

Example Calculation - Sound Reduction by Increased Absorption

Given: Factory Building - Average Sound Level 92 dBA.

Concrete Block (painted) Building 140' x 50' x 20' high

Concrete Floor

Roof Deck - 2" TECTUM™ Roof Deck or 1½" Steel Deck

Wood Doors - 1 of 240 s.f. and 2 of 24 s.f. each

16 Windows - 12 s.f. each

Machinery, etc. - absorption 150 sabins

Personnel - 12 men

To Find Calculated Reduction in Sound Level

- List average absorption coefficient or NRC for each material (see pg 3 and 4).
NRC = The average of the four middle frequencies

	NRC
a. Block Walls (painted)	0.07
b. Concrete Floor	0.02
c. 2" TECTUM Roof Deck	0.60
or 1½" Regular Steel Deck	0.01
d. Doors	0.09
e. Windows	0.16
f. People - Average absorption about 4 sabins each	

- Total Absorption (in Sabins) is equal to the Surface Area x the Absorption Coefficient

Item	Area	Abs. Coeff.	Sabins
a. Block Walls	7500 s.f.	0.07	525
b. Concrete Floor	7000	0.02	140
c. 2" TECTUM Roof Deck	7000	0.60	4200
or 1½" Regular Steel Deck	7000	0.04	280
d. Doors	288	0.09	26
e. Windows	184	0.16	29
f. People - 12 x 4 Sabins each			48
Total Sound Absorption with TECTUM Roof Deck			5248
Total Sound Absorption with Steel Deck			1048

- Calculated Change in Sound Level

$$= 10 \log_{10} \frac{5248}{1048} = 10 \log_{10} \quad = 5.01$$

$$= 10 (0.690)$$

$$= 6.9 \text{ or } 7 \text{ dB}$$

4. Sound Level with TECTUM Roof Deck = $92 - 7 = 85$ dB
5. Other Roof Decks. Similar calculations show that 2" TECTUM roof deck would be 5 dBA quieter than plywood and 6 dBA quieter than precast concrete.
6. The use of TECTUM sound absorbent wall panels can reduce the noise level still further. They can be mounted on the walls adjacent to the production equipment or may be used around a particularly noisy machine.

Tectum Inc.
REVERBERATION TIME CALCULATION SHEET

Job: _____ Date: _____

Type of Room (Gymnasium, Auditorium, Pool, Deck, Sanctuary, etc.) _____

Room Dimensions: L = _____ W = _____ H = _____

Room Volume: (Vol. = L x W x H) _____ x _____ x _____ = _____ Cu. Ft. = V

	Type of Material	Absorption Coefficient	Area Sq. Ft.	Total Absorption
Ceiling	_____	_____	_____	_____
Floor	_____	_____	_____	_____
Walls	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Other	_____	_____	_____	_____
Surfaces	_____	_____	_____	_____
	_____	_____	_____	_____

Total Existing Absorption (add all totals above) = _____ sabins = A

Estimated Existing Reverberation Time, $T = \frac{0.05 \times V}{A} =$ _____ seconds = T

Desired Reverberation Time, DT = _____ seconds (you pick this)

Absorption Required, $AR = \frac{0.05 \times V}{DT} =$ _____ sabins = AR

Estimated Add'l Units of Absorption Needed AU - Absp. Req (AR) - Exist. Absp. (A)

AU = AR - A = _____ = _____ sabins

Estimated TECTUM* Panel Required for Additional Absorption Needed _____

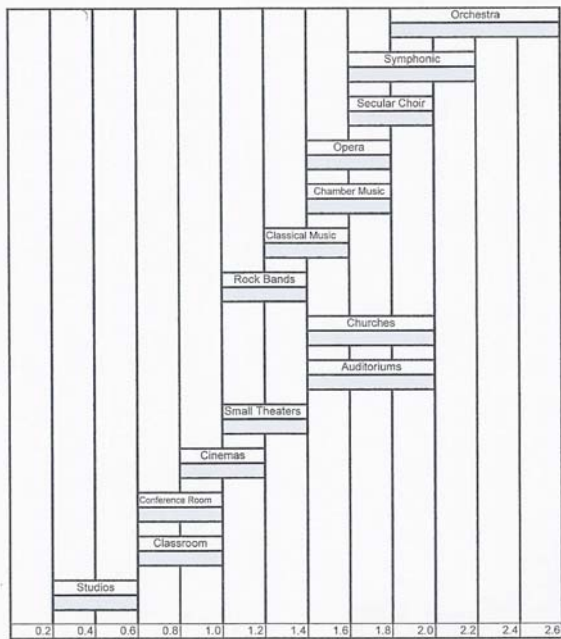
CAUTION: Actual field results may vary from estimated and calculated values. Calculations are based on recognized acoustical principles. Contact an acoustical consultant for additional information.

Reverberation

When the vocalist cuts off his note, the sound at the source will end immediately. The time delay in the ending of the direct sound from this note at the listener's position will be a function of the distance between the vocalist and the listener.

However, the sound waves which are already in the room will continue to travel back and forth between room surfaces, and a listener will hear them as a continuation, or echo, of the sound after it has stopped at the source. The sound waves lose energy by absorption at each successive reflection, and since this energy is no longer supplied by the source, the sound will die out gradually.

This prolongation of the sound after the source has stopped, due to continued multiple reflection, is termed reverberation. If sound dies out very slowly, a room is described as "live" or "excessively reverberant," and if it dies out very rapidly, a room is called "dead."



Recommended Optimum Reverberation Times for Various Room Uses.

Reverberation is an important factor governing hearing conditions and it has an important bearing on the "noisiness" of working areas.

Of special importance is its effect on the understanding of speech. If sound dies out very slowly in an auditorium used for speaking, the prolongation of each speech sound causes an overlapping and confusion of successive words or syllables which may render intelligibility extremely difficult or impossible. In rooms where quiet surroundings are desired, reverberation is annoying because it prolongs distracting noises.

Reverberation Time

The amount of reverberation in a room is measured by its reverberation time. This is defined as the number of seconds required for the energy of the reverberant sound in the room to die out to one millionth (or 1/10) of the value it had at the moment the source was cut off, which is the time it takes the sound to decay 60 dB.

The reverberation time is a basic acoustical property of a room which depends only on its dimensions and the absorbing properties of its surfaces and contents. In a typical room with normal acoustical treatment, the reverberation time is essentially the same throughout the room, regardless of the position of either the source or the listener; however, for unusual room designs, this may not be true.

The reverberation time as just defined corresponds roughly to the number of seconds which a sound of "average" initial loudness can be heard by a person with normal hearing acuity before it dies out to inaudibility under completely quiet conditions. This may vary typically from a fraction of a second in a very dead room to the order of 5 to 15 seconds in a very live room. Unfortunately in real life situations, most sounds are not of "average" initial loudness, and the background is never completely quiet. Therefore, it is difficult to roughly estimate reverberation time of a space by a subjective observation.

The reverberation time of a room, like the reflected sound energy, varies inversely with the room absorption, as defined above. However, reverberation time also varies directly with the volume and geometry of the room, being in general longer in large rooms and rooms with oblique angled surfaces. This follows from the fact that in a large room sound on the average travels farther between room surfaces, and therefore reflections and the accompanying absorption occur less frequently. Other complications occur in real life. Room shape can also enter into the picture. Long hallways or large rooms with low ceilings have grossly different reflection patterns than spaces that are more nearly cubic in shape.

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.

Material	NRC
Brick, painted	.00 - .02
Brick, unpainted	.00 - .05
Carpet, indoor-outdoor	.15 - .20
Carpet, heavy on concrete	.20 - .30
Carpet, heavy on foam rubber	.30 - .55
Concrete (smooth), painted	.00 - .05
Concrete (smooth), unpainted	.00 - .20
Concrete (block), painted	.05
Concrete (block), unpainted	.05 - .35
Cork, floor tiles (3/4" thick)	.10 - .15
Cork, wall tiles (1" thick)	.30 - .70
Drapery, light weight (10oz.)	.05 - .15
Drapery, medium weight (14oz.), velour draped to half	.55
Drapery, heavy weight (18oz.), velour draped to half	.60
Fabric on Gypsum	.05
Fiberglass, 3-1/2" batt	.90 - .95
Fiberglass, 1" Semi-rigid	.50 - .75
Glass	.05 - .10
Gypsum	.05
Linoleum on Concrete	.00 - .05
Marble	.00
Plaster	.05
Plywood	.10 - .15
Polyurethane Foam (1" thick, open cell, reticulated)	.30
Rubber on Concrete	.05
Seating (occupied)	.80 - .85
Seating (unoccupied), metal	.30
Seating (unoccupied), wood	.30
Seating (unoccupied), fabric upholstered	.60
Seating (unoccupied), leather upholstered	.50
"Soundboard" (1/2" thick)	.20
Sprayed Cellulose Fibers (1" thick on concrete)	.50 - .75
Steel	.00 - .10
Terrazzo	.00
Wood	.05 - .15