room through its ceiling.

Thin sheet lead is an economic and convenient material to use in blocking the plenum path. There are two methods by which it can be applied. It may be laid over the ceiling tiles or it may be used as a curtain to continue the vertical partition from the hung ceiling to the slab. The first method is usually called an "over the ceiling" barrier; the second, a plenum barrier.

Ventilation and lighting systems, as well as construction details of the ceiling will usually govern the choice between these two methods. The ease of cutting and forming the thin sheet to achieve a good fit around lighting fixtures, sprinkler heads, piping and conduit, etc., makes application fairly simple and inexpensive.

Over the ceiling barriers of one pound lead were tested under standard conditions with a ceiling of lightweight (0.6 pounds/sq ft) ceiling tile. The attenuation was improved from 21 db to 39 db in this test. See figure at right.



INSTALLATION PROCEDURE

For barriers with no penetrations

Attach wood cleat or metal partition ceiling channel to underside of floor slab. Cut desired length of lead sheet several inches longer than plenum height. Fold 1" of top edge over thin fiber board, wood batten or gypsum board strip 1" wide.

Fasten to cleat with heavy duty staples on 4" centers through 2 thicknesses of lead and the batten strip, or with round head screws and 3/4" flat washers on 8" centers to metal channel.

Push top edge of lead against ceiling slab.

Overlap vertical edges 1".

Turn up overlapping edges and fold into a tight standing seam.

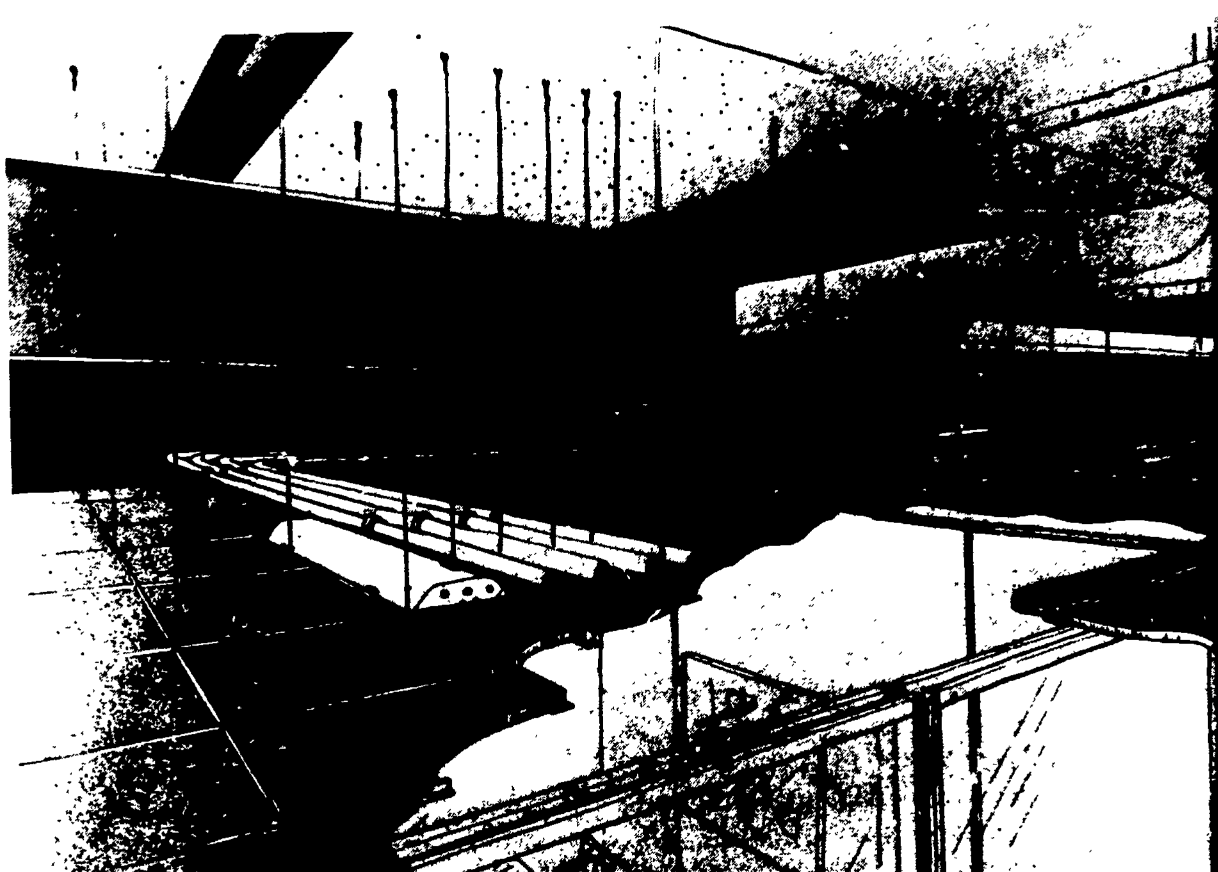
Drape of 1" will self-seal at bottom. Apply tape if desired.

For penetrations up to 2" in diameter

Fold a vertical 1" tuck in the lead 1" beyond the center line of penetration in direction of work.

Slit the tuck the shortest distance from top or bottom to point of penetration.

Snip or cut the tuck at the location of pipe or wires.



Drape the barrier foil over the pipe or wires. Squeeze-fit the lead around pipe or wires. Tape if desired.

Fold over the slit edges of the tuck and form a tight standing seam.

For small circular or square penetrating ducts

Fold a vertical tuck and slit as above.

Make two diagonal cuts in the tuck at penetrat... point to accommodate size of duct.

Fold the pie-shaped flaps against the duct and tape in place.

For large rectangular ducts

Drape the barrier foil from the cleat onto the top of the duct.

Fold top edge of a shorter barrier sheet over a batten strip and fasten to bottom of duct with sheet metal screws and washers on 8" centers.

Make usual standing seams at vertical edges of duct and tape the flaps to the duct edges.

Lay a few feet of barrier foil on top of the duct on both sides of partitions to reduce drumming noise.

For patching holes

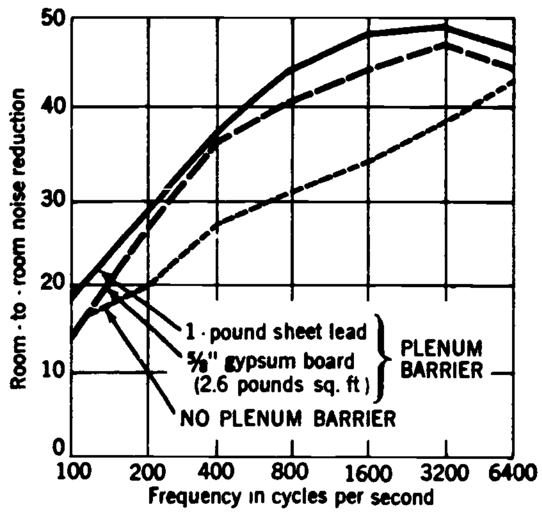
Cut a piece of barrier lead 4" larger in all dimensions than the hole. Turn up 1" of the lead barrier all around the hole and also on the patch. Insert and fold edges together and crimp to form standing seams.

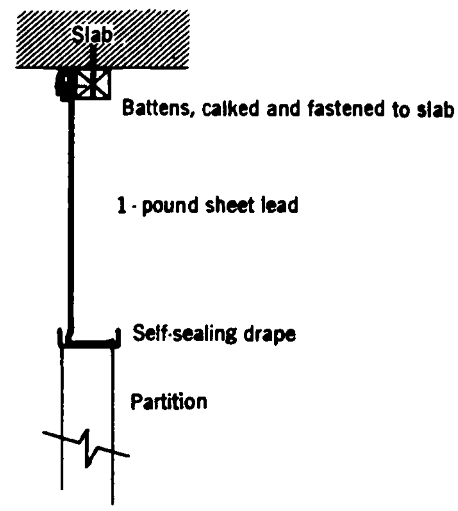
For spaces with critical requirements

Lay additional lead barrier with 1" overlap over the acoustical ceiling tile in the area 6 ft. from the partition in the noisy room.

Precautions to keep in mind

Be certain that the top edge of the lead barrier is folded over a batten strip or other smooth edge, cleat or bracket so that the sheet is fully supported across its width rather than just at points of attachment. This will effectively eliminate any danger of tearing at fasteners.





Miscellaneous Helpful Information

WEIGHTS OF MATERIAL

Weights given are average

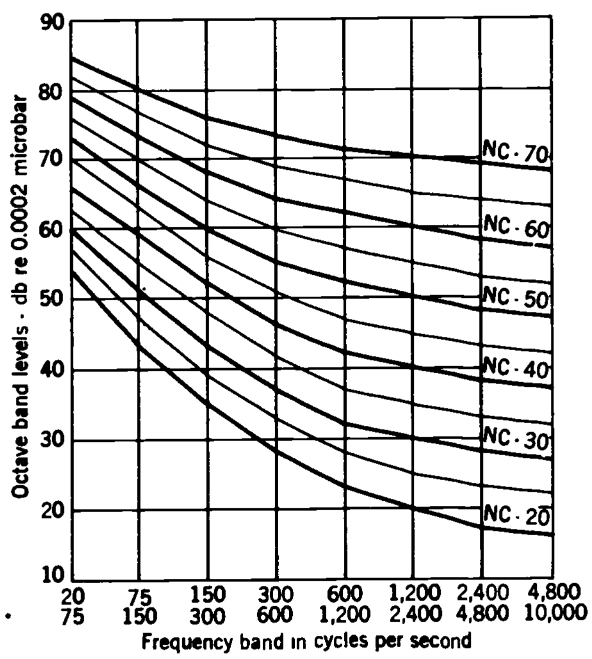
MASONRY & CONCRETE MATERIALS	LBS. per CU. FT.
Cinders or ashes	40-45
Granite, without mortar	158-168
Limestone, marble, without mortar	165
Sand or gravel, dry & loose	90-105
Sand or gravel, dry & packed	100-120
Sandstone, bluestone, witn mortar	147
WOOD (12% MOISTURE CONTENT)	
Birch, red oak	44
Cedar	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 & PLASTER	LBS. per CU. FT.
Plaster	96
EXTERIOR WALLS & WALL MATERIALS	
Masonry (Incl. mortar; no plaster unless noted)	lb/sq. ft.
4" brickwork	35
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 & plaster, 2" x 4" wood studs	14-16
Plaster	4-5
2" Solid plaster partition	18

WHAT TRANSMISSION LOSS IS REQUIRED?

Ideally, each acoustical problem would be solved by measuring the level of background noise and the level of the noise to be shut out or contained by the barrier. The transmission loss of the barrier, at each frequency, would then have to be at least the difference between allowable background level and the level of disturbing noise.

The allowable background noise is often distributed over the frequency spectrum with most of the sound energy at low frequencies. In other words, the normal noise background — the combined noise of traffic, air diffusers, distant and unintelligible conversation, etc.— is somewhat predictable. Where no specific data is available, a "normal" background can be assumed. The NC, or Noise Criteria, curves shown here are very commonly used to represent background level. The accompanying



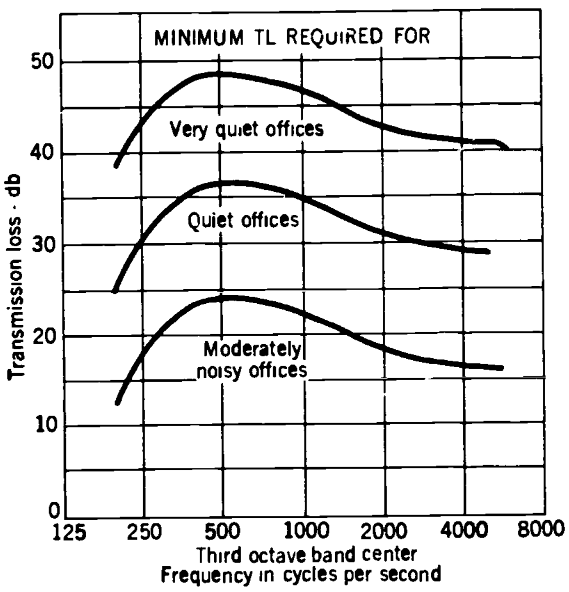


table gives a rough gauge of background level by listing the NC curve which commonly applies to several locations.

Where intense noise—as from a piece of machinery—is anticipated, it is usually possible to get information from the manufacturer about the noise levels it will produce. This can vary widely between manufacturers. Garbage disposal units, for example, manufactured by two companies had noise ratings (overall) of 76 and 85 db. Similar discrepancies are often found between different make' of pumps, fans, air conditioners and office machines. Care in purchase and installation of such equipment will help reduce the problems of sound transmission.

Where it is impossible to pin down source levels, there are data based on past studies which can be used. The curves (see above) and Table (see below) represent such "average requirements."

Properly designed barriers will reduce the sound transmission to acceptable levels.

What to do about leaks. The unaided ear held close to but not touching the walls can locate leaks rather well. Better still, a doctor's stethoscope, with the head removed so that the open rubber tube can be moved along over cracks or joints, will locate leaks accurately.

Most such leaks will be gaps or cracks and the remedy is calking, spackling, or plugging with an appropriate material. Where the gap does not exceed about 1/16", duct sealing tape will do a credible job.

Where no gap or crack is present and the leaky area is large, suspect structural flanking by a nail or bolt, electrical box, piping, etc. There is often no simple solution to such built-in flanking. Isolating the offending structural elements with air or a resilient material is desirable but usually entails expensive alterations—they are best designed out of the wall to start and kept out by close policing during construction.

Painting and finishing lead poses one possible problem. The metal is soft and even though most paints adhere well, it can be cut or abraded by physical contact. Veneers, laminates, fabric finish, and other finishing materials are best used over exposed surfaces of lead. Where no physical contact is expected, lead may be painted with any quality paint.

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

TRANSMISSION LOSS OF WALL	HEARING CONDITIONS	RATING
30 db. or less	Normal speech can be understood quite easily and distinctly through the wall.	Poor
30 to 35 db.	Loud speech can be understood fairly well. Normal speech can be heard but not easily understood.	Fair
35 to 40 db.	Loud speech can be heard, but is not easily intelligible. Normal speech can be heard only faintly, if at all.	Good
40 to 45 db.	Loud speech can be faintly heard but not understood. Normal speech is inaudible.	Very good — recommended for dividing walls between apartments.
45 db. or greater	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.	Excellent — recommended for band rooms, music practice rooms, radio and sound studios.

Lead Industries Association
292 Madison Ave.
New York, New York 10017

Look Ahead with Lead

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